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AGRI MIRROR: FUTURE INDIA

A Voice for Agriculture

AIASA Agriculture Magazine

Climate Change and Food Security

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All India Agricultural Students Association

AIASA is a professional organization of present and former students in the field of Agriculture, Veterinary, Dairy, and horticulture, fisheries, forestry, Home science, sericulture, ABM and other allied sciences, registered under Societies Registration Act 1860. The Association was formally launched on 10th May, 2011 by the then Hon'ble Union Minister of State for Agriculture during the All India Convention on Agricultural Administrative Reforms and the website was launched by the Hon'ble Union Minister of Agriculture on the occasion of 87th ICAR Foundation Day on 25th -26th July, 2015 at Patna, Bihar.

The Society was registered on 1st Dec 2011 under the Societies Registration Act 1860, with the approval of Ministry of Agriculture, ICAR and Ministry of Consumer Affairs. Down the course of time, the drift between the technical work force and bureaucracy has increased abysmally harming the cause of farming sector and farmers at the national and state level. Policy making in agriculture has been largely limited to subsidies and loan disbursement, with negligible component of science in it.

AIASA envisions a common platform where Agriculturists/ technocrats and Bureaucrats will work together for the Indian agriculture with a "right person at right place" mode, to promote more application of science which is often left back. AIASA is established with the prime motto to bridge the drift and strengthen the voice of the agriculturalists, veterinarians, fishery experts and personnel of all allied fields at states, national and international levels.

AIASA advocates for resolving the long pending issues of creation of the All India Cadre of "Indian Agriculture Service" for appointment of right person at the right place and grant of professional status to agriculture sector at par with other professions for better job opportunities and career advancement of the personnel serving the primary sector.

The Society is covered for exemption from Income Tax u/s 80G(5)(vi) vide Order no DELAE27111-19092016 dated 19.09.2016.

Aims and Objectives

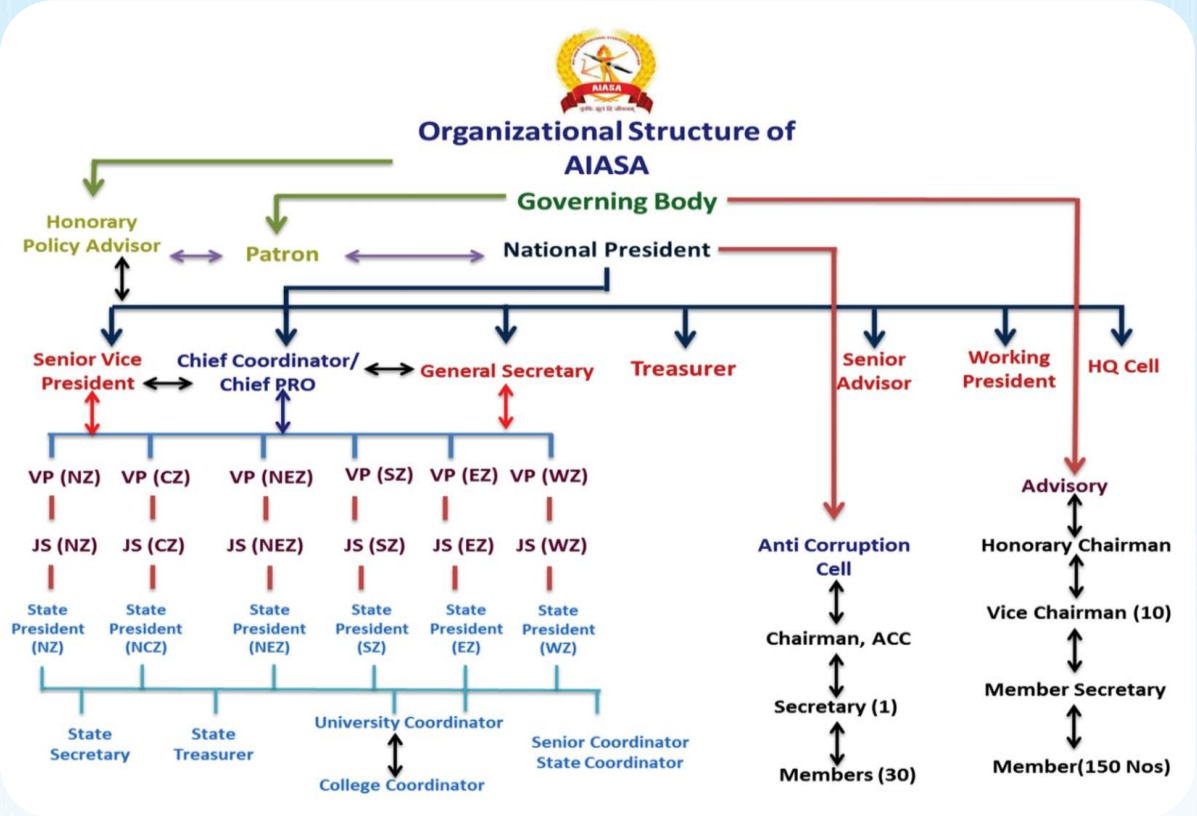
- To promote National Integration, Patriotism, Communal Harmony with the development of leadership among members.
- To facilitate and foster the bond between the students & professionals (Teachers, Scientists, Technical officials and Farmers /entrepreneurs).
- Professional status to Agriculture sector and to establish Agriculture Council of India (ACI) with need based administrative reforms.
- Creation of Central/Indian Agriculture Services.
- Granting UPSC status to ASRB for recruitment under Indian Agriculture Services.
- To make efforts for improving the job opportunities by having specialized cadre for agriculture services in center & state.
- Introduction of Agriculture course in CBSE, ICSE and state boards at school levels.
- Granting Fellowship to Agricos on par with UGC, CSIR, DST etc. fellowships.
- To represent the students in the national and international policy making body.
- To eradicate bureaucratic interference and corruption at all the levels and strive for introducing transparent system.
- To find out immediate solution for all problems which may jeopardize the common interest of the members by meeting, discussion and other democratic ways to the concerned authorities and act as a communicator to authorities/govt.
- Attracting and retaining youth in agriculture.
- To make efforts for advancement of agricultural research, education, extension, agricultural trade and development activities and other policy issues for promoting sustainable production and productivity including conservation & judicious use of natural resources.
- To make effort and convince the higher authority for restructuring the entire agricultural administrative system/set up at par with other professions, which remain as it was since its inception in the pre Independence era.

Mission

Empowering youth in agriculture for development of agriculture and the nation.

Vision

To foster the bond between agricultural students & professionals and to raise the voice for techno-administrative agriculture reforms including creation of Indian Agricultural Services and advancement in agriculture by involvement of agriculturists in policy formulation and implementation.



Best five Articles

AMFI-SI-01

CONTRACT FARMING

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Introduction

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

Definition of Contract Farming

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

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

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

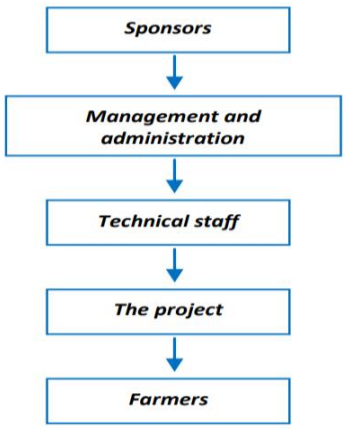

Fig-1 Centralized model

Nucleus estate model: This is a variation of the centralized model. To ensure a limited assurance of needed production, the company owns and maintains an estate plantation. It is generally employed to ensure processing plant throughput, but it is also utilized for research and breeding purposes. This strategy works well for products like tea, coffee,

rubber, cocoa, sugar, and oil palm, as well as fresh vegetables and fruits, with which farmers may have little or no expertise.

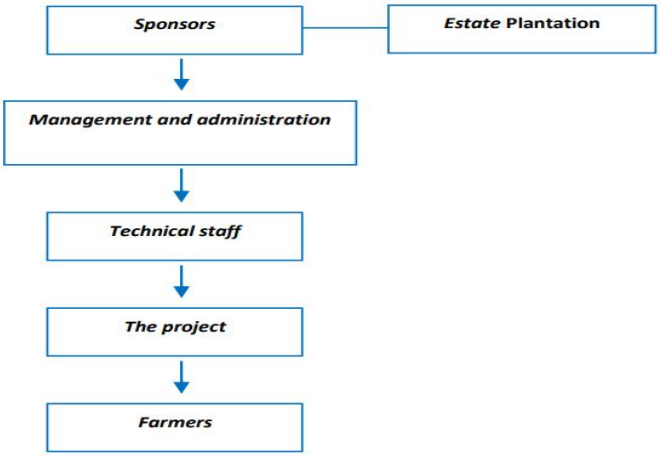

Fig-2 Nucleus estate model

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

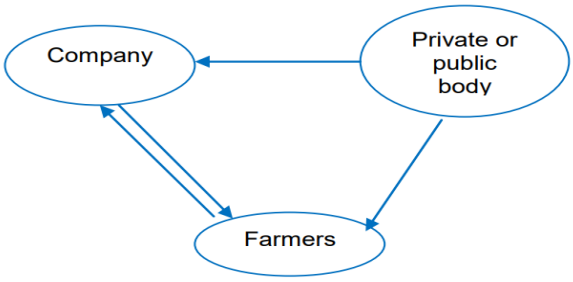

Fig-3 Multipartite model

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

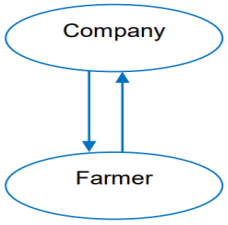

Fig-4 Informal model

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

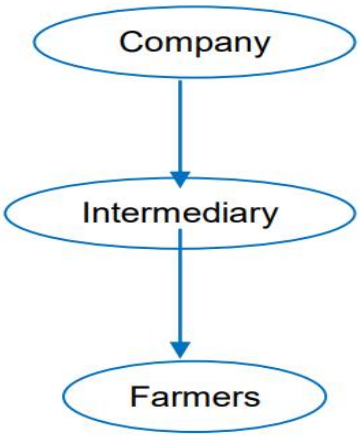

Fig-5 Intermediary model

Advantages to the Farmers: (Wagh, 2017)

1. Provision of inputs and production services.
2. Access to credit.
3. Introduction of appropriate technology
4. Skill transfer.
5. Guaranteed and fixed pricing structures.
6. Access to reliable markets.

Disadvantage to the Farmers

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

Advantages to the Sponsors

1. Small-scale contract farming is more politically acceptable.
2. Overcome the Land constraints
3. Production is more dependable than open-market purchases, and because the sponsoring business is not responsible for production.
4. More consistence quality can be obtained.

5. An uninterrupted and consistent supply of raw materials.
6. The firm will be protected from market price fluctuations.
7. The firm will be able to establish long-term planning.

Disadvantages to the Sponsors

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

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AMFI-SI-02

BIOACCUMULATION OF POLLUTANTS IN AQUATIC ORGANISMS

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Introduction

In recent times, rise in population growth and inadequate capacity of traditional sewage treatment results in the disposal of pollutants in aquatic environment. These pollutants include pharmaceuticals, endocrine disrupting hormones, antibiotics, personal care products, heavy metals, pesticides, marine debris and plastics, artificial sweeteners, surfactants, hydrocarbons, nanoparticles, poly-fluoroalkyl substances etc. These pollutants are in continum in different soil-water matrices and can cause harmful effects to aquatic flora and fauna even at lower concentrations (nanogram level). The sources of these EPs can be clearly identified; however, once they are released after domestic or industrial use, it becomes very difficult to trace their fate and transformation in sewage plant or aquatic environment. This is due to their high potential to accumulate in aquatic organisms and reach at higher trophic levels through food chain causing wide range of toxicity to fishes and higher vertebrates. There are three types of process of accumulation of pollutants in aquatic organism such as bioaccumulation, bioconcentration and biomagnification. The present article elucidates about these types of accumulation process and potential of different types of pollutants to accumulate in aquatic organisms.

Bioaccumulation

Bioaccumulation includes the uptake of chemicals from both water and diet. Bioaccumulation occurs within trophic level. The substances enter the organism through respiration, food intake, epidermal contact with substances and other means. Conservative pollutants can enter living organisms at any time and accumulate in their tissues. Such organisms are able to build up very high levels of such pollutants. Rate of bioaccumulation is measured in terms of bioaccumulation factor which is defined as concentration of pollutant in the test organism (g/Kg) / concentration of the pollutant in the surrounding media such as sediment or soil (g/Kg). Factors affecting bioaccumulation of pollutants in aquatic organism are physical & chemical properties of pollutant, environmental condition and characteristics of exposed organism. Chemical factors such as low water solubility, high lipophilicity, structural stability, acid dissociation constant and molecular weight play a pivotal role in determining the rate of bioaccumulation.

Sl. No	Types of Pollutant	Example	Aquatic Organisms	Reference
1.	Heavy metals	Cd, Pb, As	*Puntius ticto*, *Puntius sophore* *Labeo rohita*, *Glossogobius giuris*	Ahmed et al. (2016)
2.		Cd, Pb	*Mastacembelus armatus*	Afrin et al. (2015)
3.		Cd, Pb, Hg	*Pseudoplatystoma corruscans*	Arantes et al. (2016)
4.		Cd, Pb, Hg	*Hypophthalmichthys molitrix* *Carassius auratus*, *Cyprinus carpio* *Silurus asotus*	Yi and Zhang (2012)
5.	Pharmaceutical Drugs	Benzoylecgonine	*Hoplias lacerdae*, *Rhamdia quelen* *Prochilodus lineatus*	Ondarza et al. (2019)
6.		Tramadol	*Salmo trutta*	Grabicova et al. (2017)
7.		Methamphetamine Cocaine	*Porphyra* genus, *Monostroma*, *Laminaria genus*	Helou et al. (2018)
8.		Cocaine ketamine 3,4-methylenedioxy-methamphetamine	*Gammarus pulex* *Hydropyshe pellucidula* *Ephemera vulgata*	Miller et al. (2019)
9.	Personal care products	Methyl Triclosan	*Rutilus rutilus*, *Cladophora sp.*, *L. hoffmeisteri* *H. trivolvis* , *Cladophora sp.* *C. fluminea* *C. carpio*	Balmer et al. (2004) Coogan et al. (2007) Coogan and LaPoint, (2008) Edziyie (2011) Leiker et al. (2009)
10.		Gemfbrozil Triclocarban Valsartan Sulfamethazine	*Carassius auratus* *Cyprinus carpio*	Muir et al. (2017)
11.	Silver nanoparticles		*Danio rerio* embryo *Cyprinus carpio* *Oncorhynchus mykiss*	Zeumer et al. (2020) Jang et al. (2014) Kannan et al. (2011)

Ecotoxicological significance of Bioaccumulation

- Bioaccumulation in organisms may enhance the persistence of industrial chemicals in the ecosystem as a whole, since they can be fixed in the tissues of organisms.
- Stored chemicals are not exposed to direct physical, chemical, or biochemical degradation.
- Stored chemicals can directly affect an individual's health
- Predators of those organisms that have bioaccumulated harmful substances may be endangered by food chain effects.

Bioconcentration

Bioconcentration includes the uptake of chemicals from water alone. Bioconcentration occurs when an organism absorbs a toxic substance from only water at a rate greater than that at which the substance is lost. Bioconcentration factor (BCF) is defined as the uptake of contaminants from the dissolved phase. It can be calculated by the following equation:

$BCF = C/C_w$

where C is the contaminant concentrations in the organisms (µg/kg) under equilibrium condition, Cw is the contaminant concentration in the water (µg/L). A key assumption for the calculation or measurement of BCF is that of equilibrium between the contaminant and organism.

Biomagnification

Conservative pollutants are not metabolized in organism body and therefore when such organisms containing pollutants are eaten, the pollutants are simply passed on to the predator and accumulate in its tissues. This process may continue up the food chain, leaving the top predator with very high and sometimes lethal concentrations of the pollutant. Pollutants will enter organisms via different routes e.g. though the mouth and digestive tract or across gill surfaces. Small aquatic organisms absorb most toxins directly from the water whereas carnivores at the top of the food chain e.g. birds and mammals - receive most of their pollutant uptake from their food.

Biomagnification is a process by which compound or pollutant increases its concentration in the tissues of organism as it travels of the food chain. It is also known as bioamplification or biological magnification. As a result, organisms at the top of the food chain suffer greater harm than from a persistent toxin or pollutant than those at lower levels. Biomagnification factor (BMF) is the ratio of a test chemical concentration in the tissues of an organism, to that in the in the organism prey.

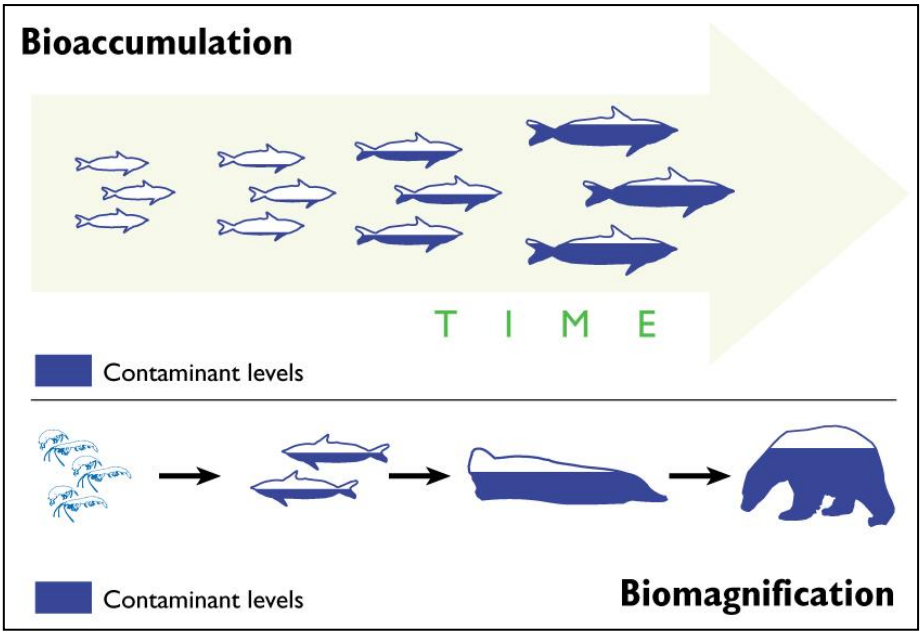

Fig. 1: Process of Bioaccumulation and Biomagnification
(Source: DDT Biomagnification - Environmental Systems (weebly.com)

Conclusion

Bioaccumulation process presents serious threats to the health of numerous ecosystems. Many products undergo toxicology testing and biodegradation studies, but if they are not subjected to bioaccumulation studies, the true extent of their environmental impact is unknown. The knowledge on bioaccumulation enables to assess the risk related with the presence of various chemicals in the environment, food, and at workplace and to present quantitatively the ability to control the use and emissions of chemicals.

AMFI-SI-03

ASSESSING MICROBIAL DEGRADATION OF POLYCHLORINATED BIPHENYLS (PCBs) IN STERILIZED SOIL BY USING NATIVE BACTERIA AND THEIR CONSORTIUM ISOLATED FROM THE TRANSFORMER POLLUTED SITES

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Abstract:

Polychlorinated biphenyl (PCB) is a group of highly persistent-chemical compounds that causes an immense risk to humans and environmental health. Here, the objective of the research was to investigate the degradation of a mixture of polychlorinated biphenyl (PCB) congeners, including PCB 10, PCB 28, PCB 52, PCB 138, PCB 153, and PCB 180, in sterilized soil over a period of 60 days. The experiment utilized three bacterial strains and their consortium, all isolated from a transformer-polluted site. Among the six bacterial species isolated, three native PCB-degrading bacteria were chosen for the study, excluding *Achromobacter pulmonis* due to its designation as a human clinical pathogen. The selected bacteria were identified as *Pseudomonas* MN833044, *Achromobacter* MN833040, and *Achromobacter* MN833041, with NCBI GenBank accession numbers MN833044, MN833040, and MN833041, respectively. The results showed that the bacterial consortium (8.03-41.58%) displayed a faster rate of PCB degradation compared to the individual bacteria strains, which biodegraded PCB at rates of 7.63-50.50% for *Pseudomonas* MN833044, 7.29-36.35% for *Achromobacter* MN833040, and 5.4-22.87% for *Achromobacter* MN833041. The degradation process followed first-order kinetics, with R^2 values > 0.85 and SEE values < 0.05. Moreover, the lower chlorinated-PCB congeners underwent more effective biodegradation than the higher chlorinated-PCB congeners. These findings suggest that bacterial consortium has potential as a bioremediation tool in PCB-contaminated soil.

Keywords: Biodegradation, Consortium, first-order kinetics, Polychlorinated biphenyl, Transformer oil

Introduction:

PCBs or polychlorinated biphenyls are anthropogenic and aromatic chlorinated organic chemicals that are highly persistent, bio-accumulative, carcinogenic, and toxic (Erickson and Kaley 2011; Vasilyeva and Strijakova 2007; Grimm *et al*., 2015; Erickson 2001). PCBs comprise a biphenyl backbone structure with 1-10 chlorine atoms, resulting in at least 209 congeners configuration (Ballschmiter & Zell, 1980; Wiegel & Wu, 2000). They are colorless, crystalline, non-flammable, and have electrical insulating properties, high boiling point, and high flashpoint (Sharma *et al*., 2018). Commercially, they are synthesized by catalytic chlorination of the biphenyl nucleus, resulting in a

complex mixture of diverse congeners (Borja *et al*., 2005). They are resistant, chemically stable, and non-reactive to harsh environmental conditions (Elangovan *et al*., 2019). The physical and chemical properties of PCBs depend on the degree of chlorination onto the biphenyl nucleus ring; lower chlorinated PCBs are volatile and oily liquids with hydrophilic properties, while higher chlorinated PCBs behave differently (Borja *et al*., 2005). Between the 1930s and 1980s, a wide range of products were manufactured on a large scale for commercial and industrial purposes, including pesticides, capacitors, dyes, lubricants, rubber goods, transformers, pigments, heat transfer fluids, plasticizers, coolants, carbonless copy paper, and hydraulic fluids. This was due to their desirable properties, such as high dielectric constant, high boiling point, excellent chemical stability, non-flammability, high flash point, low vapor pressure, and electrical insulating properties (Erickson 2001; Erickson and Kaley 2011; Pentyala *et al*., 2011; Grimm *et al*., 2015; IARC 2016; Sharma *et al*., 2018).

A substantial amount of the 1.5 million tons of PCBs produced globally has been released into the environment, despite restrictions under the Stockholm Convention (IARC, 2016; Pieper & Seeger, 2008). PCBs persist in environmental matrices such as air, soil, sediment, and water, despite efforts to control their release (Vasilyeva and Strijakova 2007; Grimm *et al*., 2015). For instance, PCB congeners have been detected in river sediments of the Pearl River Delta in China, ranging from 16.15 to 477.85 µg/kg (dry weight) (Lai *et al*., 2015; Wang *et al*., 2019b). Contamination sources include accidental discharges, improper disposal, poorly maintained transformers, leachate, hazardous waste sites, uncontrolled landfills, atmospheric deposition, and incinerators (Breivik *et al*., 2007). Closed dielectric fluids systems like transformers and capacitors may also leak significant amounts of PCBs into the environment (IARC 2016). PCBs are known to persist in the environment for a long time, cycling through air, water, and soil (Sharma *et al*., 2018). Interestingly, Zhang *et al*., (2016) developed a field analysis technique to study bioremediation of PCBs congener mixtures, such as Aroclor 1016, 1221, 1232, 1242, 1248, 1254, and 1260, from contaminated soil and sediment matrices. In a separate study, Stella *et al*., (2015) extracted PCBs and their metabolites from a composite soil sample using hexane: acetone (1:1, v/v) and 1% acetic acid in n-hexane: acetone (1:1, v/v). They then analyzed the samples using GC-MS, Varian, CA fitted ion trap detector, and DB-5MS column, Agilent, Czech Republic (30 m × 0.25 mm × 0.25 mm). The oven temperature was initially programmed to 60 °C and held for 1 min in the split-less mode, then opened splitter with ratio 1:50, heated up to 120 °C at a rate of 25 °C/min, and finally ramped up to 240 °C at a rate of 2.5 °C/min and held for 28 min.

According to Borja *et al*., (2005), biodegradation of organic pollutants can occur via two major pathways: mineralization and co-metabolism. Mineralization involves complete utilization of the pollutant as a carbon and energy source by microbes, resulting in the transformation of the organic compound into its constituent elements. In co-metabolism, microbes metabolize the organic contaminant and another suitable

substrate as a source of carbon and energy, resulting in modification of the contaminant without complete conversion to its constituent elements. Many bacteria have been found to be highly efficient in degrading PCB congeners through aerobic oxidation, including *Pseudomonas*, *Alcaligenes*, *Achromobacter*, *Janibacter*, *Burkholderia*, *Acinetobacter*, *Comamonas*, *Sphingomonas*, *Ralstonia*, *Enterobacter*, *Corynebacterium*, *Rhodococcus*, *Bacillus*, *Paenibacillus*, *Arthrobacter*, and *Micrococcus* (Furukawa 2000; Borja *et al*., 2005; Leigh *et al*., 2006; Elangovan *et al*., 2019). The effectiveness of PCB biodegradation is influenced by various factors such as carbon sources, solubility, oxygen content, bioavailability, electron acceptors, conductivity, structure, temperature, microorganisms, light intensity, nutrient availability, pH, and concentration (Robinson and Lenn 1994; Borja *et al*., 2005). Additionally, microbial dichlorination of ortho-substituted PCBs is relatively slow compared to meta- and para-substituted PCB congeners (Wiegel and Wu, 2000). Based on the study, it was found that *Bacillus* sp. strain LS1 exhibited a promising ability to degrade polycyclic aromatic compounds, particularly in the case of PCBs 18 and 52, but with lower performance in PCB 77 degradation. At a concentration of 10 mg/L, the strain was capable of degrading PCBs 18, 52, and 77 by 62.8%, 59.6%, and 39.8%, respectively, within 96 hours (Han *et al*., 2023). However, to best of knowledge, there is little research on the biodegradation of PCB congeners using bacteria isolated from transformer polluted sites. Therefore, the present study was undertaken to investigate the degradation of PCB congeners using bacteria from such sites, with the aim of providing valuable information for potential PCB remediation.

Material and methods

Chemicals

Analytical grade PCB congener mix-10, 28, 52, 138, 153, and 180, supelco (Part number 47330-U, Lot No. AA16634V, 99.5% purity) for analysis were procured from Sigma-Aldrich, Germany. Potato dextrose agar (PDA), potato dextrose broth (PDB), nutrient agar (NA), and nutrient broth (NB), were purchased from HiMedia Biosciences, India. Agilent Technologies supplied primary secondary amine (Bondesil-PSA 40 µm, 100 gm) and anhydrous $MgSO_4$. Pesticide grade solvents like hexane, dichloromethane, ethyl acetate, acetone, and AR grade sodium sulfate (anhydrous) were obtained from Merck Life Science Pvt. Ltd., India.

GC analysis

To perform the PCB analysis, the GLC Clarus 500 was utilized with an Elite 1 column (30 cm x 0.25 mm x 0.25 µm). The column temperature was initially set at 190 °C and maintained for 1 minute, followed by a ramp-up rate of 10 °C/min until it reached 280 °C/min and held for 8 minutes, resulting in a total run time of 19 minutes. The analysis

was validated using Thermo Scientific Focus GC-MS, DSQ II, employing the capillary column TG-5 MS (30 m x 0.25 mm x 0.25 µm).

Isolation of PCB degrading bacteria

A 1 kg soil sample was collected and profiled from a transformer power plant. The soil was moistened and kept for 5 days at laboratory conditions of 30±2°C temperature and 89±2% relative humidity. Next, 10 g of contaminated soil (dry weight) was mixed with 50 ml of sterile water to prepare a soil solution. The solution was then serially diluted (106 times) with an equivalent amount of sterile water (9 ml) and 100 µl of each diluted supernatant was spread onto nutrient agar plates (NA). These plates were incubated in a BOD incubator maintained at 26±2°C. Microbe isolation was then conducted to achieve a pure culture by repeatedly streaking onto fresh NA plates. Morphologically distinct microbes were isolated and sub-cultured in NA slants. The isolated culture was finally checked and identified through 16S rRNA gene analysis.

Identification of PCB degrading bacteria

The isolated microbes were identified through 16S RNA gene analysis, which was outsourced to M/S R.S Instrument Pvt. Ltd. Plasmid DNA of the microbial isolate was extracted and examined on a 1.0% agarose gel for quality control. The 16S rRNA gene fragment was amplified using 16S rRNA-F forward and 16S rRNA-R reverse primers, and the PCR amplicon was purified to remove contaminants. The amplified PCR product was then sequenced using the BDTv3.1 cycle sequencing kit on an ABI 3730xl Genetic Analyzer. The consensus sequence of the 16S rRNA gene was obtained from the forward and reverse sequence data using aligner software. The BLAST tool (Basic Local Alignment Search Tool) was used to compare and align the 16S rRNA gene sequence with the 'nr' database of NCBI, USA, and the first ten sequences were selected based on the maximum identity score. These sequences were aligned for multiple alignments using the Clustal W algorithm (Tamura, K. & Nei, 1993). Subsequently, a distance matrix was generated using the RDP database, and a phylogenetic tree was constructed using MEGA 6 (Tamura *et al*., 2013).

Degradation study of PCB congeners

The purpose of the study was to assess the biodegradation of PCBs using individual bacterial strains and consortia, which were isolated from contaminated sites in a chloride-free medium. The experiment was conducted in triplicate. The isolated culture was inoculated aseptically and incubated in 100 ml of NB for 48 hours at 30±2 °C, until the cell population grew to a saturation ranging from 1×106 to 1×109 bacterial cells ml-1 NB using a mechanical shaker at 110 rpm. Then, 20 µl of the bacterial inoculum was transferred aseptically to sterilized soil (2 g) fortified with PCB-mixtures (5 µg/g level) in a conical flask. Un-inoculated sterilized soil spiked with PCB-mixtures was used as a

control treatment. All the conical flasks were sealed with cotton plugs, agitated on a weekly basis, and kept in a BOD incubator maintained at 26±2 °C temperature and 90±2% relative humidity. Representative samples were randomly withdrawn at regular intervals of 0, 5, 10, 15, 20, and 30 days (d), respectively. The samples were extracted and cleaned up according to the Citrated buffer QuEChERS method with modifications, as described by Asensio-Ramos *et al*. (2010). Gas-liquid chromatography (GLC) with an ECD detector was used to analyze and quantify the samples.

Results and Discussion

In this study, five new PCB degrading bacteria were isolated from transformer polluted sites. However, after screening studies as described in Material and Methods, only the best three strains were chosen for the experiment. The three bacterial isolates were identified through 16S RNA gene analysis and their sequence data were deposited in the NCBI GenBank database with accession numbers MN833044, MN833040, and MN833041 for *Pseudomonas* sp. MN833044, *Achromobacter* sp. MN833040, and *Achromobacter* sp. MN833041, respectively. *Achromobacter pulmonis* was not included in the study because it is a human clinical pathogen. The isolated bacteria were also characterized morphologically using a Transmission electron microscope (TEM) and their molecular phylogenetic tree is shown in Fig. 1 and Fig. 2.

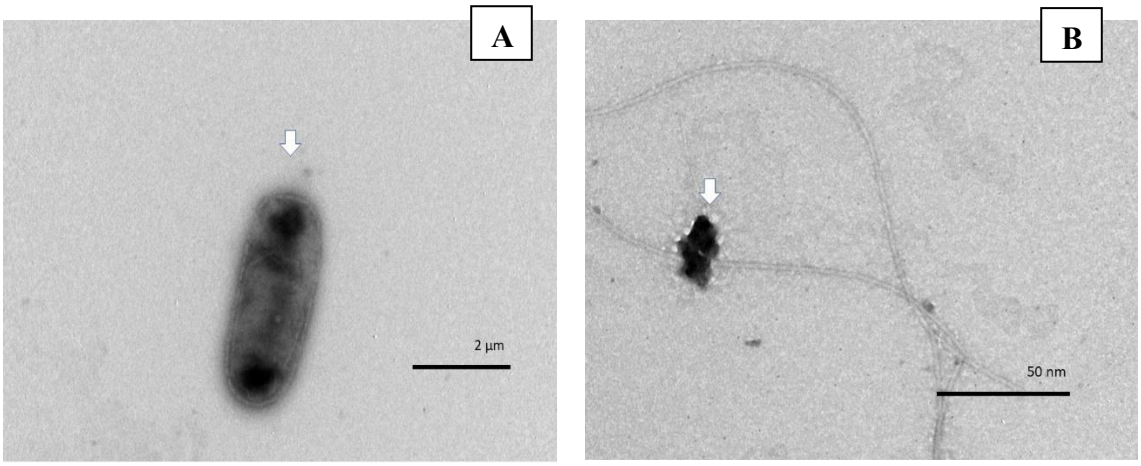

Fig. 1 Transmission electron microscope images (TEM) depicting; **(A)** *Pseudomonas* sp. MN833044 and **(B)** *Achromobacter* sp. MN833040 grown on PCBs as carbon sources onto fresh NA slants. White arrow indicates *Pseudomonas* sp. (Scale bar = 2 µm) and *Achromobacter* sp. MN833041 morphology (Scale bar = 50 nm)

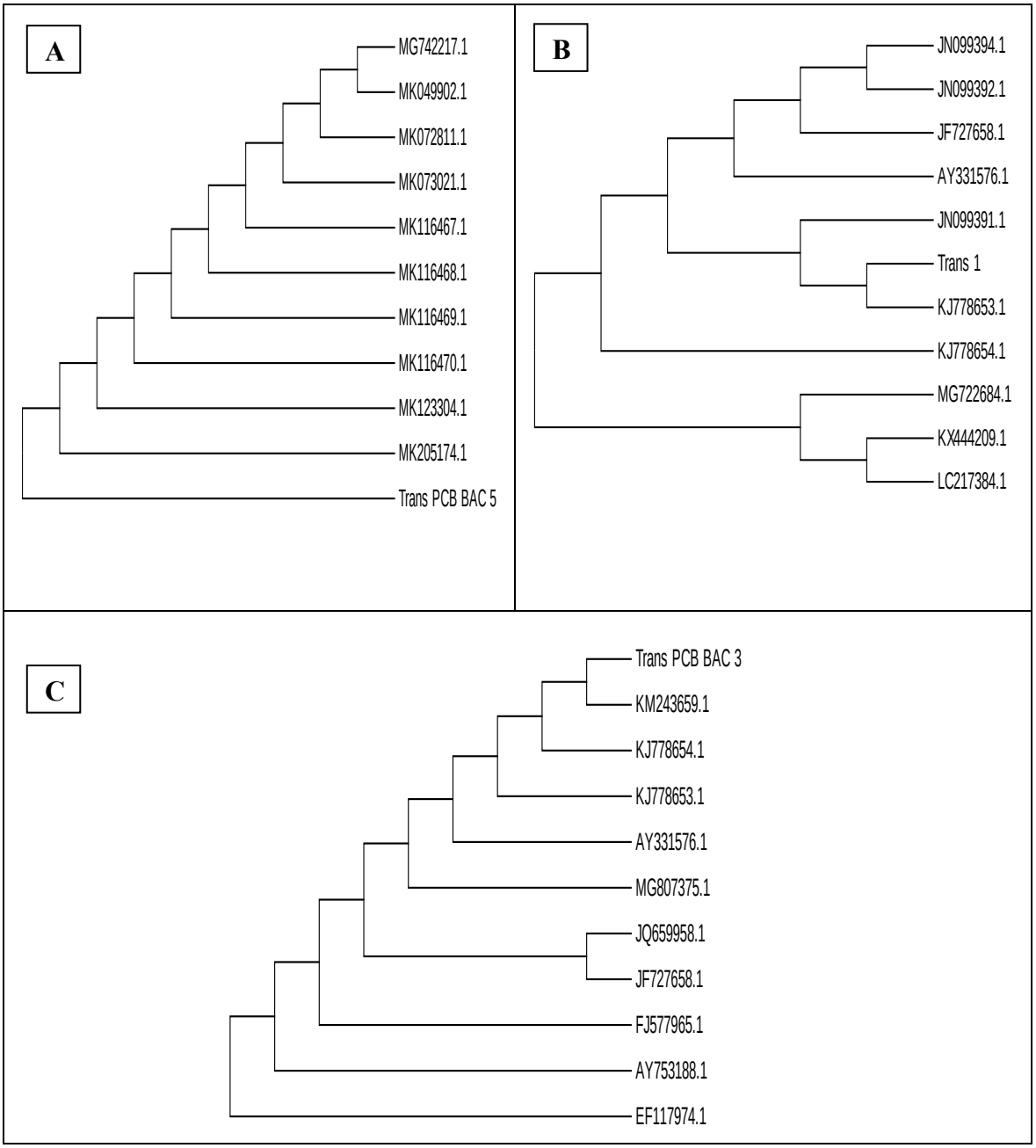

Fig. 2 Molecular phylogenetic analysis; **(A)** *Pseudomonas* sp. MN833044 (Trans PCB Bac 5), **(B)** *Achromobacter* sp. MN833040 (Trans 1), and **(C)** *Achromobacter* sp. MN833041 based on 16S rRNA by applying Maximum Likelihood method of Tamura-Nei model, Neighbor-Join and BioNJ algorithms using the Maximum Composite Likelihood (MCL) approach. Evolutionary analyses were conducted in MEGA 6.

In the laboratory experiment, the effectiveness of PCB-mixtures (PCB-10, -28, -52, -138, -153, and -180) biodegradation was examined using the isolated strains in a sterilized soil system over 60 days (Fig. 3). The dissipation kinetics of the PCB congeners best fit the first-order reaction kinetics (Table 3). In the *Pseudomonas* sp MN833044. treatment, the percentage of PCB dissipation was 50.50% for PCB 10, 36.4% for PCB 28, 30.65% for PCB 52, 14.12% for PCB 138, 7.63% for PCB 153, and 5.0% for PCB 180 over the 60-day period. The *Achromobacter* sp. MN833040 treatment reduced PCB 10 by 36.35%, PCB 28 by 33.06%, PCB 52 by 25.15%, PCB 138 by 10.84%, PCB 153 by 11.51%, and PCB 180 by 7.29% during the study. The data showed that *Achromobacter* sp. MN833041 treatment reduced PCB 10 by 22.87%, PCB 28 by 18.30%, PCB 52 by 15.62%, PCB 138 by 9.77%, PCB 153 by 9.57%, and PCB 180 by 5.4% from soil. In the consortium treatment, the total residual PCBs declined to 41.58% for di-, 27.36% for tri-, 21.39% for tetra-, 13.18% for hexa-, and 8.03% for hepta-chlorinated PCB congeners during the 60-day experimental period. Based on the first-order kinetic parameters, the calculated half-life ($t_{1/2}$) of PCBs was relatively higher in *Achromobacter* sp. MN833040, followed by *Achromobacter* sp. and *Pseudomonas* sp. MN833041 in the soil system. These findings demonstrate that the biodegradation of PCBs is significantly affected by *Pseudomonas* sp. MN833044, *Achromobacter* sp. MN833040, and *Achromobacter* sp. MN833041, respectively.

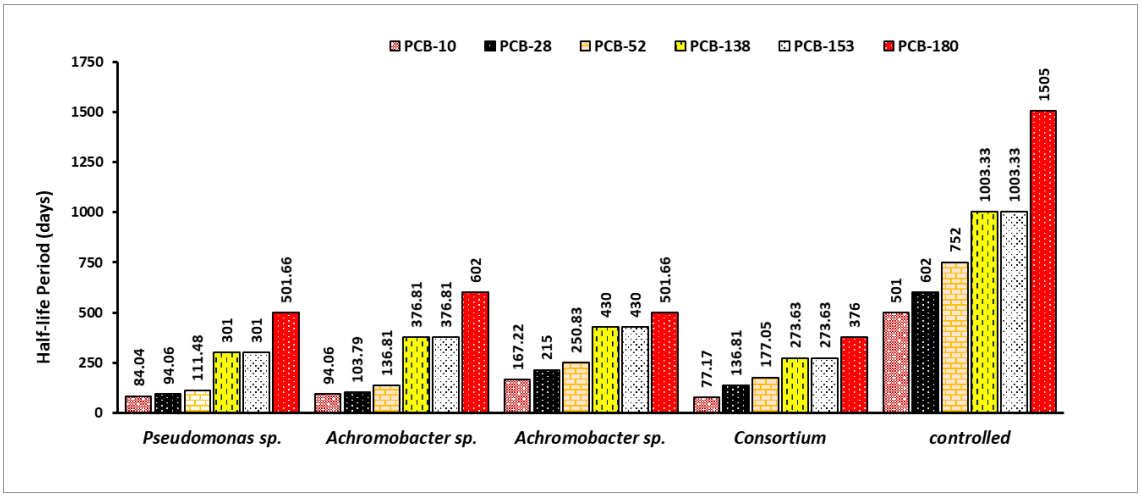

Fig. 3 Half-periods of PCB-mixtures congeners (PCB-10, -28, -52, -138, -153 and -180) in treated soil system with *Pseudomonas* sp. MN833044, *Achromobacter* sp. MN833040, *Achromobacter* sp. MN833041 and consortium after 60 d

According to the study, *Bacillus* sp. strain LS1 showed promising potential in degrading polycyclic aromatic compounds, with better performance in degrading PCBs

18 and 52 compared to PCB 77. At a concentration of 10 mg/L, LS1 was able to degrade PCBs 18, 52, and 77 by 62.8%, 59.6%, and 39.8%, respectively, within 96 hours (Han *et al*., 2023). Mixed bacterial cultures like *Rhodococcus* sp. and *Stenotrophomonas maltophilia* can biodegrade PCBs congeners in minimal mineral water media (Horváthová *et al*., 2019). Periodical re-inoculation can lead to a 59% reduction in contaminated sediment and a 65% reduction in water media. Wang *et al*., (2019a) investigated the removal of PCBs from contaminated sites using *Dehalococcoides mccartyi* strains CG3, SG1, *Methanosarcina*, and *Desulfovibrio*, and found interspecies synergistic interactions in microbial communities that facilitate organohalide respiration by *D. mccartyi*. Moreover, Samadi *et al*. (2019) isolated and identified *Lysinibacillus macrolides* and *Bacillus firmus* from PCBs contaminated soil with electrical transformer liquid, which can remove 80% of 2-chlorobiphenyl and 2,4-dichlorobiphenyl within 96 hours. *Dehalococcoides mccartyi* CG1 can enantioselectively dechlorinate chiral PCBs (Lu *et al*., 2018). Nuzzo *et al*., (2017) isolated two indigenous *Dehalococcoides* organohalide-respiring bacteria from the PCBs contaminated marine sediment of the Venice Lagoon and observed that they can dechlorinate Aroclor 1254 reductively under laboratory conditions. isolated and identified *Rhodococcus* sp., *Pseudomonas* sp., *Pseudoxanthomonas* sp., *Agromyces* sp., and *Brevibacillus* sp. from PCBs containing transformer oil using polyurethane foams as a bio-carrier, and these acclimatized microbes can dichlorinate PCBs under aerobic and anaerobic conditions (Nabavi *et al*., 2013)

Microbial communities have the ability to degrade complex PCBs due to their versatility and complex metabolic interactions (Pieper, 2005). Several diverse enzymes such as 2-hydroxyl-6-oxo-6- phenylhexa-2,4-dienoic acid hydrolase, dihydrodiol dehydrogenase, 2,3-dihydroxy biphenyl dioxygenase, and biphenyl dioxygenase are responsible for the biodegradation of PCB congeners (Elangovan *et al*., 2019). Thus, biodegradation is considered to be the most cost-effective and eco-friendly way to eliminate toxic and recalcitrant PCBs from heavily polluted environments (Harms *et al*., 2011). Although there is no evidence that a single organism can degrade multiple chlorinated biphenyls, microbial dechlorination of PCBs typically removes meta and para chlorines, generating primarily ortho-substituted mono- through tetrachlorobiphenyls (Furukawa, 2000; Wiegel & Wu, 2000). The degree of biodegradation is highly influenced by environmental factors such as compound structure, pollutant stereochemistry, solubility, and chemical concentration (Borja *et al*., 2005). In a recent study, the resuscitated *Castellaniella* sp. SPC4 was found to aerobically degrade PCB 77 at a rate of 0.066/h using a bph-encoded biphenyl pathway in a 20 mg/l media (Su *et al*., 2019). Additionally, an aerobic actinobacteria strain was isolated from PCBs contaminated sediment in Taizhou city, China by Su *et al*., (2015). A study conducted by Chakraborty and Das, (2016) demonstrated that Pseudomonas aeruginosa JP-11, isolated from coastal sediments of Odisha, was capable of utilizing over 98% of biphenyl as the sole carbon source within 72 hours through the HOPDA

benzoate-catechol metabolism pathway. The bacteria also produced metabolites such as 2-Hydroxy-6-oxo-6-phenylhexa-2,4-dienoate, which was found in the Krebs cycle, using biphenyl dioxygenase enzyme. Likewise, Kimura *et al*., (2018) also studied *Pseudomonas furukawaii* sp. nov, which was isolated from PCB-contaminated soil in Japan. The bacteria showed a strong link to the Pseudomonas genus and had a 97.8% sequence similarity with Pseudomonas balearica strain SP1402T. Additionally, Shimura *et al*., (1999) found that *Bacillus* sp. strain JF8, isolated from compost, was capable of effectively utilizing biphenyl compounds such as tetra- and pentachlorobiphenyl as a carbon source at 60°C.

Hitherto, Kaya *et al*., (2018) investigated the anaerobic dichlorination of PCB-118 and Aroclor 1254 by indigenous organohalide respiring bacteria in sediment microcosms from Grasse River, Fox River, and Baltimore harbor. The results showed that the dichlorination percentage of penta-, hexa-, and hepta-chlorinated congeners varied across the different locations. In another study, Horváthová *et al*., (2018) demonstrated the effectiveness of PCB biodegradation in historically Delor 103 contaminated-shallow river sediments using individual bacterial strains and their consortia, including *Achromobacter xylosoxidans*, *Stenotrophomonas maltophilia*, *Ochrobactrum anthropic*, and *Rhodococcus ruber*. The *Rhodococcus ruber* consortia were found to be more efficient in PCB degradation than other consortia or individual strains, indicating that bacterial consortia may be more effective than individual strains. Additionally, native microbes were found to contribute nearly 50% of PCB biodegradation by establishing synergistic relationships with exogenous microbes. Similarly, Mathews (2014) also demonstrated the ability of *Pseudomonas aeruginosa* MD2 to biodegrade PCBs from wastewater at the Notwane sewage treatment plant in Botswana. Furthermore, Fujihara *et al*., (2015) reported that *Pseudomonas aeruginosa* KF702, isolated from PCB-contaminated soil, could utilize PCBs as the sole source of carbon, possibly due to the presence of biphenyl catabolism genes that facilitate the degradation of aromatic compounds. In their 2019 study, Jia *et al*., (2019) isolated and identified a potential bacterium, *Arthrobacter* sp. YC-RL1, which efficiently hydrolyzed PCBs by meta-cleavage at 45°C and pH 7. Additionally, two potential microbes, *Alcaligenes* sp. and *Acinetobacter* sp., were characterized for their ability to degrade and assimilate 5, 2'-trichlorobiphenyl, suggesting that *Alcaligenes* sp. could co-metabolize various PCB congeners by oxidative degradation.

According to Horváthová *et al*., (2019) study, mixed bacterial cultures like *Rhodococcus sp*. and *Stenotrophomonas maltophilia* can degrade PCBs congener in minimal mineral water media, resulting in 59% degradation in contaminated sediment and 65% degradation in water media with periodical re-inoculation. Similarly, It was observed that halo-priming of tetrachloroethene could stimulate in-situ PCB dichlorination in pure culture and river sediment microcosm by indigenous *Dehalococcoides mccartyi* CG1 (Xu *et al*., 2018). Wang *et al*., (2019a) investigated the

removal of PCBs from contaminated sites using *Dehalococcoides mccartyi* strains CG3, *Dehalococcoides mccartyi* strains SG1, *Methanosarcina*, and *Desulfovibrio*, which showed interspecies synergistic interaction in the microbial communities, facilitating organohalide respiration by D. mccartyi. In addition, Lu *et al*., (2018) found that *Dehalococcoides mccartyi* CG1 could enantioselectively dechlorinate chiral PCBs 174, 149, and 132. In fact, Samadi *et al*., (2019) isolated and identified two potential microbes, *Lysinibacillus macrolides* and *Bacillus firmus*, from PCBs contaminated soil with electrical transformer liquid, which removed 2-chlorobiphenyl and 2,4-dichlorobiphenyl about 80% within 96 hours. Similarly, Nuzzo *et al*., (2017) isolated two indigenous *Dehalococcoides* organohalide-respiring bacteria from the PCBs contaminated marine sediment of the Venice Lagoon, which dechlorinated Aroclor 1254 reductively under laboratory conditions. Nabavi *et al*., (2013) also isolated and identified *Rhodococcus* sp., *Pseudomonas* sp., *Pseudoxanthomonas* sp., *Agromyces* sp., and *Brevibacillus* sp. from the PCBs containing transformer oil using polyurethane foams as a bio-carrier.

Conclusion

In conclusion, the study on the biodegradation of PCBs by bacteria and fungi isolated from transformer oil has provided valuable insights into the factors affecting the rate and extent of PCB biodegradation. The results suggest that *Pseudomonas* sp. MN833044 is a promising candidate for the bioremediation of PCB-contaminated sites due to its rapid biodegradation ability. Additionally, the study highlights the importance of microbial consortia for efficient PCB biodegradation. Future research could focus on optimizing the conditions for PCB biodegradation and exploring the interactions between different microbial communities during the process. Overall, the findings of this study contribute to the development of effective strategies for PCB bioremediation and environmental protection.

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CUSTOMIZED FERTILIZERS - A NOVEL APPROACH TO INCREASE CROP PRODUCTIVITY

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Abstract

Chemical fertilizer is one of the key inputs that help in sustaining the production and productivity of crops. Since there is no scope for extending the cultivable area in many countries, the only option to improve agriculture production to meet the requirements of growing population is increase productivity to the maximum possible level per unit area using fertilizers. In countries like India where imbalanced use of chemical fertilizers already created multi-nutrient deficiencies there is an urgent need to motivate farmers to adopt balanced fertilizer use. Though there are blanket fertilizer recommendations for crops for different regions and countries research conducted by Dobermann and Cassman (2002) identified limitations in customized fertilizer widely practiced across Asian countries. In fact, existence of large field variability in nutrient supply capacity of soils, nutrient use efficiency, and crop response to available nutrients affect the effectiveness of blanket fertilizer recommendations in producing a good crop yield. Knowledge-intensive soil and crop management technologies are required to manage these constraints and ensure increased crop productivity on a sustainable basis.

Key words : Chemical fertilizer, customized fertilizer, nutrient use efficiency and crop productivity

Introduction

According to FCO, customized fertilizer is the implication of the fertilizers best management practices and is generally assumed to maximize crop yields while minimizing unwanted impacts on the environment & human health. Fertilizer best management practices will make it easier for farmers, extension agents, crop advisers and researchers, to exchange their experiences and also to restrict the unwanted nutrient impact on the ecosystem. Application of customized fertilizer is compatible with existing farmers system can be comfortably accepted by the farmers. Production of customized fertilizers will ensure improved 'Fertilizer Use Efficiency' and will create a new "Virtual" source of nutrients, implying from the existing quantity of DAP, MOP, Urea, SSP and AS available and consumed in India, the agricultural produce output will increase. Simultaneously the distribution and availability of fertilizer will be better. Customized fertilizer satisfies crop's nutritional demand, specific to area, soil, and growth stage of plant. As the micronutrients are also added with the granulated NPK

fertilizer the plants can absorb the micronutrient along with macronutrient which prevents nutrient deficiency in plant (Anand Singh et al., 2019)

Objectives

Customized fertilizer is aimed at a balanced distribution of plant nutrients in the field and provides the best nutritional package for premium quality plant growth and yield. They are defined as multi nutrient carrier designed to contain macro and/or micro nutrient forms, both from inorganic and/or organic sources, manufactured through a systematic process of granulation, satisfying the crop's nutritional needs, specific to its site, soil and stage, validated by a scientific crop model capability developed by an accredited fertilizer manufacturing/marketing company. Such fertilizers also include water soluble specialty fertilizer as customized combination products. The objective behind the customized fertilizer is to provide site specific nutrient management for achieving maximum fertilizer use efficiency for the applied nutrient in a cost effective manner. The major provisions for the production of customized fertilizers lie in the promotion of site specific nutrient management (SSNM) to achieve the maximum fertilizer use efficiency of applied nutrient in a cost effective manner. The CF may include the combination of nutrients based on soil testing and crop requirement, which actually consists of 100% water soluble fertilizers grades. Nutrient requirement of the crop in a particular area is mixed physically and steam granulated by technology known as fusion blending. The farmers get all the required nutrients in terms of NPK with secondary and micro-nutrients in balanced proportion.

Benefits of customized fertilizers

Customized fertilizers have many advantages over other chemical formulations as depicted below.

- Customized fertilizers are generally assumed to maximize crop yields while minimizing unwanted impacts on the environment and human health
- Application of customized fertilizer is compatible with existing farmers system and hence, it will be comfortably accepted by the farmers.
- It safeguards improved fertilizer use efficiency (FUE) and texture ensures uniform distribution of nutrients
- It satisfies crop's nutritional demand, specific to area, soil, and growth stage of plant
- It promotes balanced fertilization, as the micronutrients are also added with the granulated NPK fertilizer and prevents multi- nutrient deficiencies
- It enhances crop productivity with improved benefit: cost ratio
- It ensures good soil health and also avoids or checks soil and underground
- water pollution

Principles and procedures to arrive at customized fertilizer grades

- Geo-referencing of chosen area

- Selecting sampling points based on appropriate statistical procedure
- Actual sampling and analyzing soil, plant and water samples mainly for nutrients
- Defining management zones and fixing yield targets
- Computing crop removal of nutrients
- Calculating nutrient requirement (amount and nutrient ratio)
- Blending of nutrients for a particular CF grade

Milestones in customized fertilizer production

Taking due cognizance of the above facts, initially four grades of customized fertilizers were created to provide a total nutrient package mainly for basal application.

Grade I: N10:P20:K10:S5:Mg2:Zn0.5:B0.3:Fe0.2

Grade II: N20:P10:K10:S5:Mg2:Zn0.5:B0.3:Fe0.2

Grade III: N15:P15:K15:S5:Mg2:Zn0.5:Fe0.2

Grade IV: N10:P20:K20:S3:Mg2:Zn0.5:B0.3:Fe0.2

These customized fertilizer grades are liable to change every three years as per the changing soil fertility and crop need. Altogether, 24 grades of these fertilizers have so far been notified. Leading fertilizer manufacturers *viz*. Tata Chemicals Limited (TCL), Nagarjuna Fertilizer, Coromandel International Limited and Deepak Fertilizers have been permitted to manufacture these customized fertilizers, although the response of companies for establishment of CF manufacturing unit was not encouraging. In order to promote and encourage manufacture of CF the companies were allowed to use subsidized fertilizers.

Customized fertilizer grades:

The grades of customized fertilizer which the manufacturing companies propose to manufacture and sell shall be based on area specific and crop specific soil testing results. The manufacturer may be in association with Agricultural Universities/KVKs concerned, shall also conduct agronomy trials of the proposed grade to establish its nutrient efficiency. The manufacturing companies, preferably in association with concerned agriculture universities/KVKs may continue to conduct agronomy tests of the proposed grades on the farm, for at least one season. The minimum nutrient contents in a specific grade of customized fertilizer, proposed to be manufactured, shall contain not less than 30 units of all nutrients in combined.

Table 1. Journey of customized fertilizer

Year	Development
2005	Concept paper was published in IJE and presented in FAI seminar
2006	FAI working group was constituted to work on CF
2007	• FAI and DAC proposal on CF • CF formulations and field validation trials was carried out by Tata, Nagarjuna and Deepak • Series of CF workshops were conducted
2008	• CF guidelines was issued by GOI on March 11, 2008 • DAC approves 12 CF grades
2009	Tata Chemicals Limited initiated setting up of Hi-tech CF Plant at Babrala, Uttar Pradesh
2010	• GOI extended support for raw materials availability • Tata's CF Plant started production on November 22, 2010 • First CF product (N10:P18:K25:S3:Zn0.5) was sold at a price of Rs. 600/- per bag (1 bag = 50 kg)

Raw materials for manufacture

1. **Use of subsidized fertilizers:** All subsidized fertilizers can be used for manufacturing of customized fertilizers. Domestic manufacturer of subsidized fertilizers will supply the required quantity of such fertilizers, as raw material, to its own manufacturing unit for production of customized fertilizers

2. **Import of subsidized fertilizers:** Manufacturers can import subsidized fertilizers under the existing policy guidelines of GOI for the manufacture of customized fertilizers not exceeding its realistic requirements.

Methods of preparation of customized fertilizer

1. Chemical granulation: It is also called „slurry granulation" or „complex granulation. Here, fertilizer production start with the basic raw materials like rock phosphate, acids and ammonia rather than their salts like diammonium phosphate and urea. A large capacity manufacturing plants are needed to carry out chemical reactions. Infrastructure cost of handling and storage of acids and ammonia are huge due to difficulty in undertaking chemical reactions. It is less flexible to produce variety of grades.

2. Bulk blending: It is the simplest and cheapest option available for the production of customized fertilizers, which involves pure mixing of solid fertilizers in a ratio required to get the desired nutrient ratio. It only requires warehouse, weighing and mixing equipment. It has the advantage of smaller capacities of decentralized production uniquely suited to give the customer exactly the NPK ratio he requires. The physical standard should be such that the shape and size of all fertilizers, raw materials are

similar and also high quality granular fertilizer material is needed, which are to be used in bulk blends. In Indian context, importing of the raw materials is needed because of these stringent specifications of raw materials, and for large scale production it is not suitable. However for the experimental purposes this is the most suitable method

3. Fluid application: Most suited method in the intensive farming system to obtain a higher yield. Two types of liquid formulations are there; clear liquids and suspension liquids. If it is suspension liquids, it needs constant agitation. It provides a dust free application method. A mixture of ammonia, phosphoric acid and micronutrients gives a good homogenous liquid fertilizer.

4. Compound or steam granulation: Raw materials are in solid form and uniform size reduction of this fertilizer material is the key to granulation. Agglomeration of granules can be attained by use of hot water or low pressure steam. Then the granulated materials should be dried and cooled by dehumidified air. Hygroscopic products like urea containing grades need dehumidified bagging plant also otherwise caking of the products will occur. This is the most suited method for the large scale production of customized fertilizers in India.

Major constraints to promote Customized Fertilizers

The available research information sounds well for upward revision of fertilizer recommendations as the existing fertilizerdoses (NPK) are proving to be sub-optimal for maximum economic yield. It is also evident that application of nutrients according to current recommendations is causing nutrient depletion particularly in respect of potassium and micronutrients. The current soil test based recommendations consider only the nutrient deficiency magnitude, not the yield targets(Har vir singh et al., 2019). Only one recommendation being currently given without considering the yield target is proving to be suboptimal for higher yield targets, thus farmers are losing yield, produce quality and profits. The current fertilizer recommendations support only medium yield target provided the supply of nutrients other than NPK is not a limiting factor. In contrast, the deficiency of one or the other secondary and / or micronutrient deficiency is observed in all parts of the country. The most important issues which hinder the marketing of customized fertilizers are:

- High cost of customized fertilizers.
- Necessity of investing heavy capital in state of the art manufacturing facility for customized fertilizer.
- Limited awareness and very low affordability of customized fertilizers among the farmers.
- Uncertainty in response when fertility is restored in the field.

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AMFI-SI-05

TYPES OF MICRO PLASTICS IN SOIL ECOSYSTEMS, THEIR IMPACT ON SOIL PROPERTIES, AND REMEDIAL MEASURES.

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Abstract:

Due of the devastation and destruction that microplastics due to ecosystems, they have become a grave danger to all of them. The size of microplastics is extremely small in nature. associated with every environment readily, and the build-up of microplastics results in the deterioration of the ecosystem's ecology and physical characteristics. Due to an ever-increasing global population and demand for food production, farmers frequently apply compost, fertiliser, sewage, and sludge, all of which have the potential to introduce microplastic into the soil where crops are grown. Microplastic build-up impedes microbial development and proliferation, poses risks to human and animal health, negatively impacts plant and animal health, and degrades soil characteristics, diminishing soil fertility and resulting in declining agricultural output and sustainability for the future. Microplastics and creating strong regulatory framework that all nations must adhere to. A brighter future may be ensured if it is produced with its adaption by nations.

Key words: soil, microplastics, ecosystem, and agriculture.

Introduction:

Having a size range of less than 5mm, microplastics are the tiniest possible type of plastic trash. Recent research has shown that these tiny plastic particles influence and damage the environment at many ecological levels, including the soil, the air, and the marine environment. Due to its tiny size and strong interactivity with environmental elements, microplastic may infiltrate any ecosystem and cause difficulty as well as toxicity in a particular ecosystem with change of existing sustainable features of each ecosystem over a longer length of time. The introduction of organic fertilisers, biosolid compounds, the usage of plastic mulches, and other techniques are some of the ways that microplastics penetrate the soil ecosystem. Microplastics provide a possible hazard to the soil's microbiome, because soil holds more microplastic trash than marine basins and over 30% of the amount found in different continental systems. Microplastics can flow through the air stream and interact with aerosol particles, lowering criteria for the cleanliness of the air. Microplastics could alter air quality and standard while interfering with aerosol particles. Plastic The accumulation of trash in aquatic habitats, including marine ones, can harm the marine food webs by biomagnification of the microplastics. Microplastic modifies the soil's characteristics, affecting the development of crops and reducing their sustainability.

Microplastics and their Varieties:

Microplastics are heterogenic plastic materials with extremely small dimensions (up to 5 mm), increased surface area, and different granules and pieces. Despite their tiny size, microplastics have a significant negative impact on the ecosystem. Any ecosystem that incorporates microplastic may experience changes to its composition and many critical functions. Types of Microplastics

A. Primary Micro Plastics:

They have a significant impact on the environment because they are used often, in greater quantities, and penetrate ecosystems unimpeded. They come in the following categories:

1. Micro beads:

Microbeads are tiny, non-biodegradable beads with a diameter of almost 1mm. To make toothpaste and other face scrubs, micro beads are employed. The micro beads may infiltrate plants, lakes, and other systems because of their tiny size without changing their fundamental characteristics. The disadvantage of these microbeads is that marine and aquatic creatures use microplastic as food, which is not biodegradable by nature. As a result, biomagnifications increase the concentration of microbeads in food webs. They are very toxic in nature.

Figure 1: microbeads

Figure 2: Nurdles

2. Nurdles:

Nurdles are used to produce a variety of tiny, plastic-related products. To create additional plastic polymers, large corporations burn and melt these materials. Nurdles deposit in other habitats to contaminate and upset the biological balance and interact with storms, hurricanes, and other destructive natural tragedies.

3. Scrubbers:

These scrubbers include inbuilt plastic cleaners that are often used in cleaning the environment.

4. Pellets:

Plastic pellets are widely utilised and employed as a raw material for the production of other items. Microplastics are introduced into other ecosystems by several mechanisms.

5. Powdered plastic:
In the case of the moulding industries, plastic granules are utilised.

6. Fibres:
In marine and other aquatic environments, fibres make up around 71% of the total microplastic contamination. Other sources of microplastic include diapers and cigarette packaging. Microfiber may enter water sources from sources like air conditioners and materials used in washing machines. The primary. Source of microplastic in the soil ecosystem is the use of synthetic and other organic fertilisers in agricultural areas. Most of these microfibers are not naturally biodegradable.

7. Fragments:
The fragmented bits of plastic from a huge section of plastic material are known as fragments. The examples in this area include lids and tiny segment plastics. Longer-term UV exposure has the potential to further fragment the microplastics into even smaller fragments.

8. Foam:
With its many applications, foam particles serve as a source of microplastic pollution in the environment.


Figure 3: Fibres


Figure 4: Foam


Figure 5: Fragments

B. Secondary microplastics:
Primary microplastics are transformed into secondary microplastics by a variety of processes, including ageing, exposure to UV radiation, wear and tear, wind abrasion, etc. These mentioned processes turn the parent microplastic into secondary microplastic materials. These secondary microplastics are less efficient than initial microplastics in comparison.
The Ecosystem of Soil and Microplastic:
Due to their extremely minute form, micro plastic compounds may infiltrate any environment without losing any of their properties. Through a variety of techniques, large-scale, intensive agriculture systems employ a significant amount of plastic as an input and build up a quantity of microplastics in the soil. The growth and sustainability

of soil microorganisms are hampered by plastics since they are not naturally biodegradable. Microplastic build-up in soil results in an impermeable layer that hinders nutrient movement in the soil profile and lowers infiltration and permeability. Microplastics can infiltrate the soil ecosystem in several ways, including the following (Yang et al., 2021):

1. Water for irrigation

Using plastic pipes, irrigation water can introduce microplastics into the soil environment. The usage of plastic pipes for irrigation delivery to the crops over an extended period may operate as a source of microplastic and create a pathway for its build-up in the soil.

2. Sludge and sewage

Microplastics are potentially present in large quantities when sewage and sludge are applied to soil as a source of nutrients for crop cultivation. As a result, microplastics are more likely to accumulate in soil over time. For instance, extensive use of urea sources adds plastic to the soil environment. Synthetic urea and urea granules may include plastic components.

3. Synthetic and compost fertilisers:

Composting and other synthetic fertilisers are major producers of microplastics in the soil ecosystem. Farmers employ additional fertiliser sources to increase production, which leads to plastic accumulation in the soil. Synthetic urea and urea granules, for example, may include plastic components, and high urea use adds plastic to the soil environment.

4. Using plastic mulch:

Mulching aids in moisture restoration and controls soil surface temperature, both of which lessen evaporation losses. Therefore, the application of plastic mulches is necessary for improved crop production, and prolonged contact between these mulching materials and crops and soil results in the accumulation of plastic in the soil ecosystem.

5. Into the atmosphere:

A significant input in soil is the transmission of microplastic through atmospheric events. Microplastics accumulate in the soil environment in catchment regions. The flow of microplastics can accumulate and settle on land over an extended period. Irrigation water and the little amount of plastic in the aerosol deposit on the field and build up there.

6. Litters:

Different litters produced by both agricultural and non-agricultural sources have the potential to cause soil to accumulate microplastic. Plastic compounds that are not biodegradable build in soil as litter is placed onto it and during soil's breakdown.

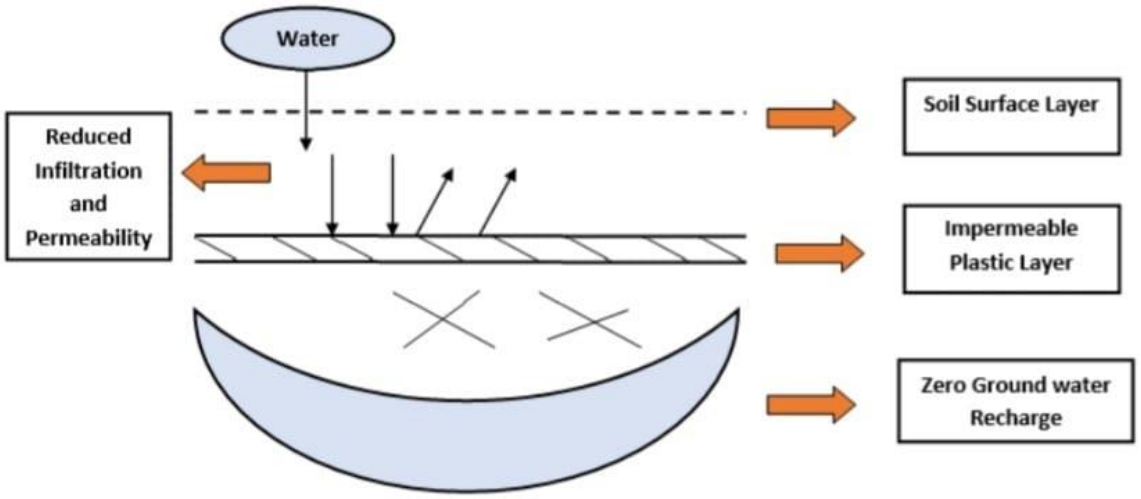

Figure 6: Harmful impact of micro plastic on infiltration, permeability, and ground water recharge.

Impact of microplastic on Soil Properties:

The persistent characteristics of microplastics can result in a variety of potential risks to soil ecosystem. In addition, the formation of pores in soil led to a loss of microhabitat, changes in the water holding capacity as well as bulk density ***(Veresoglou et al., 2015; de Souza Machado et al., 2018),*** and speeds up soil water evaporation ***(Wanet al., 2019).*** Micro plastic reduces aggregate stability by preventing micro aggregates from effectively being integrated into macro aggregates or by introducing fracture points into aggregates. Additionally, research has shown that earthworms' stomachs and guts acquire microplastic, which affects how they feed and how they mature ***(Hodson et al., 2017; Huerta Lwanga et al., 2016)***. Furthermore, the presence of microplastics in soil has a considerable impact on soil microbial respiration and the activity of soil B-glucosida urease and phosphatase ***(Yang et al., 2018; Wang et al., 2020).*** Additionally, because of their size, they interact with other compounds such as pesticides, antibiotics, and heavy metals i.e. (Cd and Pb) in soil, which harms soil biota more severely and affects several soil characteristics ***(Brenneckeet al. 2016; Li et al. 2018; Rilliget al. 2019).*** Measures to Reduce Risk: The greatest strategy to lessen the build-up of microplastic in soil is to use and discard microplastic as little as possible. The best thing to do is to use microplastic as little as possible, although this is challenging given the inconvenience. Limiting the disposal of plastics in landfills and cutting back on the use of sewage sludge and waste water can help reduce the build-up of microplastics in the soil. These practises are possible sources of microplastic in the soil. Respectively, certain nations, including the USA, Canada, and the UK, outlawed the industrial usage of plastic microbeads ***(Yu et al., 2022)***. As an alternative to traditional plastic, bio-based and biodegradable materials can be used. Therefore, the key to mitigating microplastic would be the creation of biodegradable polymers and designed microbes that can quickly mineralize microplastic.

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AMFI-SI-06

A STUDY ON CATALYZING RURAL ECONOMIC DEVELOPMENT THROUGH AGROTOURISM

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Abstract

Agrotourism had become the talk of the town in hospitality and tourism sectors of the world. For a country like India, rural economy is of crucial significance as it possesses as much as two-third population and more than seventy percent workforce. In terms of national economy too, rural comes up with forty six percent of total income. But the bitter reality is that more than two-third of rural income has been brought about by non-agricultural activities. In order to end the disparity of agricultural workforce, concepts such as agrotourism needs to be introduced and divert the tourist market to promote agriculture. This paper intends to sketch the role of agrotourism in aiding rural economy. For promoting agrotourism, higher awareness is needed to be inculcated to urban people so as to create a greater consumer base and also to farmers on development of farm-based activities and hospitality with reference to tourism.

Keywords: Agrotourism, Rural economy, Hospitality, Farmers

Introduction

Agrotourism means opening up farms to people from urban areas as well as from abroad, provide accommodation, food and make them experience farm life and rural scenarios. It can be accomplished by integrating farm environment and factors of commercial tourism. Mother Nature has several magic elements without brick walls interrupting them. People from urban areas have very limited access to nature's beauty and eternity. They are enveloped by walls around beginning from school education till their office roles. Agrotourism has enormous excitement factors in it and is highly adventurous. Urban tourists will have a greater market to trace back to their roots. Agrotourism falls beneath the wider theme of rural tourism.

Initially, tourism was considered as an activity performed during leisure time. But as time passed by, tourism has turned out to be a passion for many people. Many people aim to travel around the world and several professions such as travel blogging, photography and so on came into the scenario to enhance their passion towards travelling and tourism. This led to inculcating many innovative factors into tourism, one among this being agrotourism. It served as an innovative way to enrich the livelihood of farm owners by offering several unique provisions for eco-tourism, entertainment, hospitality, recreation, sales and education.

Agrotourism in India

In India, agrotourism is still in the initial stages of development. The official launch of the concept happened during May 1, 2004 at Baramati in Maharashtra. The Agri Tourism Development Corporation (ATDC) was established in 2004 to promote agrotourism in the state. This has been used as a platform by tourists to book reservations and provide guidance to tourists by directing them to respective centers after booking. Farmers of Maharashtra were trained under the Maharashtra State Agri tourism Vistar Yojana on how to conserve and enhance their environment, showcase the village culture, promote handicrafts, authentic foods, maintain hygiene, sell farm produce.

Benefits of Agrotourism

- Caters the educational needs of students as well as common people by providing them practical experience on all the theoretical concepts they have gone through in their text books.
- Offers recreational facilities to urban people by providing a visual treat to reduce their stress, work burden and help them maintain a stable work-life balance.
- Serves as an additional source of income to the farming community and reduces their sole dependency on agriculture for their survival.
- Enriches the livelihood of rural artisans by promoting local and authentic products.
- Helps in improvement of rural infrastructure through laying of roads, connectivity through railways, construction of hospitals and so on.
- Prevents movement of rural artists to urban areas in search of jobs which would provide regular income.
- Helps in women empowerment in rural areas by providing them employment and exhibit their innovations in farms to tourists.
- Assists in poverty alleviation and employment generation, preventing urbanization, improves contribution of rural areas to national economy, and increases per capita income.
- Paves way for cultural inheritance as rural areas stand as a place of cultural heritages.

Challenges in Agrotourism

As any other sectors of tourism, agrotourism also faces certain challenges in establishment. The major concern is related to health and safety of tourists as most of the rural areas in the country lack proper medical necessities and hospitals in the vicinity. Certain agriculture lands also have some of the air pollutants due to extensive use of pesticides, herbicides and pollens from certain dangerous weeds. The next challenge would be the lack of knowledge of the local people about the needs and necessities of the tourists as cultural barriers exist. Certain areas also lack network

connectivity. Middlemen also exert a pressure on this type of tourism by increasing the prices of local products and influence the decisions made by the tourists.

Agrotourism in promoting rural economy

ATDC has conducted a survey on the tourist visits to the agro tourism centers and the results were 0.40 million, 0.53 million and 0.70 million in the years 2014, 2015 and 2016 respectively. It has also been found that the farm families in these centers have generated 35.79 million INR through agrotourism (Agri tourism, 2017). The values have been projected positively and are in increasing trend. It also promotes rural employment and increases the revenue generation at all levels.

Conclusion

Mahatma Gandhi once said "the future of India lies in its villages". In relevance with this statement, villages contribute on a higher scale to nation's economy. Thus, integrating a successful sector called tourism with agriculture will always prove to be beneficial. Something new to see, do and buy will automatically promote a place as a tourist destination. Though it has certain negative aspects like seasonality, cultural gap, connectivity, middlemen issues, these can be solved by framing government policies relevant to this sector.

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www.agritourism.in

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ADVANCED WASTEWATER TREATMENT TECHNOLOGIES

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Introduction

Over the years, disposal of wastewater into the surface water sources causes significant issues and harms people's health. The wastewater contains many pathogenic bacteria, microorganisms, suspended solids, nutrients, minerals, toxic pollutants etc. Traditional waste water treatment methods include preliminary, primary, secondary and tertiary treatments. Preliminary treatment includes the removal of coarse solids and other large materials from wastewater. The physical processes of sedimentation and flotation are used in primary treatment to remove organic and inorganic solids. In secondary treatment, the effluent is treated to remove the residual organics and suspended solids. Tertiary wastewater treatment focuses on making the water safe for drinking. However, increase in urbanization and population has led to the emergence of new chemical compounds used for different commercial and domestic purposes. These compounds are released in the water directly after use or indirectly through wastewater treatment plants (WWTPs) and are referred to as emerging pollutants (EPs). The traditional WWTPs are not designed to remove these EPs and their metabolites, resulting in widespread occurrence throughout the surface waters and sediments globally over the decades. EPs cause varying degrees of physiological stress such as genotoxicity, endocrine disruption to aquatic and human health and leads to development of antimicrobial resistance even at nanogram level. The present article focuses on highlighting different types of advanced wastewater treatment technologies for removal of EPs in water.

Advanced Wastewater Treatment

Advanced wastewater treatment is employed when specific wastewater constituents, that cannot be removed by secondary treatment. Individual treatment processes are necessary to remove nitrogen, phosphorus, additional suspended solids, refractory organics, heavy metals and dissolved solids. Since advanced treatment usually follows high-rate secondary treatment, it is also referred to as tertiary treatment. However, advanced treatment processes are sometimes combined with primary or secondary treatment (e.g., chemical addition to primary clarifiers or aeration basins to remove phosphorus) or used in place of secondary treatment (e.g., overland flow treatment of primary effluent). Advanced wastewater treatment processes can be:

- Physical Process
- Chemical Process
- Advanced biological method /process

Physical Method:

The different types of wastewater treatment method for physical process include adsorption, membrane filtration (nanofiltration, electrodialysis etc.). Physical method eliminates solids from wastewater as it flows through screens or filter media, or solids are removed by gravity settling or air flotation.

Adsorption

Adsorption is most commonly implemented for the removal or low concentrations of non-degradable organic compounds for process water. Adsorption takes place when molecules in a liquid bind themselves to the surface of a solid substance. Adsorbents have a very high internal surface area that permits adsorption. Activated carbon is by far the most commonly used adsorbent and is particularly suited to the removal of polar compounds. The effectiveness of the adsorption treatment is determined by the type of pollutant to be removed. Substances with a high molecular weight and low water solubility are better adsorbed with activated carbon.

Membrane filtration

Membrane filters works on mainly three mechanisms such as sieve /pore size (ultra & nano filtration), diffusion /solubility (reverse osmosis), electric force (nano filtration & electrodialysis). It includes various methods:

- Reverse osmosis
- Nano- filtration
- Ultrafiltration
- Microfiltration

Reverse Osmosis

It is also knowns as the hyperfiltration as it is not porous and selectively allows liquid but retain most of the ions and solutes. It has high operating pressure in the range of 20 to 100 bar. Reverse osmosis comprises of plate and frame, tube, roll and hollow fiber type. It can eliminate a variety of organic matter, dissolve inorganic salts and impurities. It is also efficient in salt elimination and reuse rate of water. It also separates organic compounds such as oxygen and nitrogen, colloid with <3.10 micrometer, ions and pesticides.

Nano Filtration

In nanofiltration the size of membrane pores is nominally ~ 1 nm due to which even minute solutes are rejected but the surface electrostatic properties allow single charge ions to be easily transmitted with polyvalent ions mostly retained. Pollutant separation by nanofiltration membrane depends on differences in charge effect and particle sizes. Nanofiltration compared to reverse osmosis has greater water permeability and works on low pressure range between 7 to 30 bar.

Ultrafiltration

Ultrafiltration (UF) is a water purification process in which water is forced through a semipermeable membrane. Suspended solids and high-molecular-weight solutes remain on one side of the membrane, the retentate side, while water and low-molecular-weight solutes filter through the membrane to the permeate side. It removes 90-100% of pathogens, and does not require chemicals, except for cleaning membranes. The pore size of ultrafiltration membranes ranges from 0.1 to 0.01 microns.

Micro Filtration

In this process particles of one size are separated from other size which are in the range of 0.01 µm to 20 µm. It is driven by pressure and is thus effective. It has largest pore size (0.1-5 micron) of different membrane filtration system. Microfiltration with ceramic filter (0.8µm) is effective in removing the turbidity due to the suspended solids. Most microorganisms can be removed and recovery of enzymes in waste-water.

Electrodialysis

It is generally a process of membrane separation and is generally used in the treatment of wastewater processes. It combines electrolytic and dialysis diffusion process, which on action of direct current electric field allows anions and cations of dissolved salt in wastewater to move to anode and cathode. The chief purpose of this method is to remove salts from aqueous solution, which is done by passing an aqueous solution via ion exchange membrane.

Other physical methods

- Coagulation: It is used for removal of suspended and dissolved particles.
- Ion exchange: normally used for hardness removal.
- Micro staining: It is a special type of filtration process which makes use of filters oven from stainless steel wires with very fine pores of 60-70 µ size. This filter helps to remove very fine particles.

Chemical Method

Chemicals are used during wastewater treatment in an array of processes to expedite disinfection. Specialized chemicals such as chlorine, hydrogen peroxide, sodium chlorite, and sodium hypochlorite (bleach) act as agents that disinfect, sanitize, and assist in the purification of wastewater at treatment facilities. The two major process in chemical treatment include chlorination and ozonation.

Chlorination

Chlorine is the most widely used disinfectant for municipal wastewater because it destroys target organisms by oxidizing cellular material. Chlorine can be supplied in many forms, which include chlorine gas, hypochlorite solutions, and other chlorine compounds in solid or liquid form. It has a major disadvantage that the chloride residual is remaining after the treatment.

Ozonation

Ozonation (the addition of gas ozone into water) is a technique for treating water. Besides, ozonation is an advanced oxidation process that can destroy all microorganisms and many organic compounds. Ozone is more effective than chlorine at killing viruses and bacteria. The ozonation process required a short contact time (approximately 10 to 30 minutes). As ozone decomposes rapidly and completely, there are no harmful residues. Also, after ozonation, there is no regrowth of microorganisms, except for those protected by the particulates in the wastewater stream.

Table 1: Advantages and disadvantages of different treatment technologies

Treatment Technologies	Advantages	Disadvantages
Biological Process	Don't require chemicals, high pressure, or high temperatures. Ecologically favourable process	Low selectivity and low reaction rates. High capital and operational cost, handling and disposing the secondary post problems. Need pre-treatment steps to degrade the pollutants in wastewater into less toxic by-products. Use of enzyme technology in commercial WWTPs is still limited.
Physical Adsorption	Cost effective method Easy availability and operation More efficient than the conventional methods.	Merely removes the pollutants from one phase (aqueous) to another (solid matrix).
Advanced oxidation process	Powerful oxidation technique oxidizes a large number of organic and inorganic materials. Can treat a wide variety of contaminants. Effective process due to formation of OH radicals.	More complex technology and requires high capital cost. High electricity consumption. Chlorination may form halogenated species. Ozonation process has relatively low mineralization degree. Photocatalysis may for toxic intermediates. Electrochemical oxidation is high energy consumption and low mass transfer rate.

Advanced Biological Method:

Enzymatic Method

Biological methods of removal are increasingly becoming significant nowadays. The enzymatic method is a biological treatment that aims to improve the water effluent, through the supply of enzymes to reduce or eliminate the toxicity of the water by the transformation of pollutants. Various oxidoreductases like laccases and peroxidases (soybean peroxidase, horseradish peroxidase, and manganese peroxidases) were used for the enzymatic degradation of pollutants. The enzymatic activity of laccase catalyses the oxidation of various aromatic and inorganic substances (particularly phenols) with the concomitant reduction of oxygen to water. Due to the highly effective catalytic and stability potential, enzyme-based biodegradation approaches are considered an evocative substitute for EPs mitigation from environmental matrices. But, notwithstanding an existing technology with recognized bioremediation potential, the exploitability of enzymes (both in pristine and engineered counterparts) is currently far from and has not yet been deployed at large-scale treatment units.

Conclusion

Wastewater generation is unavoidable, but it can be treated in an effective way to minimize environmental impacts. Industrialization led to the introduction of new contaminants in pesticides, pharmaceuticals, cosmetics, etc. which have complex compositions and are hazardous in nature. Even though 75% of the earth's surface is covered by water the availability of drinking water is less than 1%. Many treatment methods are emerging for the ultra-purification of wastewater. Water treatment technology development and implementation have been primarily driven by three primary factors: the discovery of new rarer contaminants, the adoption of new water quality standards, and cost. During yearly periods, chemical clarification, granular media filtration, and chlorination were virtually the only treatment processes used in municipal water treatment. However, today we can see a dramatic change in the industry's approach to water treatment as they are seriously considering alternative treatment technologies to the traditional filtration/chlorination treatment approach. The NF technique can be applied for treating wastewater containing small contaminants. Advanced oxidation is a chemical treatment method, that is highly efficient in eliminating organic compounds, but their operation is also costly. Integrated treatment methods along with algae bacterial symbiosis can make the system more efficient and economical.

AMFI-SI-08

ALERT SERVICES IN FARM RESEARCH

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Alert services have emerged as a valuable tool for the research community in guiding and updating their research activities and initiatives. It remains as an excellent way of receiving information on latest advanced researches done across the world. Being available from various databases, library services, publisher web pages and other web based resources, the researcher can gain access even to previous years research information on a wide range of subjects related to his research work. All popular journals, magazines provide alert services through email or through Rich Site Summary Feeds (RSS feeds). The researcher has the freedom to receive alerts from newspapers, magazines, journals according to his or her choice of language and alerts of a particular geographical region by selecting the alerts in the sources field. This will give best results needed by the researcher within a very short span of time.

Types of Alerts

The researcher can receive a wide range of alerts depending on his nature of research or study. The different types of alerts like journal alerts where he can select a full text of the article published or the Table of Content (TOC) by just clicking the content and receiving it according to his need and use. There are also citation alerts, library alerts, search alerts, new books alerts, new addition alerts which assist in doing research effectively.

Google and other popular Alerts:

It remains as one of the most popular alert service across the world among the researchers. Launched in 2003, this alert service sends email to the user when it finds new results on web pages, blogs, newspaper articles or scientific research that matches the users search item. It is a content change detection and notification service offered by Google to its users. An E-mail is needed for creating and receiving alerts from Google alerts on the research topic of your choice and it gives alerts at stipulated intervals of time. All popular scientific publications like Nature journal offers alert services in addition to services offered by Google for researchers for carrying out their research. An E-mail needs to be created and registered in the nature journal website for receiving its alert services. Whenever a new article is added to the journal, the users receive a notification via email. This alert service is also given individually free by popular publications like Springer, Taylor & Francis for assisting our scientific and research

community. At present our Government of India through its E shodth is also providing these alert services from the covid 19 pandemic using about twelve databases catering to the needs and priorities of our scientific and research communities.

Conclusion

In years to come with climate change issues and price fluctuations in farm markets playing an important role in our farm research, the need of the hour is to effectively use research alert services to do more farm researches which are location specific and tailor made to meet our development needs and priorities in the near future. Our Policy Planners, Farm Professionals and Researchers need to integrate and work together in assisting, guiding and supporting our research system with more regional and location specific farm alerts to combat or mitigate climate change related farm challenges in the near future.

AMFI-SI-09

APPLICATIONS OF SOLAR ELECTRICITY IN CROP PRODUCTION AND PROTECTION

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The sun light plays an important role in agriculture, starting from plant photosynthesis to drying of post harvest agro produces. In earlier days, solar energy was more effectively utilized in open yard sun drying for drying purposes. The sunlight is more abundantly available in tropical parts of the country, which will show more potential for harnessing and utilizing solar energy effectively in Indian agriculture. Presently, electricity is one of the energy sources used in agriculture, mainly used for operating the irrigation water pumps, electric fencing, stand alone agricultural machineries, light trap, bird scarer etc., However, the availability of electricity is limited to all the agricultural fields due to several factors. Solar photovoltaic (PV) technology is recently getting popular among the farming community due to simple operations, low maintenance, and highly reliable energy source. Solar PV technology utilizes solar radiation to generate electricity. Generally, heat and electrical energy can be obtained from solar radiation by using suitable devices. Solar thermal devices are used for tapping the heat energy from solar radiation. The solar PV devices are employed for converting the sunlight into electricity.

What is solar electricity?

The electricity production via solar PV devices is called solar electricity or green electricity. It is produced from sunlight using a solar cell. The solar energy conversion into electricity takes place in a semiconductor device is called a solar cell. *Generally, the working principle of solar cell is based on the photovoltaic effect, i.e.,* generating a potential difference at the junction of two different materials in response to electromagnetic radiation. *The solar radiation falls on the solar cells' surface can directly produce direct current (DC) electricity. In order to meet the desired electrical load, the solar cells can be connected in series or parallel to form solar panels. Further, the* solar array can be formed by connecting the solar panels for producing large scale electricity. *The electrical load can be connected directly to solar panels or through a battery. These cells are made up of* semiconductor *materials, and mostly silicon materials are used.*

What are the components of a solar PV system?

Generally, the solar PV system is consists of solar panels, battery, charge controller, inverter, electrical cables, junction boxes, and a supporting structure. The solar panels are used to produce DC from sunlight. The battery is used to store the solar electricity produced by the solar panel. The charge controller monitors and controls the flow of

current from the battery to the utility point and current supply from solar PV panels to the battery. If the battery is fully charged by electricity from solar panels, it should not be recharged further, *i.e.*, overcharging. The charge controllers would prevent the battery from overcharging by disconnecting the power from panels to the battery. The purpose of the inverter in the solar PV system is to convert direct current into alternating current (AC). This component is an essential component of the solar PV system connected with AC machines. The cables are used for connecting the solar PV system's different components for electricity flow. The supporting structure can accommodate the different components of the solar PV system.

Benefits of solar PV power systems

- Solar energy is renewable, freely available, and also a pollution-free resource for solar electricity production.
- It has no mechanical moving parts, thus results in a low maintenance cost.
- This system can be more effective in remote and off-grid areas.
- A battery can be used to store solar electricity for further usage.
- Act as a power source for a variety of applications, starts from street light to satellites.

How can we effectively utilize solar electricity in agriculture?

Solar electricity can be used for different applications in agriculture. The solar PV devices available for different applications are presented in Table 1.

Table 1. List of solar PV powered devices used in agriculture

S. No	Name of PV devices	Nature of applications
1	Solar PV water pumping system	For irrigation purposes
2	Solar insect trap	To monitor and manage the harmful insects
3	Solar PV powered bird scarer	To protect the seeds, agro and horticultural produces from birds
4	Solar PV drones (with sensors)	To monitor the plant infesting insect pests, diseases and nutritional deficiencies
5	Solar PV powered weeders	For mechanical weeding operations
6	Solar-powered vehicles	Transport of agro produces
7	Solar PV supported automated irrigation system	For efficient use of water through drip irrigation by planning irrigation scheduling

8	Agrophotovoltaics system	Simultaneous production of food and electricity
9	Solar PV powered electric tractors	Different operations in agriculture such as sowing, ploughing, etc
10	Solar PV sprayer	Spraying of liquid chemicals
11	Solar PV duster	Application of powdered chemicals for managing the insect pest and diseases
12	Solar hybrid dryer (Solar PV and solar drying)	For the drying of different agricultural produces
13	Solar PV powered winnowers	For winnowing of grains to remove small insects, inert materials and also for grading
13	Solar PV desalination systems	To produce consumable plant water from saltwater
14	Solar PV powered solar greenhouses	To provide a better environment for plant growth with a protection from insect and vector transmitted diseases
15	Solar fencing	To protect the plants from wild animals

There is more potential for solar electricity to replace the conventional electricity used for different applications in agriculture in India. This step would help to develop energy, sustainable, and profitable agriculture. Among the several PV devices used in agriculture, solar fencing, solar PV water pumping system, and different models of solar insect traps have already reached commercialized scale production and reached huge numbers of them to help the farming community.

Solar PV powered water pumping system

Solar fencing

Solar insect trap

AMFI-SI-10

BEAUTIFUL ALARMING MENACE – WATER HYACINTH

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Introduction

Water hyacinth (*Eichhornia crassipesis*) an aesthetic aquatic weed free floating and fresh water friendly perennial plant that was introduced into various parts of the world owing to its enchanting beauty un-anticipating the hazards that could create to the environment. These plants multiply and spread in an exponential rate that made it strong to withstand all the efforts made by man to eradicate or control them. It could infest and conquer all sorts of water bodies like ponds, ditches, lakes and reservoirs and sometimes so densely populated so as to heavy interruption to navigation, irrigation, hydroelectric production, increased evapotranspiration, flood and mosquito control as well as destroy natural properties of habitat, degrade water quality and hinder agricultural endeavors such as rice cultivation and fishing.

Spread of Water hyacinth

Water hyacinth also called as Demon, blue devil, Bengal terror, curse of Bengal, million dollar weed for the magnum of destruction caused by this weed and the fast spread and occurrence across the country irrespective of the efforts made by man to control it. Similarly the plant, water-hyacinth is also variously named in different languages in India. For example it is called Jalkumbhi or Falkumbhi or Sokh Samundar (Hindi); Pisachi Thanana (Telugu); Vengaya Thamarai or Akasa Thamarai or Neithamarai (Tamil); Kolavazha (Malayalam); Kazorpati or Bilatidala or Kalikatidala (Oriya); Kachuripana (Bengali) and Kulavali (Kannada). The beautiful, large, purple flowers make it a favourite ornamental plant native to the Amazon basin in South America. Interestingly, the Water Hyacinth was a gift of the British to India, introduced towards the end of the 18th century. Lady Hastings, the wife of the First British Governor-General, who was enchanted by the beauty of the flowers, brought it to India, which has now spread to most water bodies. Today water-hyacinth occurs throughout India, Pakistan, Sri Lanka, Bangladesh, Burma, Malayasia, Singapore, Indonesia, Phillippines, Thailand and adjacent areas. it has become an environmental and social challenge throughout India.

Characteristics of Water hyacinth

It commonly forms dense, interlocking mats due to its rapid reproductive rate and complex root structure. Water hyacinth reproduces both sexually and asexually. Seeds generally germinate within six months, with dry conditions promoting

germination. Low nutrient concentrations and temperature (air and water) are considered the strongest determinants for water hyacinth growth and reproduction. The cover of water-hyacinth provides obnoxious smell, colouring matter of suspended particles in water. It increases carbondioxide concentration and also it decreases clarity of water and reduces dissolved oxygen content. The rate of organic matter production by water-hyacinth is so high that the dead organic matter accumulates in the water body. The decomposition of dead plants occurs very slowly and the leaves remain identifiable for several months. Under anaerobic conditions the decomposition is still slower. The decomposing organic matter remains buoyant and suspended below the mat. This helps in the formation of sudds or floating islands, which can be walked over. The evapotranspiration rate from water-hyacinth cover is very high as reported by various authors which results in heavy water loss and water-hyacinth displaces large volumes of water in the reservoirs. Its prolific growth causes considerable economic problems and affects fisheries, traffic, irrigation, water supply and the whole ecology of the infested lake.

Status of Tamil Nadu

The species has invaded almost all water bodies of the country leaving Himachal Pradesh, Jammu and Kashmir and Mizoram. Among these we believe the temperate climate of Himachal Pradesh and Jammu and Kashmir prevented them from the water hyacinth invasion. Most rivers in Tamil Nadu have been covered by the green carpet of Water Hyacinth because of the pollutants dumped by the industries on their banks. Many textile processing units in Tamil Nadu use a number of unclassified chemicals that are likely to be from the Red List Group which is said to be harmful and unhealthy. Water hyacinth has been reported to be a menace in Noyyal river, Singanallur tank of Coimbatore, Cauvery river due to the effluents fromm dyeing units at Namakkal, Valankulam lake and Ukkadam main tank of Coimbatore. In the city of Chennai, Velachery Lake, the boundary of pallikarani drainage swamp, a portion of Adyar river, Buckingham canal and Otterinullah have turned eutrophic due to Eichhornia crassipes. This is also the case with water bodies around Trichy, Madurai, Tirunelveli, Coimbatore, Salem and other districts. Eichhornia crassipes is the first order among water weeds causing menace only second to Ipomoea aquatica. In Tamilnadu almost 80% of 39000 tanks are already infested with this weed. Even very big lakes like Chembarakkam lake, Dusi- Mamandur lake, Kavaripakkam lake, Veeranam lake, etc are affected by Water Hyacinth.

Control Measures for Water hyacinth

Early control attempts concentrated on removing plants from the water with pitchforks, dumping the accumulated mass on land to die. It is called the physical method. Manually removing plants from small areas of water such as farm dams and drains is an effective form of controlling water hyacinth, but only when the rate of removal is faster than the rate of regrowth. On a larger scale, manual removal is less

likely to achieve control of water hyacinth. In chemical method the most commonly used technique for applying herbicides to water hyacinth is high volume spraying with hose and handgun power sprays either from a boat or from the banks. In some situations large infestations have been aerially sprayed. The chemicals used makes the water unfit for irrigation and human consumption. Moreover these chemicals causes the weed mass to sink and result de-oxygenation of water. Thus the herbicides could be applied in portions followed by physical removal method to avoid submergence of dead mass.

Biological control of the hyacinth was studied with several kinds of animal viruses, bacteria, and fungi, as well as with manatees, insects, herbivorous fish such as grass carp and tilapia, ducks, geese, turtles, snails, and other animals. However, the results were disappointing, perhaps because of defence mechanisms in the plants and the impact was very temporary and patchy. As part of a control program, nutrient run-off into infested waterways should be minimised. Drainage or reduction of water levels can also reduce the area of water hyacinth plants, but it is important to note that seeds will remain viable in the soil and will germinate when the area refills with water.

Initiatives by Neighbour States

Andhra Pradesh has proposed the use of biogas produced from water hyacinth to be used for generating electricity, heating and industrial purposes. The aim is to provide efficient energy solution that is reliable, scalable and cost effective The Kottapuram Integrated Development Society (KIDS), a non-governmental organisation of Kerala, in collaboration with the India-Canada Environmental Facility, is utilising water hyacinth for producing biogas. The project has been running successfully, according to Sunny George, a scientist who is associated with the project. Another project of KIDS involves production of vermi-compost from water hyacinth.

Possible Solutions

Various authors studied the utilization of water hyacinth as substituting bean straw with water hyacinth as animal feed, feed for solid-phase fermentation, raw material for making pulp, paper and paper board and the vermicomposting of water hyacinth.

Fertilizers

Water hyacinth can be converted into compost and used on the land with proper management & technology. Water hyacinth is a well known cleaner of polluted water & different pollutants (like heavy metals) are deposited in its root. So roots are generally removed in case where water hyacinth is collected from polluted water. As a green manure it can be either ploughed into the ground or used as mulch.

Water Hyacinth and Cow dung in 8:1 ratio has been shown to greatly increase the agricultural production by many folds. Only the leaves and stalk portion of the Water Hyacinth has to be used. Straw can be added as an extra source of Carbon. Mud plastering at the outside of the heap is essential in all models for restoring moisture &

temperature during composting. Fresh water hyacinth is mixed thoroughly with cow dung (25%).After partial decomposing for 40 days, the earthworms are introduced and again composting is done for the next 40 days.

Composting

Composting as an alternative treatment has the advantage of producing a product that is easy to work into the soil compared with dried water hyacinths. The windrow or pile composting method the most popular example of a nonreactor, agitated solids bed system

Vermicomposting

A study was conducted in Tamil Nadu Agricultural University, Coimbatore to explore the possibility of conversion of water hyacinth into nutrient rich vermicompost. Among various treatments, vermicomposting with E. eugeniae along with enrichment was found to be superior, considering the total N, P, K, Ca and Mg content of the vermicompost. This kind of manure production can be done by any farmer with access to a small pond with Water Hyacinth. No investment or instruments is required, only labour and time.

Bio-plastic

Researchers at Manonmaniam Sundaranar University in Tirunelveli, Tamil Nadu, have found that water hyacinth-derived sugar molecules like lignin, cellulose and hemicellulose can be converted into polyhydroxybutyrate (PHB), a polymer that is a raw material for making biodegradable plastic. Plastics developed using PHB are compostable. Also, making PHB from natural resources can reduce cost and harmful gas emissions.

Bio-gas

It has been estimated that each year one hectare can yield about 100 tonnes of dry water hyacinth, that this, in turn, can produce 30,000 m^3 of gas, and that this could satisfy the cooking needs of 40 or 50 rural families.

Hydrochar

The hydrothermal carbonization of C-rich biomass in the presence of water results in the production of a solid material that is referred to as hydrochar. The advantage of hydrothermal carbonization processes over the previously processes is that it usually takes place at relatively low temperatures (150-350°C, at about 2 MPa pressure) and wet feedstock can be directly used, including wet animal manures, sewage sludge, and algae. The hydrochar process is also ecofriendly because it does not generate hazardous chemical waste or by-products as does dry pyrolysis.

Chemical and Biological Components extraction

Isolation cellulose from water hyacinth was carried on extraction and acetylation to produce cellulose diacetate, where water hyacinth yields 5.6 % of cellulose. The cellulose can be further used for membrane preparation.

Instead of cellulose, water hyacinth is also known as a source of shikimic acid. Higher shikimic acid concentration (0.03 -2.70 % w/w) found in aerial parts than the roots (0.05-0.90 % w/w). To achieve that results, methanol was applied for solvent.

Water hyacinth has capacity as a growth media for rhizobacteria in juices and dehydrated powder forms. Water hyacinth in dehydrated powder (5 and 10 g/L) support the recoverability the population densities of total rhizobacteria (3 x 107 -108 cfu/g). water hyacinth also can generate phenol and cycloalkenes during hydrothermal treatment. Carbon fiber also can be generated from water hyacinth by polymerization of water hyacinth tar in formaldehyde and hydrochloride acid as catalyst. This carbon fiber has axial modulus and tensile strength around 42 GPa and 600 MPa respectively which are comparable to commercial carbon fiber.

Paper, Plywood and Fiber board

The plywood production from coconut coir fiber and water hyacinth was investigated to reduce the residue and be increased of value and to reduce the use of natural wood by using coir and water hyacinth which are pressed to be plywood production.

A fiber board for use as a construction material includes self adhering compressed fragments of water-hyacinth. The fiber board preferably additionally includes one of glue, sand, cement, sawdust, metal filings, dried rice husk, banana fiber, lime and coconut waste, integrated into the self adhering fragments of water hyacinth. A method of manufacturing a fiber board includes the steps of gathering quantities of water-hyacinth from the surfaces of bodies of water; chopping and pulping the quantities of water-hyacinth into fragments; providing the fragments with moisture; and compressing the moist fragments into a desired fiber board shape.

The pulp freeness (°SR) and drainage properties of water hyacinth and bamboo pulps showed that with a high freeness value of the pulps the drainage time increased. Blending of water hyacinth and bamboo pulps increased the physical strength. Paper hand-sheets made with a blend of water hyacinth pulp (75°SR) and bamboo pulp (80°SR), at 75:25 proportion, gave a tear index of 4·90 mN m^2 g^{-1}, tensile index of 51·10 N mg^{-1} and burst index of 7·25 kPa m^2 g^{-1}. The pulp sheets at a blend proportion of 75:25 also gave satisfactory greaseproof properties.

Conclusion

However, it's not all bad. There are certain unique advantages of the plant. The plant thrives in highly polluted waters and can reduce the level of pollutants in the water, thus helping in tackling the widespread issue of water pollution through a process called phytoremediation. Research has shown that the plant is capable of cleaning up polluted industrial wastewater of toxic heavy metals like chromium and crude oil. Also, technologies are currently being developed to utilise water hyacinth as a green fuel and to make paper and paper boards. We have to make the best of the evil perhaps attempting to eradicate the species. All advantages and possible remedial solutions has to be explored and promoted to create a sustainable environment and, better employment and socio-economic conditions

AMFI-SI-11

BEETLES AS EFFECTIVE DECOMPOSERS OF EXCREMENT

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INTRODUCTION

Excrement is a very special habitat for coprophagous species, and the spatial distribution of dung increases the tendency of these insects to concentrate in a limited space. The excrement of vertebrates generally is a rich source of nutrients, and insects play an important role in the rapid recycling processes of faeces. However, carnivorous excrement contains little material useable by insects because of their efficient digestive process. In contrast, the digestive system of herbivores is less efficient and the dung produced is quite similar to the original leaf material. More than half the food consumed by herbivorous animals is returned to the ground in the form of unassimilated material, *i.e.*, dung. Because it has abundant in organic matter and moist, herbivore dung is an ideal medium for establishment of a specific, rich entomofauna involved in the process of decomposition and elimination of faeces. Quantitatively, large herbivore dung pats are the most important resource for dung beetles in most regions, and this fauna is especially abundant in historic grazing areas.

The process of colonization of excrement typically consists of three waves of insects. The first wave of colonizers involves certain flies arriving within hours to lay eggs or larviposit on the dung before a crust is formed on the pat. The second wave is several families of beetles. Lastly, mites become abundant.

Beetles

Among beetles that use dung resources, the dung beetles belonging to the Scarabaeidae (Scarabaeinae,Geotrupinae and Aphodiinae) are the most important and numerous. Not all scarab larvae are strictly coprophagous, and some ingest soil organic matter or feed on roots of plants. However,many are coprophages, and often exceedingly abundant. Thousands of individuals from many species may be found colonizing single dung pats in temperate and tropical grazing ecosystems. Most Aphodiinae are saprophagous and within the Geotrupinae coprophagy is the rule for the Geotrupini. Only Scarabaeinae has coprophagy as a characteristic of most of its species. In this case, most of the nutrients eaten by the adults are derived from eating microbes or colloids suspended in dung. The larvae feed on the dung supplied by their parents in a nest chamber.

Various other groups of beetles visit dung but they are primarily predators. Coleoptera of the families Hydrophilidae, Staphylinidae and Histeridae are associated with carrion as predators of larvae of flies and dung-beetles. However, the two former families also include coprophagous species. In the temperate region, the hydrophilids *Cercyon* and *Sphaeridium* (Coleoptera: Hydrophilidae) are coprophagous, arriving within the early hours after deposition of dung.

The Dung beetles

The behavior of dung beetles (Coleoptera:Scarabaeidae) is specialized and diversified inresponse to exploitation of excrement by adults and larvae. The Scarabaeidae consist of approximately 7,000 species (5,000 Scarabaeinae, 1,900 Aphodiinae and 150 Geotrupinae). Many species of Scarabaeinae and Geotrupinae have developed special feeding and breeding strategies that allow them to remove dung rapidly the soil surfaces by digging burrows below the dung pad to store fragments of dung in tunnels. They also may form dung into balls and roll them away from the pad for burial far from the food source. The importance of these habits is the protection of food for adult or larvae, avoiding competitors, predators and unfavorable climatic conditions. Only Aphodiidae do not make a nest. Aphodiidae eat directly into the dung and many species deposit theirs eggs directly in dung pads without nest chamber or in the surrounding soil. Geotrupinae and many tribes of Scarabaeinae are tunnelers. These species dig a tunnel below the dung pat and accumulate dung in the bottom of the burrow; this food can be used either for adult or for larval feeding. Finally, some species of Scarabaeinae are rollers, making a ball of dung that is rolled away from the pat for a variable distance before burying.

One of the most important aspects of the biology of Scarabaeinae and Geotrupini is the interesting behavior. Geotrupini nests are the most primitive and consist of simple burrows filled with“sausages” of dung, usually containing one egg each.

The reproductive biology of Scarabaeinae has several distinct patterns, which have been reviewed and compiled in comprehensive and wonderful books by Halffter and Matthews (1966) and Halffter and Edmonds (1982). The process of nesting involves the creation of a place in the soil where a supply of dung is accumulated for development of larvae.

Scarabaeinae nesting frequently involves bisexual cooperation of a pair of beetles, for either shortor long periods of time, and parental care sometimes exists. The adults make brood balls in the protected nest, each of which contains the amount of food required for larvae to enable them to complete larval development. Nesting behavior is considered as an adaptation to isolate immature larvae from each other and from adults, increasing the survival of offspring. Obviously this is a process that requires the investment of considerable time and energy on the part of the parents. Nesting derives from feeding behavior and basically corresponds to food relocation: tunnelling and ball rolling.

The tunnelling scarabs take food from the dung pat and bring it into a previously excavated gallery. Various types of nesting have been described for tunnellers, and it is sometimes difficult to ascribe a particular type of nesting to a species.

The most primitive and simplest nest behaviour is observed in some genera of Dichotomini,Oniticellini, Onitini, and also Onthophagini. A female digs a simple burrow, fills it with food, forms a brood mass and provides a single egg. In this case, there is no bisexual cooperation or maternal care, and the species involved show relatively high fecundity.

Other groups of dung beetles make nests containing several or many brood masses such as those observed in some species of Dichotomini, Onitini,Onthophagini and Oniticellini. The brood masses are constructed in series, in the same tunnel or separated in individual side branches. In this type of nesting, bisexual cooperation may exist, but the role of the male is restricted to introducing food into the tunnel. These species have relatively high fecundity, and there is no maternal care.

Coprini and several Dichotomini, Onitini and Oniticellini species construct nests that contain several spherical brood masses arranged in a single or branched tunnel with or without separation.

Some scarabs produce a nest containing only a few brood balls in a chamber, and physically separated from other chambers. This nesting behaviour is present in species with low fecundity: Phanaeni (without maternal care), several Dichotomini (with or without maternal care), and several Coprini (with maternal care).

Finally, the species of *Oniticellus* (Oniticellini) show endocoprid nesting behavior: digging burrows and making brood chambers in the dung pat, where nesting takes place. The species of this genus present moderate to extensive maternal care.

Rollers

The roller habit of food relocation is only present in some tribes of Scarabaeinae: Scarabaeini, Chantonini, Gymnopleurini and Sisyphini. Species of these groups make a brood ball that is rolled away from the pat. The weight of the ball can be up to more than fifty times the weight of the beetle. The process is initiated by one partner and the ball acts as a sexual display to the other sex. The brood ball also may be rolled by two partners, but sometimes the female is transported on the ball. Combat is common between members of the same species when rolling balls. Generally, sexual cooperation finishes when copulation takes place in the burrow, after which the male leaves the female. Females prepare four to five pyriform brood balls and lay eggs in a narrow cavity at the upper end of each pair. The female may abandon the nest after oviposition, such as in Scarabaeini, Canthonini,Gymnopleurini and Sisyphini, or they can remain in the nest until the offspring emerge, as has been described for the African genus *Kheper*.

Finally, there are some species of dung beetles that demonstrate special feeding and nesting biology. They are species using part of the food resources accumulated by

other dung beetle species in burrows or a breeding chamber. These species are called kleptoparasites, and examples are found in Aphodiidae and Scarabaeidae. These species live as parasites in the nest prepared by either roller or tunneller dung beetles.

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AMFI-SI-12

BENEFITS OF MULBERRY TEA

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Introduction

Mulberry tea is a natural, caffeine-free drink that is packed with vitamins and minerals and is used to prevent and treat many health conditions, including cold symptoms, weight loss, blood vessel problems, and diabetes. Mulberry tea which is extracted from the leaves of the mulberry tree. It is an inherent to Asia but now it is cultivated worldwide. Black mulberry and White mulberry are the most known species among the 10 species. The leaves are harvested in autumn and dried for making tea. The records of 3000 years of cultivation of mulberry trees are found in China. The mulberry tree was used by an ancient Chinese for food, papermaking, silkworms and its medicinal qualities.

Benefits of Mulberry Tea

Mulberry tea leaves contain 25 times more calcium than milk. Not only that, mulberry leaves have ten times more iron than spinach, and over twice the fiber of green tea.

Lowers Blood Glucose Levels

The increase in blood vessels causes the Type 2 diabetes. The presence of gallic acid in mulberry tea reduces the blood glucose. The diabetic patients who drank the mulberry extract, their glucose spikes was reduced after consumption in the first two hours.

Weight loss

The mulberry tea prevents from the absorption of carbohydrates due to the presence of moranoline (1-deoxynojirimycin). It helps the body to flush out the carbohydrates and starches from the body so that it does not turn to glucose. The hunger is reduced by diminishing blood sugar levels. This leads to achieve the weight loss.

Blood vessel health

The mulberry tea helps to reduce the chances of atherosclerosis by lessening the oxidation of cholesterol in blood vessels which is due to the presence of flavonoids and quercetin in mulberry leaves. It helps to prohibit the oxidative stress reactions.

Fantastic Beverage

The mulberry tea can be enjoyed hot as well as cold. It is available in loose leave as well as prepackaged. The tea bags should be steeped for at least 3-5 minutes and loose tea should be steeped for at least 8 minutes. The carbohydrates blocking effects should be maximized by avoiding the tea sweetening.

Contains Vitamin and Minerals

The presence of Vitamins and minerals helps in the production of red blood cells, manages reproduction and growth, energy production, manages thyroid activity, eliminates acne, conserves the nervous system, healthy eyes, minerals absorption, preserve the digestive tract and assists in healthy pregnancy. The following vitamins are also part of the leaves mulberry nutrition profile.

- **Vitamin A** - Promotes good vision and healthy skin, for more try carrots
- **Vitamin B1 & B2** - Involved in metabolism and nerve function
- **Vitamin C** - For a healthy immune system and skin, for even healthier skin try coconut oil
- **Bioflavonoids** - Supports a healthy heart
- **Amino acids** - Assists in the use of proteins and nutrients
- **Calcium, potassium, magnesium, and phosphorus** - Builds healthy bones, for more minerals try brazil nuts
- **Iron** - Promotes healthy blood, for more iron try arugula
- **Zinc** - Needed for good reproductive health immune health

Fights Diabetes

The mulberry tea prevents diabetes by restricting the high amount of monosaccharide to enter into the circulation. The weight problems are also eliminated as it blocks the unwanted excessive sugars from entering to the blood stream. The mulberry leaves prevents from the type 2 diabetes by maintaining the control over blood sugar level.

Fights Atherosclerosis

The mulberry leaf tea helps to prevent the cholesterol-rich plaque buildup in the arteries which is also known as atherosclerosis. It restricts the oxidation of LDL cholesterol. The study on humans and mice states that the primary agents are astragalin and isoquercitrin.

Vision

The mulberry tea possesses the high content of Vitamin A which helps to enhance the eye sight and eliminate the eye strain. It helps to prevent from eye sight loss and retina degeneration. It also helps to get rid of blemishes and dark spots on the skin. The skin issues could be treated by soaking the mulberry tree leaves for about thirty minutes in the hot water. It can also treat dry skin. The mulberry leaves if added to hot

bath and saunas helps to open the pores as well as detoxify the body. It boosts the hair growth and makes it healthy.

Antioxidant

The Mulberry tea possess compound 1- deoxynojirimycin or DNJ which provides an anti-diabetic effects and antioxidant properties and lessens the cholesterol and inflammation. The antioxidant such as beta carotene and ascorbic acid helps to prevent the cellular damage caused by free radicals.

Blood Tonic

The mulberry tea boosts the circulation, cleanse the blood and strengthen the system. It calms the nerves and enriches the blood. It purifies the liver and reinforces the kidneys. It also speeds up the recovery process. It reduces the bad cholesterol and prevents the blood flow blockage which helps to eliminate heart attacks and strokes. It boosts the immunity and balance the internal production.

Conclusion

Mulberry leaf tea extract is available in a 30:1 concentrate standardized to contain 2% moranoline content from Natural Factors. The recommended dosage is 100 mg two to three times daily. Mulberry leaf tea extract has no known toxicity.

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AMFI-SI-13

BIOINDICATORS IN AQUATIC POLLUTION: SIGNIFICANCE AND TYPES

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Introduction

Optimum water quality in aquatic environment is considered as one of the major factors in controlling the state of health of both aquatic organisms and humans. United Nations Sustainable Development Goals (SDG) 2030 agenda focused on the significance of maintaining water quality through wastewater treatment and restricting the release of pollutants directly into water. Detection of water quality and various pollutants of water is characterized on the basis of various physical, chemical and biological characteristics: Physical characteristics includes colour, odour, dissolved oxygen (DO), insoluble substances, temperature etc. Chemical characteristics are chemical oxygen demand, pH, acidity, hardness, total carbon, chlorine, oil and grease etc. Biological characteristics includes Biological oxygen demand, Presence of pathogens etc. Nowadays, the increasing use of the waste chemical and agricultural drainage systems represents the most dangerous chemical pollution. The most important heavy metals from the point of view of water pollution are Zn, Cu, Pb, Cd, Hg, Ni and Cr. Some of these metals (e.g. Cu, Ni, Cr and Zn) are essential to living organisms, but become toxic at higher concentrations. In the attempt to define and measure the effects and presence of pollutants on aquatic system, bioindicators plays an important role. An indicator species, or a bioindicator, is any organism that may signal a change occurring within an ecosystem, habitat, or location. These organisms will represent the overall physical, chemical and biological nature of the particular ecosystem. By examining the bioindicator species, it may be possible to draw conclusions about the health of the larger ecosystem and how it is changing. Various aquatic organisms including fish, shellfish, oyster, mussels, clams, aquatic animals and aquatic plants and algae are potentially useful as bioindicators of metal pollutants. This article is an attempt to elucidate significance of bioindicators and their types in monitoring aquatic environment.

Biomonitoring

Biomonitoring is defined as the process in which "analytical information" used i.e. plant and animals or their fragments to provide continuous, real time analytical information. It refers to the use of biological responses to assess changes in the environment due to anthropogenic factors. One way of biomonitoring is surveillance before and after a project is complete or before and after a toxic substance enters the water. Another way of biomonitoring is to ensure compliance with regulations or guidelines or to ensure that the water quality is maintained. Biochemical, genetic, morphological, and physiological changes in certain organisms have been noted as being related to particular environmental stressors and can be used in biomonitoring.

Properties of bioindicators

- **Good Indicator Ability:** Bioindicator should provide measurable response (sensitive to the disturbance or stress). They must respond in proportion to the degree of contamination or degradation. Sensitive to severe environmental changes (DO, temperature, pH) and is not migratory in nature (Sedentary).
- **Abundant and Common:** Easy availability, Small and easily cultivable (small life span and high reproductive rate); Indigenous or representative of a particular location; Hardy nature (some species presence in extreme environmental conditions indicate that particular factor).
- **Well Studied:** Ecology and life history well understood. Easy and cheap to survey, capable to accumulate pollutants in body (discharge rate from body is low than accumulation rate).
- **Economically/Commercially important:** Species already being harvested for other purposes.

Classification of Bioindicators

Based on International Union of Biological Sciences (IUBS), Bioindicators are divided into four categories:

- Microbial system
- Plants system
- Animal system

Microbial Indicators

Microorganisms can be used as indicators of aquatic or terrestrial ecosystem health. They are found in a large quantity; microorganisms are easier to sample than other organisms.

- *Escherichia coli* - sewage pollution & faecal contamination.
- *Streptococcus* and *Entrobactors* -faecal contamination.
- *Thiothrix spp* - oil pollution
- *Spirillium volutans* - industrial pollution

Bioluminescent bacteria are also used as bioindicators. These are used to test water for environmental toxins. If there are toxins present in the water, the cellular metabolism of bacteria is inhibited or disrupted (luciferase enzyme responsible for luminescence is competitively inhibited by pollutants). This affects quality or amount of light emitted by bacteria. It is a very quick method and takes just 30 minutes to complete but could not identify the toxin.

Macrophytes (Plant Indicator)

Seaweeds accumulate metals in their tissue and older tissue can store more as compared to newer tissue (e.g. *Fucus species*). Cyanophyta, a form of phytoplankton, is a powerful bioindicator that can indicate rapid eutrophication of water bodies such as

rivers, lakes. Marine algae *viz. A. curicuatum*, *C. gracilis* and *P. capillacea* are indicator of heavy metals (Co, Cr, Cu, Fe, Mn, Ni, Zn) in seas. Hydrophytes (*Phragmites australis*, *Typha angustifolia*, *Potamogeton pectinatus*, *Ranunculus sphaerosphermus* and *Groenlandia densa*) acts as bioindicators of iron and manganese pollutions in marshes and lakes. Green Algae (*Enteromorpha intestinalis* and *Cladophora glomerata*) acts as bioindicators of heavy metal such as manganese (Mn), copper (Cu), Zinc (Zn), Arsenic (As), cadmium (Cd) and lead (Pb) in stream. Sagittaria is an indicator of eutrophic condition, Lemna for heavy metal and Eichhornia for organic pollution.

Animal Indicators

Daphnia is the freshwater indicator organism and is used to check the effects of toxicity on an ecosystem. It is the indicator genus having a short life span and is highly reproductive. They are transparent so it is easy to study their internal organs and the effect of temperature on it. They are used to monitor the effectiveness of certain drugs but absorbing the drugs through their thin cell membrane. Some of the example of crustacean bioindicators are:

- Cladocerons – acid stress condition e.g. *Diaptomus minutus*
- *Daphnia longiremis*- eutrophic condition
- Copepods- thermal pollution
- Rotifers - polluted water with high chlorine content. e.g. *Brachionus angularis*, *B. plicatlis*.
- The abundance of polychaete, *Capitella capitata*, *Sagitta enflata* (arrow worm) and *Sagitta acerosa* (glass worm) are reliable indicators of organic pollution.

Filter feeders, such as bivalves (clams and mussels), tend to concentrate metals in their gills or other tissues *e.g.* Blue mussel (*Mytilus edulis)*. Some benthic macroinvertebrates such as stoneflies (Plecoptera), caddisflies (Trichoptera), mayflies (Ephemeroptera), and shellfish, show increases or decreases of certain enzymes, changes in DNA, RNA, amino acids, and protein production, oxygen consumption and ion concentration, in response to environmental stressors such as alteration in temperature, presence of metals and pesticides. Physiological indicators of contamination include deformities, sores, or lesions. Hence the absence of pollution sensitive benthic macroinvertebrate groups (Ephemeroptera, Pecoptera, and Trichoptera) and dominance of pollution-tolerant groups (Oligochaetes and Chironomids) are indicator of pollution. Gastropods are indicator of sewage pollution, Mollusca and polychaete for industrial pollution.

Recently, *Puntius saphore* fish was used as bioindicator to determine the effects of pollution in river by using the micronucleus and alkaline single cell gel electrophoresis assay in Gomati river. Fishes sensitive to pollutions are Minnows, Barbs and Danios because pollution causes drastic decrease in their population. Finfish like pike and largemouth bass can accumulate metals and organochlorines in their body. Fish scales of *Puntius sarana sarana*, and *Labeo rohita* are used as indicator of Silicates, Nitrates, Cu,

Fe, Mn, Pb, Zn contamination in water. Marine mammals are present at the top of food chains. Blubber tends to contain lots of organo-chlorines due to their habitat and feeding. It indicates the health of individual marine mammals, and the condition of the wider ecosystem.

Conclusion

Bioindicator have a remarkable potential in predicting the impact of anthropogenic activities particularly pollutants and predicting environmental change in a timely manner. Organism that reveals presence of pollutants in a practical way of assessing the health of environment indicates general toxicity of environment as well as conservation of natural resources. Presence or absence of multiple species of different orders with similar tolerance levels can be considered as indicator of pollution in aquatic system.

AMFI-SI-14

DESIGNER EGGS: A NEW DIRECTION IN CONTEMPORARY HEALTHCARE.

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Introduction

Eggs are a natural source of life-sustaining chemicals that offer a very nutritious dietary source, including crucial nutrients for humans. Customers are driving the market for a new category of food with potential health benefits much beyond those that have previously been established since they are constantly looking for newer items. Egg is a well-liked food item in all cultures around the world because of its superior nutritious profile, low cost, and variety in meal preparation. They provide protein as a single food item. The body needs protein to create and repair bodily tissues. Many customers want products that are slightly unique in terms of quality, freshness, taste, colour, etc. Changing the old product is one strategy for marketing a new one. One of the most difficult issues the industry is dealing with is the sharp fall in egg consumption over the past 50 years, but because eggs have become more valuable source of protein in the post-World War I era, demand has grown. Designer eggs help to reduce this issue.

Design Eggs: Why they're needed and How to prepare them.

Hens have a special ability to deposit dietary lipid into the egg yolk, the hen egg is a



possible source of unsaturated fatty acids. Drugs work to decrease cholesterol in eggs by either preventing the hen from synthesising cholesterol or by preventing the blood from carrying cholesterol to the developing yolk on the ovary. The FDA has not yet given the medications (Atorvastatin) commercial use approval, despite its potential to decrease cholesterol. Altering the fatty acid makeup of the yolk is another method for reducing the effects of cholesterol in eggs.

Making Designer Eggs: Techniques

Special feeding techniques have made it feasible to produce eggs with even lower cholesterol and saturated fat levels as well as significantly higher levels of carotenoids, vitamins, minerals, antibodies, and even bioactive peptides. causing the hen to undergo metabolic changes that may lead to the creation of substances that ultimately end up in the egg. Modify membrane transport properties to make it easier to carry substances into the egg.

Modification in Nutritional Profile with Designer Eggs

- Omega-3 enriched egg
- Low cholesterol eggs
- Immunomodulating egg production
- Mineral enriched designer eggs
- Herbal enriched designer eggs
- Pigment enriched designer eggs
- Antioxidants enriched eggs
- Vitamin enriched designer eggs.

Eggs with Omega-3s: The PUFA family includes omega-3 fatty acids, often known as n-3 fatty acids. Eggs are a poor source of n-3 fatty acids but contain a high proportion of n-6 PUFA. Eggs with a high yolk omega-3 fatty acid concentration are produced by feeding diets rich in omega-3 fatty acids. Two varieties of omega-3 exist:

1. Marine Type: PUFA, DHA, and EPA,which are more frequently found in deep-sea fish from cold waters, fish oil, and marine algae

2. Terrestrial type: 3 PUFA, LNA, which can be found in flaxseed, walnuts, spinach, and mustard greens as well as soybean and canola oils.

Reduced Cholesterol Levels

The health risks of high cholesterol are well known to the chicken business. Safety and product quality have always been the top priorities. The general public can purchase designer eggs with lower levels of cholesterol and saturated fat. By including herbal supplements like basil (tulsi), bay leaves, citrus pulp (nirangenin), grape seed pulp, guar gum, roselle seeds, spirulina, tomato pomace (lycopene), and many other herbs in chicken diets, the cholesterol levels in the chicken and yolk fat can be lowered by 10–25%.

Mineral and Vitamin Enriched Designer Eggs

Mineral Enriched Eggs

- Chromium Enriched Eggs
- Selenium Enriched Eggs
- Iron Enriched Eggs
- Zinc Enriched Eggs
- Iodine and Manganese Enriched Eggs

Vitamin Enriched Eggs

- Vitamin A Enriched Eggs
- Vitamin B_{12} Enriched Eggs
- Vitamin D Enriched Eggs
- Folic Acid and Biotin Enriched Eggs
- Vitamin K Enriched Eggs

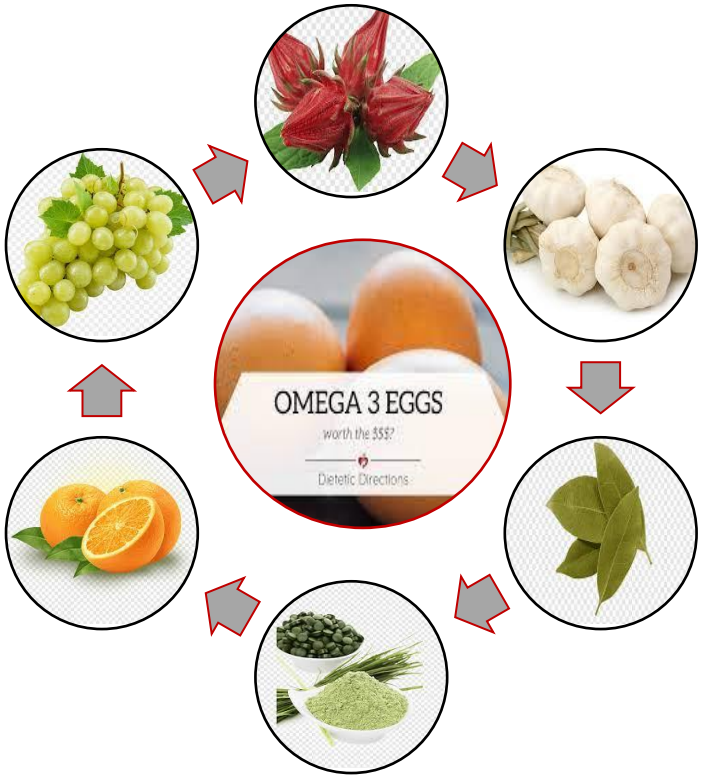
Herbal Enriched Designer Eggs

To boost hen performance and generate herbal-enriched supereggs, chicken feed can be supplemented with phytobiotics, or products derived from plants that contain a variety

of secondary plant metabolites. Herbs like garlic/onion leaves, spirulina, basil leaves, turmeric powder, citrus pulp, flaxseed, red pepper, fenugreek seeds, etc. will be added to chicken feed as supplements.

These "super eggs" will have characteristics such as increased omega-3 fatty acids, decreased LDL cholesterol, immunomodulator, antioxidant, and anticarcinogenic qualities. For instance, a typical egg has a vitamin E level of 90–100 mg per gramme of yolk, whereas an egg with a herbal supplement has 220–240 mg per gramme of yolk, adding to its improved antioxidant capacity. All of these point to the possibility of promoting human health by popularising herbal-enriched foods, both in hens and possibly in humans.

As a Food, Egg Has Many Uses



Since 300 A.D., when an oral drench of up to 12 entire eggs was advised for the treatment of diarrhoea, hen eggs have been recognised as having potential as a functional diet. Furthermore, the yolk of hen eggs has been touted as a novel source of polyclonal antibodies that can act as passive defences against gastrointestinal infections. High concentrations of certain antibodies are seen in the egg yolk of hens that have been exposed to a bacterial infection. In multiple in vivo experiments, it has been demonstrated that oral delivery of certain antipathogen antibodies isolated from egg yolk from immunised hens can prevent infection. Certain egg-yolk antibodies from immunised hens may bind prospective pathogens in the gut lumen and block their adhesion to the gut mucosa, thereby preventing the first stage of infection.

Conclusion

Consumers who prefer eggs with distinct nutritional qualities or characteristics from generic eggs have options thanks to designer eggs. Generic shell eggs are a cheap, high-quality, nutrient-dense source of protein that also contain a range of important vitamins and minerals and other useful ingredients. Eggs can serve purposes beyond the good nourishment they already give by feeding hens specialised diets. Designer eggs with novel functional characteristics are in high demand, but there is currently a shortage of expertise in their industrial manufacture. For the commercial manufacturing and marketing of these new generation eggs and egg products, more study is required. Further study in this exciting area is required to enhance the calibre of designer eggs, evaluate the long-term impacts of their intake, and finally persuade consumers of the advantages of eating these eggs.

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AMFI-SI-15

ANALYSIS OF VARIANCE (ANOVA) OF ALPHA LATTICE DESIGN USING R SOFTWARE AND PBTOOLS

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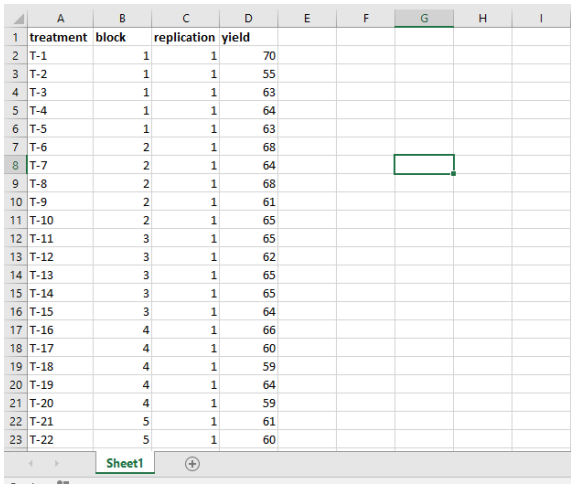
Introduction:

The alpha lattice design is the one of the incomplete block design used among researchers to regulate the random variation in evaluation trails having large number of genotypes (Barreto *et al.*, 1996). It has been predominately used by plant breeders for the evaluation of various genotypes. It could even be useful where there is no factorial type relationship among treatments and the number of treatments are large and soil heterogeneity is very high in the experimental site. The complete block type of designs assumes that variation between units of a block is less than that between units of different blocks. In an alpha lattice design, the number of plots per block is smaller than the total number of treatments (e.g., genotypes). In the field, an incomplete block design is indistinguishable from a randomized complete block design. However, practical considerations dictate that all designs used for agricultural trials be resolvable. The alpha lattice design allows us in the adjustment of treatment means for block effects. This in turn brings benefit from the small incomplete blocks which help varietal comparisons under more homogenous conditions. The alpha lattice design also provides effective control within replicate variability.

R is a free, open source software program for statistical analysis, based on the S language available at https://mirror.niser.ac.in/cran/ . It compiles and runs on a wide variety of UNIX platforms and similar systems (including FreeBSD and Linux), Windows and Mac OS. For learning the usage of R, one can use some of the online websites such as http://www.statmethods.net/ or https://journal.r-project.org/ etc.,

Analysis of variance (ANOVA) using R

In the first step the data should be arranged as per the figure 1. After arranging the data save the file and open the R software, then import the data into the R. Then follow and use the R script given below.



	A	B	C	D
1	treatment	block	replication	yield
2	T-1	1	1	70
3	T-2	1	1	55
4	T-3	1	1	63
5	T-4	1	1	64
6	T-5	1	1	63
7	T-6	2	1	68
8	T-7	2	1	64
9	T-8	2	1	68
10	T-9	2	1	61
11	T-10	2	1	65
12	T-11	3	1	65
13	T-12	3	1	62
14	T-13	3	1	65
15	T-14	3	1	65
16	T-15	3	1	64
17	T-16	4	1	66
18	T-17	4	1	60
19	T-18	4	1	59
20	T-19	4	1	64
21	T-20	4	1	59
22	T-21	5	1	61
23	T-22	5	1	60

Sheet1

Figure 1: Arrangement of data in MS excel

library(agricolae)

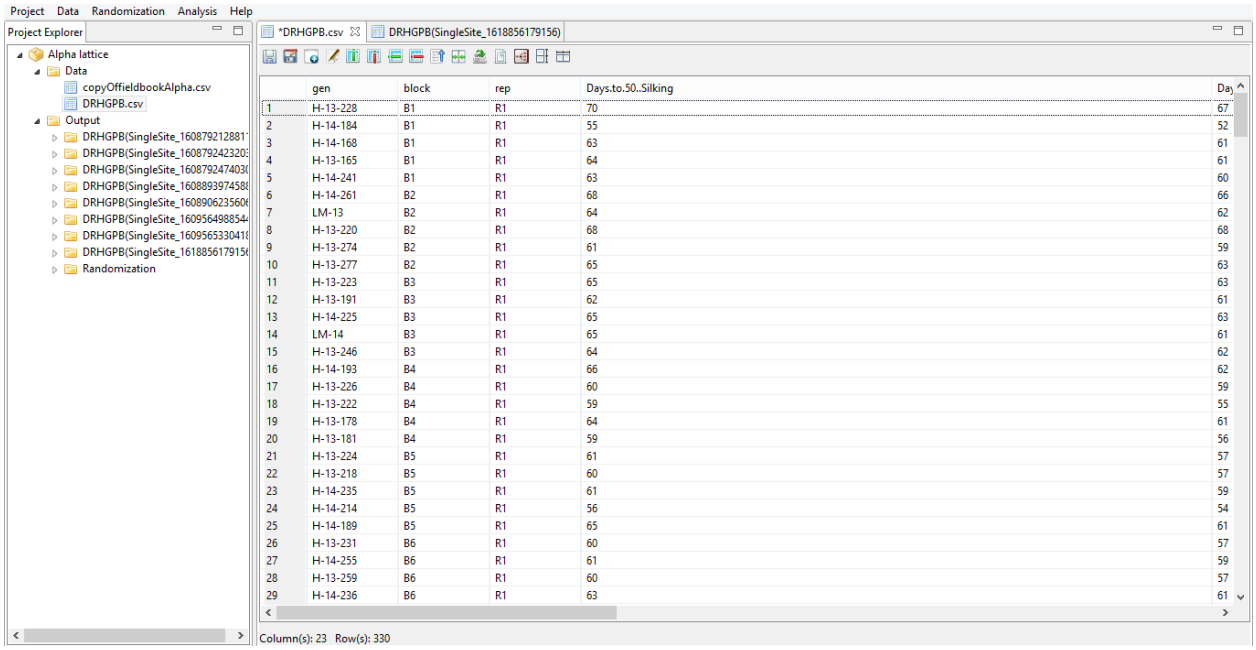
PBIB.test(block,treatment,replication,yield,5,method = c("REML", "ML", "VC"), test = c("lsd","tukey"),alpha = 0.05,console = TRUE,group = TRUE)

Note: R is case sensitive; **5** is block size

Analysis of variance (ANOVA) using PBTools - Plant Breeding Tools

The PBTools software can be downloaded from the IRRI website (http://bbi.irri.org/products) at free of cost. After installing the software, for ANOVA of alpha lattice design follow the steps given below

1) Create the new project by clicking on the respective tab and import the ".csv" data file (data should be arranged as per figure 2)



	gen	block	rep	Days.to.50..Silking	Da
1	H-13-228	B1	R1	70	67
2	H-14-184	B1	R1	55	52
3	H-14-168	B1	R1	63	61
4	H-13-165	B1	R1	64	61
5	H-14-241	B1	R1	63	60
6	H-14-261	B2	R1	68	66
7	LM-13	B2	R1	64	62
8	H-13-220	B2	R1	68	68
9	H-13-274	B2	R1	61	59
10	H-13-277	B2	R1	65	63
11	H-13-223	B3	R1	65	63
12	H-13-191	B3	R1	62	61
13	H-14-225	B3	R1	65	63
14	LM-14	B3	R1	65	61
15	H-13-246	B3	R1	64	62
16	H-14-193	B4	R1	66	62
17	H-13-226	B4	R1	60	59
18	H-13-222	B4	R1	59	55
19	H-13-178	B4	R1	64	61
20	H-13-181	B4	R1	59	56
21	H-13-224	B5	R1	61	57
22	H-13-218	B5	R1	60	57
23	H-14-235	B5	R1	61	59
24	H-14-214	B5	R1	56	54
25	H-14-189	B5	R1	65	61
26	H-13-231	B6	R1	60	57
27	H-14-255	B6	R1	61	59
28	H-13-259	B6	R1	60	57
29	H-14-236	B6	R1	63	61

Figure 2: Data arrangement for PBTools

2) Then open the project and the imported file, after opening the imported file click on the analysis tab.

3) Then click on single environment analysis, then a new window appears, the select "Alpha-Lattice" from the drop down menu.

4) In the response variable tab add the trait.

5) Then add genotype, block and replicate in the respective tabs (figure 3).

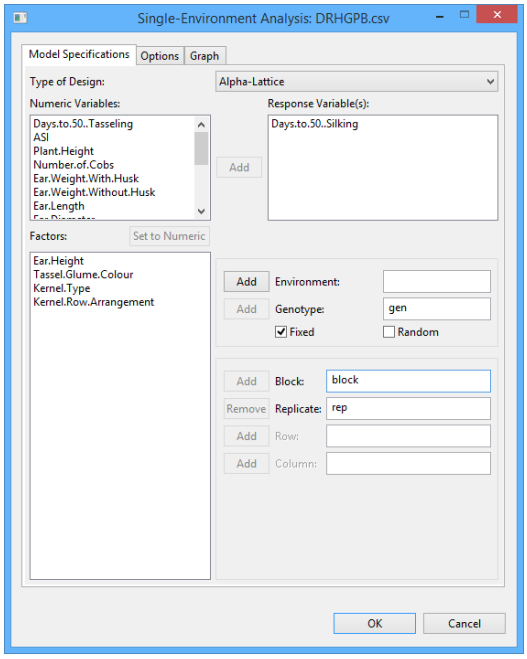


Figure 3. Model specifications for ANOVA

6) Make genotypes fixed or random (in my case fixed), then click on **ok**.

7) ANOVA will appear in the output tab of the software.

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AMFI-SI-16

EFFECT OF DRIP IRRIGATION IN RICECULTIVATION

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Abstract

Drip irrigation is the most efficient and one of the best irrigation practices in the case of rice cultivation. Because it makes farmers independent from the uncertainty of rainwater. In Indiaaround 54% of cultivated land is rainfed. From the environmental perspective, it could reducethe methane and CO2 emissions from the rice field.

Keywords: Drip irrigation, Yield, Crop water requirement, Water scenario

Introduction

Drip irrigation is the slow, even distribution of low-pressure water to soil and plant rhizosphere via plastic tubing placed at the root zone of the plants. It is an alternative to irrigating crops via sprinklers or furrows. Crops with high or low water requirements can employ drip irrigation. Rice is one of the most important cereal food crops in India. It feeds more than 60% of the population. It covers around 23% of the total agricultural crop area and production is around 120 million tons in FY 2020-21 and it will be around 555 million tons in 2035 (Riaz, Zaman; 2006). But the problem is we mostly practiced flood irrigation techniques and for this, so much water is needed. For the production of 1 Kg of rice, almost 2500 litres of water is used. That's why as a solution we can use drip irrigation which gives more yield and less water use.

Water scenario of India

India has only a 4% share of global freshwater resources to fulfill the needs of 18% of the world population (World bank, 2022). Per year around 80% of water is received during monsoon season but due to limited water harvesting infrastructure, only 1/3rd of this precipitation can be utilized and the rest creates runoff losses. Another source of water is groundwater, and the agriculture sector alone used 89% of it for irrigation and other practices,that's why the water table is getting down at an alarming rate of 0.3 meters per year. In India, nearly 54% of cultivated land is rainfed, for that in most cases farmers are dependent on rainfall and if it does not happen that will ruin their crops along with their life. For farming likerice cultivation, it needs a huge amount of water in the traditional flood irrigation method. So,if we want to change this harsh condition we have to adopt new technology like dripirrigation which is much more water efficient and also at the same time gives a higher yield.

A brief introduction to drip irrigation

Drip irrigation or trickle irrigation is a type of micro-irrigation system that has the potential to save water and nutrients by allowing water to drip slowly to the roots of plants, either from above the soil surface or buried below the surface. It is the most efficient water and nutrient delivery system for growing crops. In places with limited

water supplies or in circumstances requiring precise control of water delivery, such as in agriculture, landscaping, and home gardening, this method of irrigation is frequently used. A pump or other water source supplies water to the main conduit in a conventional drip irrigation system. Then, a number of smaller tubes or hoses that are attached to the primary pipeline are used to disperse the water. The tubing has emitters fitted along it at regular intervals, which are tiny devices that release water drops. It is possible to precisely manage the application of water by adjusting these emitters to release a certain volume of water every hour. Compared to other irrigatio
techniques, drip irrigation provides a number of benefits. Water is provided directly to the plantroots, minimizing water loss from evaporation or runoff, making it potentially more efficient. Because water is only provided to the plants and not the surrounding soil, it can also aid in reducing weed growth. Drip irrigation systems can also be automated, giving users precise control over water delivery schedule and volume, which can assist save labour and time costs.

Types of Drip irrigation system

There are mainly 2 types of drip irrigation system-

a. **Surface drip system:**

It is direct application of water to the soil's surface using drip irrigation. The method is simpleand easy to maintain which makes it more popular.

b. **Sub-surface drip system:**

In subsurface drip irrigation, the lateral is positioned close to the plant root zone area beneath the soil. Through the emitters, water is gradually supplied below the surface in this irrigation system. These systems have become more widely accepted as a result of the significant reduction of earlier clogging issues. A sub-surface drip system may have a longer operational life while causing little disruption to crop cultivation or other cultural practices.

Drip irrigation in rice cultivation

For rice cultivation, Drip irrigation is the most efficient way of water utilisation. The amount of irrigation water required under drip irrigation is the lowest i.e., almost 258mm and the highest value was 365 mm and in conventional irrigation systems it was found to be 600 mm (Sarkar et al, 2018). The water requirements under drip irrigation were less as compared to conventional (flooding) irrigation. Because of the stagnant water condition of rice fields, it contributes 12% of global methane emission but if we adopt drip irrigation it will decrease bya significant level.

Necessity of Drip irrigation in current scenario

Rice (Oryza sativa L.) is the most important staple food in the world. It is specially grown in eastern and southern Asia. It may be produced in a wide range of conditions and is often successful where other crops would not. Nature's gift to humanity, water, is not always unlimited and free. Only around 1520 million cubic kilometres of water are present in the universe, with 97% of that being ocean and seawater, 2% being frozen arctic waters, and only1% being water in lakes, rivers, and underground reservoirs that

can be carried about and used directly by humans (Shaker, 2004). However, rice cultivation, considered to be the largest user of water resources, uses around 50% of the water resources utilised in all economic activities (Fan et al., 1996; FAO, 2010).

Cost of a drip irrgation system

Installation cost of drip irrigation system depends on several factors like size of the area, type of crop, type of soil, quality of water, level of automation etc. In India it costs between 45000 rupees to 60,000 rupees.

Government subsidy for drip irrigation in India

States are able to obtain the money through NABARD (National Bank for Agriculture and Rural Development) loans at 3% below the cost of funds, with the remaining 3%funded by the central government. Small and marginal farmers will receive subsidies worth 55% of the indicative unit cost under the PMKSY (Pradhan Mantri Krishi Sinchayee Yojana), while
other farmers will receive subsidies worth 45% of the indicative unit cost.

Conclusion

For agriculture, water is the most important factor, especially in rice cultivation with the conventional method i.e. flood irrigation, there is a huge amount of water loss. From this, we can see that almost 62% of the water has been saved in drip irrigation, and production has also increased by 125%. Through all of this farmer's income will increase by around 50%. So,obviously drip irrigation is the most efficient way of irrigation but the drip irrigation system requires good and proper management and in this system, the initial cost is very high to maintain and it may be difficult for farmers.

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AMFI-SI-17

EFFECTS OF SEEDLING DENSITY OR PLANT POPULATION ON YIELD OF LENTIL

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Introduction:

Lentil is a major grain legume crop in many developing countries in West Asia, North Africa and many other areas of the world. The seeds are rich in protein with average concentration of 26%. It is increasingly recognized that lentil offers most practical means of solving the protein malnutrition which has necessitated giving more efforts to improve and increase its production in the country. It can have a potential role in crop rotation, in particular in organic farms, allowing the biological equilibrium of agro ecosystems and soil fertility to be maintained as because of leguminous plants, special ability to live in symbiosis with rhizobia that fix free atmospheric nitrogen also needs to be stressed but seed rate have an major impact on production of lentil and also recommended seeding rates differ based on cultivar and seed size, location, soil moisture, and environmental conditions such as rainfall and temperature where too low and high plant population beyond a certain limit often adversely affects the crop yield also the number of plants per unit area influences plant size, yield components and ultimately the effect of yield.

Effect of seedling Density or plant population on yield of lentil

Seed rate is one of the main factors that have an important role on growth, yield and quality of lentil and also the plant density can affect canopy development, radiation interception, dry matter production, and evaporation of water from the soil under the crop - weed competition, the development of fungal and viral diseases, harvesting height, seed yield that was reported Lopez et al. (2005).An experiment was conducted by Ouji et al. (2012), reported that the highest plant height was obtained at (17 cm row spacing and120 seeds/m2combination) with the lowest plant height (23.7cm) was produced at (34cm row spacing and 80 seeds/m2 combination) also the lentil seed yield though in the case of a row spacing of 25 cm it was slightly higher by 6.1% than in the plots where lentil was sown at a spacing of 20 cm(karsker et al. 2019) which are consistent with the results of Habbasha et al. (1996) and Singh et al. (2003) who reported that increasing plant density increased plant height. He also reported that the number of pods/plant was affected significantly by different row spacing and seeding rate and their interaction which indicated that pod number per plant increased with the row spacing so the increase of row spacing from 17cm to 34cm increased pod number per plant by 35.5% and also revealed that the increase in plant density led to the loss of pod number per plant so that with the increase in population from 80 and 120 seeds/m2 ,pod number per plant increased by 48.6% but at plant density higher than optimal (160

seeds/m2) pod number per plant decrease due to the number of effective branches and pods per branch decreased and the similar trend also found by Momoh and Zhou (2001). Optimum plant population density is an important factor to realize the potential yields as it directly affects plant growth and development where the plants are widely spaced, biological yields tend to increase linearly with increase in plant density due to no or minimum competition between the adjoining plants and also the higher leaf area index and greater absorption of solar radiation. Generally, grain yield was tending to decreasing with increasing sowing rates. However, the higher sowing rate causes higher inter-plant competition and results in poor individual plant as reported by BiÇER (2014) where as the high plant density may lead to competition among plants and increase risk of disease and lodging of the crop, resulting in reduced grain yield and also the low plant populations are unable to utilize the resources efficiently and often produce low yields that is reported by selim (1999, 2012). Seed rate is one of the main factors that have an important role on growth, yield and quality of lentil also an optimum spacing can ensure proper growth of the aerial and underground parts of the plant through efficient utilization of solar radiation, nutrients, water, land as well as air spaces. Spacing for line sowing is recommended to maintain the required number of plant population and to undertake intercultural operations for harvesting a higher yield.

Yield of individual plants and community

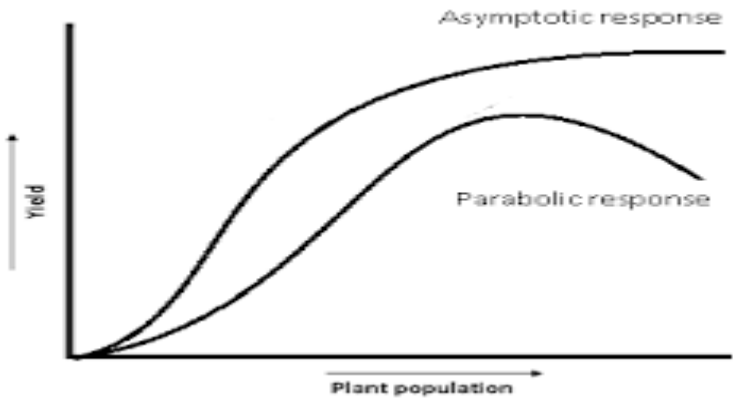
The full yield potential of individual plants achieved when sown at wider spacing, when sown densely, competition among plants is more for growth factor resulting in reduction in size and yield of the plant .Yield per plant decrease gradually as plant population per unit area is increased however the unit area is increased due to efficient utilization of growth factors, maximum yield per unit area can therefore, be obtained when the individual plants are subjected to serve competition.

- **Plant population and growth** :

High plant density brings out certain modification in the growth of plants .plants height in increase in plant population due to competition for light sometime it may happen that moderate increase in plant population may not increase but decrease plant height due to competition for water and nutrient but not for light .leaf orientation is also alerted due to population pressure. The leaves are narrow, erect and are arranged at longer verticals intervals under high plant density.

- **Parabolic Response curve** :

Parabolic curve used to describe plant population and yield relationship when the economic yield is a fraction of the total dry matter in this case yield also increase in increase of plant population then reach maximum however unlike an asymmetric curve yield decrease with further increase in population.



Conclusion:

It is clearly conclude that the yield of lentil can be improved by planting of optimum density. The effect of plant row spacing, plant seeding rates and interaction between them is a significant on all measured parameters where as changing the row spacing had a greater influences on plant height at harvest which was increased by decreasing space between plants also the higher seed rates produced higher seed yields but the subsequent increases in yield was not so significant because of too low or too high plant population beyond a certain limit often adversely affects the crop yield that was depend on number of plants per unit area, plant size, yield components ultimately the seed yield there for the optimum plant population density is an important factor to realize the potential yields as it directly affects plant growth and development.

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AMFI-SI-18

EPIPHYTIC MICROBES AND THEIR POTENTIALS

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ABSTRACT

Plants harbours various life forms, in that particularly some beneficial microbes over their surface as beneficial epiphytes. Many epiphytes had been discovered for their potential use as plant growth promoting regulators, biocontrol agents and good metabolisers. Prominent epiphytes like some species of Saccharomyces, Ascomycetes, Basidiomycetes are common. Auxin and cytokinin synthesis by yeasts, Vitamin biosynthesis by *Methylobacterium*, killer toxins against phytopathogens produced by Wickerhamomyces were all some of the potentiality of plant epiphytic microbes. Their structure and living depends upon the prevailing environment factors.

KEYWORDS: Biocontrol agents, Epiphytes, Microbiome, Plant growth promoters.

INTRODUCTION

Epiphytic microbes are those organisms that dwell on the surface of plant such as leaf, stem that is over the phyllosphere. These organisms don't harm plants just living in a nonparasitic relationship. They serve multiple functions in plants. Epiphytes involve in the metabolic pathway of plants making some alterations or through some induction. Commonly found epiphytes in plants are several species of yeasts, Ascomycetes, Basidiomycetes and some of Methylotrophs. Some yeasts species are known to induce auxin biosynthesis on external induction of IAA. *Methylobacterium oryzae* belonging to facultative methylotrophs possess certain genes that improves vitaminB_{12} biosynthesis, phosphate solubilisation, decreasing heavy metal toxicity, improving urea metabolism. Epiphytes are also prominent in the aquatic environment. Biofilms found in certain aquatic plants harbour several useful and potential epiphytes like some nitrifying bacteria such as *Nitrococcus*, *Nitrosomonas*, *Nitrospira*. Some other genes include *Proteobacteria*, *Chloroflexis*, *Acidobacteria* were also present. Epiphytes as a whole serve as a good mutualistic partner of plants.

GROWTH AND METABOLISM

Growth and metabolism are the basic constituents of any life form. The role of epiphytes here is very crucial. They are present both in terrestrial and aquatic plants. Several species of yeast like *Aureobasidium pullulans*, *Cryptococcus flavus*, some *Candida* species are known to promote or alter the auxin biosynthesis in plants by exogenous production of IAA. These fungi produce IAA through tryptophan dependent or independent way [1]. *Methylobacterium* species colonising around the stomata, trichomes produce their own auxin, cytokinin, ACC deaminase enzyme and stimulate plant growth. It possesses ACC deaminase enzyme through which it reduces the excess ethylene level. Vitamin B_{12} synthesis improves cobalt metabolism [2]. In the aquatic environment eutrophication or

algal bloom is a major problem which pollutes the water leaving no sunlight or oxygen to pass through causing death of flora and fauna. Biofilm is good mitigation measure formed by the epiphytes on the aquatic flora containing denitrifying bacteria that denitrifies the nitrates back to air. *Nitrosomonas*, *Nitrococcus*, *Nitrospira* are found in free floating *Eichhornia crassipes* and *Trapa natans*. qPCR analysis shows the abundance of denitrifying genes like nitrite and nitrate reductase [3]. The leaf phyllosphere of *A.thaliana* contains prominent microbes like *Actinobacteria*, *Proteobacteria*, and *Bacteriodetes* have many potentials. The phyllosphere and rhizosphere microbial structure and diversity is influenced by several environmental factors like radiation, temperature, humidity [4]. *Herbaspirillum seropedicae* also promotes growth through biofilm formation on leaves with or without exopolysaccharide formation [5].

DISEASE RESISTANCE

Disease resistance is an important trait essential in plant, that too by means of biological control will be more efficient and ensures biosafety. Fungal and bacterial epiphytes confer protection by producing some metabolites that are antagonistic against pathogens and also through certain mechanisms. *A.pullulans* is a biocontrol agent and has several biotechnological applications. *P.aphidis* secrete some extracellular metabolites that inhibits the fungal pathogens. *Methylobacterium oryzae* genome encodes bacteriocin and a precursor called 4-Hydroxy benzoate that acts as a precursor for activating antifungal proteins in *Nicotiana tabacum* [1]. The blue mould rot, a serious postharvest disease of apple caused by *Penicillium expansum* is biologically controlled by *Starmerella bacillaris* that grows on grapes. It is fructophilic, producing more glycerol hence also used in cider formation [6]. *Wickerhamomyces anomalus*, *Torulaspora delbrueckii* effectively controlled the green mould and blue mould caused by *Penicillium* species in lemon by producing low molecular weight killer toxins that has antagonistic activity. *W.anomalus* produces panomycocin that controls anthracnose rot caused by *Colletotrichum gloeosporoides*. *Leucosporidium scottii* produces volatile antifungal compounds against *Botrytis cinerea* of apple [7].

CONCLUSION

Microbial epiphytes are ubiquitous everywhere. For control of a disease use of chemical fungicide may be a solution but it can have adverse effect on the quality of the produce causing detrimental disease in both animals and humans. Phyllosphere microbes residing in the above surface of plant have best potential in increasing the metabolism, growth and disease resistance of plants. In the near future it is best that we go for testing the bio efficacy of all these epiphytes and commercially formulate them in such a way they could be used by the farmers to do farming in a chemical free and sustainable way.

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AMFI-SI-19

EXTRAFLORAL NECTARIES IN PLANT INSECT INTERFACE REACTION

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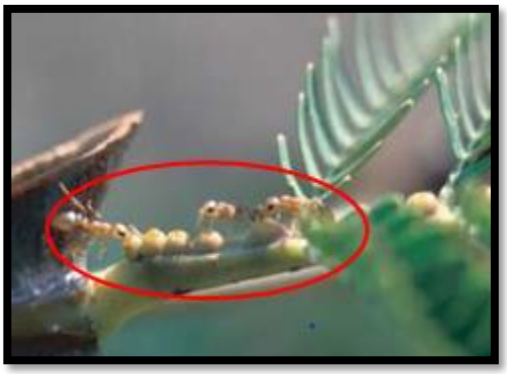
Introduction

Nectar is a Greek word, "nektar" which is derived from the ancient Egyptian word "ntry". The nectar was first recorded in 1609 which means a "sweet plant secretion" and mentioned as floral nectar only. Plants have two types of nectars *viz*., floral nectar and extrafloral nectar. The floral nectars are obtained evolutionarily from extrafloral nectars.

Extrafloral nectaries

Nectar-secreting organs located on any above-ground plant parts which are not involved in pollination are called extrafloral nectaries (EFNs). EFNs reported in more than 100 families of plants. These function in plant defense against herbivory *via* the recruitment of ants and other predatory or parasitoid insects. The location of EFNs vary such as leaf blade, leaf petiole, cotyledon, stem, bract, stipule, fruit, pod, flower bud, peduncle, flower stalk, external surface of flowers. The EFN also known as Extranuptial nectaries or Non-reproductive nectaries or Extra-reproductive nectaries.



Extrafloral nectaries

Types of EFNs and visitors

Insect / arthropod	Plant parts	Plant
a) Solenopsis sp.	Stem	*Passiflora sexocellata*
b) Ectatomma tuberculatum	Base of a leaf	*Qualea multiflora*
c) Camponotus crassus	Bract	*Oratea spectabilis*
d) Camponotus planatus	Underside of a leaf blade	*Hibiscus tiliaceus*
e) Oxyopes macroscelides	Leaf petiole	*Banisteriopsis mallifolia*
f) Ectatomma tuberculatum	Developing fruits	*Tocoyena formosa*

Types of EFNs and visitors

Extrafloral nectar

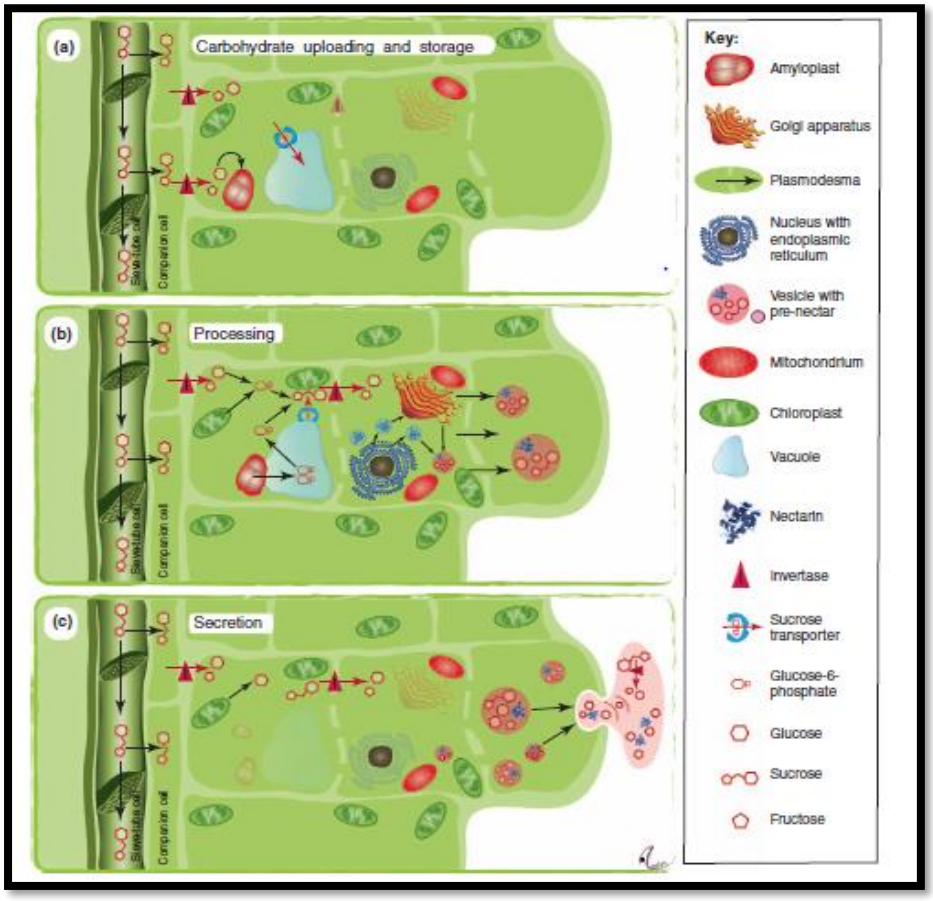
Extrafloral nectar is an aqueous solution containing sugars and amino acids which is secreted from extrafloral nectary organs. Extrafloral nectar is secreted on the vegetative parts and attracts members of the third trophic level - indirect defense against herbivores. The EFN is secreted in higher amount on young leaves, developing fruits and response to herbivore inflicted damage, mechanical damage and exogenous application of jasmonic acid (JA). EFN contains mono saccharides, disaccharides, amino acids, lipids and proteins.

e.g., The extrafloral nectaries of *Vicia faba* - leaf tissues surrounding the nectaries, exhibit high levels of L-3,4-dihydroxyphenylalanine (L-DOPA), a non-protein amino acid toxic to insects (Gish *et al.* 2016).

Plant Families with EFN

- Fabaceae
- Rosaceae
- Euphorbiaceae
- Bignoniaceae
- Asteraceae
- Malvaceae
- Salicaceae
- Cucurbitaceae
- Caprifoliaceae
- Apocynaceae
- Liliaceae
- Convolvulaceae

Extrafloral nectar secretion



Extrafloral nectar secretion

Nectar formation and secretion probably require three metabolically different phases:

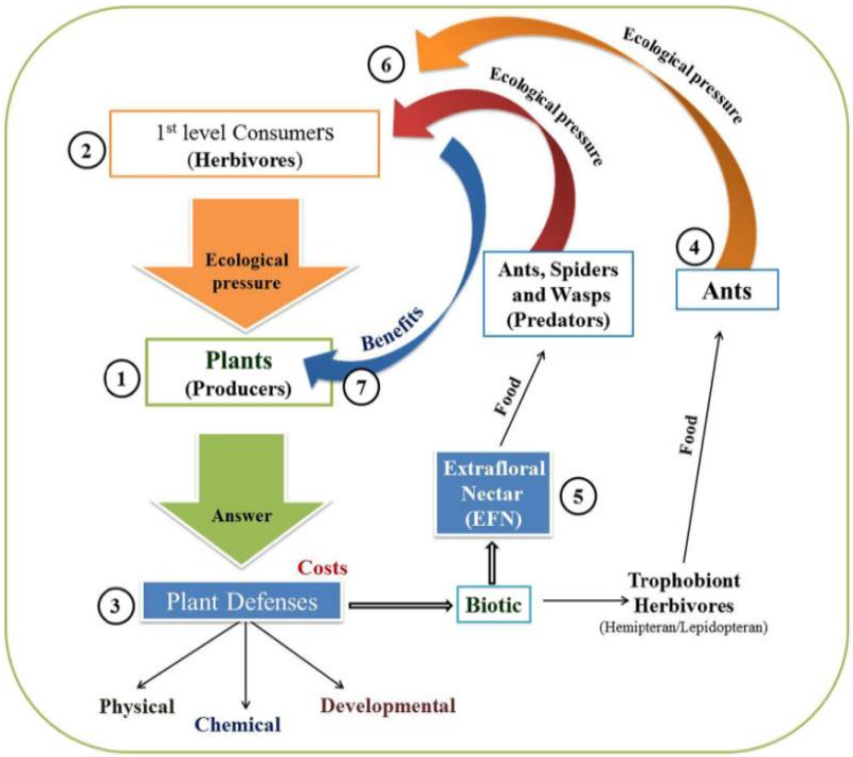
(a) optional carbohydrate uploading and storage,

(b) nectar processing and the synthesis of non-carbohydrate components and

(c) secretion.

Invertases seem to be involved in several steps: (i) the uploading of sucrose from the phloem into the nectariferous tissue; (ii) the formation of the sink required for the secretion of sugars into the extracellular space; and (iii) the formation of hexose-rich nectars. The last step can be catalysed by invertases that are localised in the nectariferous tissue or in the secreted nectar itself. The photosynthesis by chloroplasts *insitu* in the nectariferous tissue might provide additional carbohydrates. Nectariferous tissues are usually characterised by a dense, rough endoplasmic reticulum, the presence of many dictyosomes and an active Golgi apparatus. The presence of protein-rich inclusions point towards the synthesis and storage of nectarins in the nectariferous tissue itself, and the generally high abundance of mitochondria indicate high metabolic activity. Therefore, many of the non-carbohydrate components of the nectar are likely to be synthesised in the nectariferous tissue. It remains to be elucidated whether the vesicles stem from the Golgi apparatus or directly from the endoplasmic reticulum and where carbohydrates and the other nectar components are combined to form the final nectar.

Extrafloral nectaries in plant-insect interaction

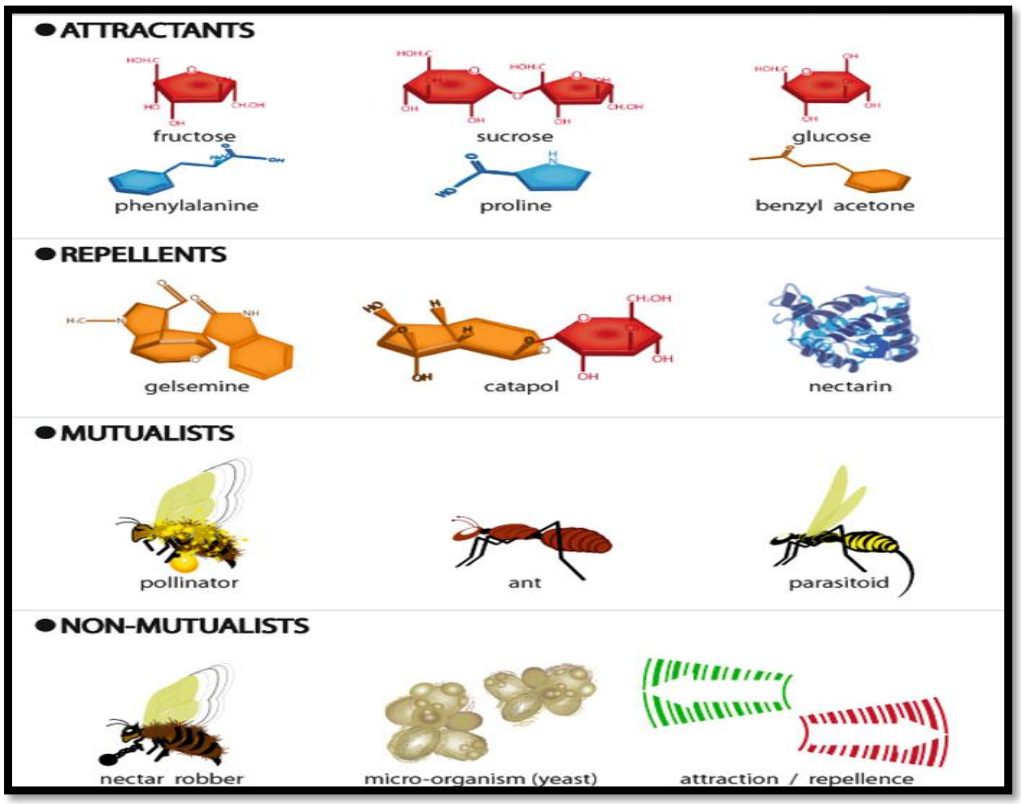


Plants (1) are the main food source to herbivores that exert strong ecological pressure (2) on them. Plants developed several distinct defenses (3) against herbivory (3) for example, the presence of trichomes (*i.e.* physical), alkaloids (*i.e.* chemical) and resprouting in dry season (*i.e.* developmental). In terrestrial environments, the association with a protective animal, mainly ants (but also spiders and wasps), is an important defense (biotic). The biotic defense occurs through an indirect association between the plant and ants, but possible also *via* herbivores (trophobiont) that produces exudates (like honeydew) that attracts and feed ants (4). Extrafloral nectar (EFN; mainly produced in leaves or inflorescences) is the main resource (5) plants offer to ants and other predators in exchange for protection. Nectar is an energetic food supply, but ants also need protein and will attack herbivores they find on plants (6) exerting an ecological pressure on the second trophic level that will directly benefit (7) the plants. Trophobiont herbivores (*i.e.* membracids) may benefit the host plant only when its damage produce fewer costs to the plant than the benefits produced by the ants (4) they associate.

Arthropods response to extrafloral nectar

Nectar chemistry serves both the attraction of mutualists such as defenders and protection. Nectar carbohydrates, amino acids and volatiles are apparently composed to provide an appetising meal to legitimate nectar consumers and/or to signal the presence of nectar to these mutualists from a distance. Being a nutritionally valuable reward, however, nectar must also be protected from illegitimate consumers, which can be animals ("nectar thieves") but also microorganisms, such as bacteria, fungi and yeasts, which might use nectar as a suitable growing medium. The most important attractive classes of compounds are mono and disaccharides, amino acids and volatile components such as benzyl acetone. Repellent effects are exhibited by secondary compounds such

as gelsemine and iridoid glycosides. Interestingly, gelsemine also repels legitimate pollinators. Nectar proteins (nectarins) mainly serve its protection from microbial infections.



Problems of EFNs in Agriculture

- Many growers, particularly large enterprises, set their pest control targets at a 100 per cent reduction in infestation. Such targets can only be achieved through the use of pesticides.
- Ants, vary in their defensive qualities. Production of EFN can result in colonization by parasitic ant species which consume nectar but either fail to defend their host plants.
- The degree to which ants act as predators or feed on plant derived carbohydrates can vary over the life of a colony and can be influenced by ecological conditions.
- Many growers are reluctant to encourage the presence of aggressive ants, as their bites and stings represent a potential irritant for farm workers and animals.
- Abiotic factors such as light or nutrient availability are also known to affect EFN production and influence its effectiveness as a plant defense.

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AMFI-SI-20

FARM RESOURCE MANAGEMENT – A KEY TO CONSERVATION AGRICULTURE

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Introduction

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

Importance of Crop Residues

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

Availability of Crop Residues

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

Residue Management Options

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

Importance of Surface Residue

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

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

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

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

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

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

Conclusion

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

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AMFI-SI-21

GENERAL MANAGEMENT KEY CONSIDERATIONS IN GOAT PRODUCTION FOR AGRIPRENEURSHIP

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Introduction:

Livestock is an integral part of India's agricultural economy and plays a multifaceted role in providing livelihood support to the rural population. Livestock sector apart from contributing to national economy (4.1 % to total GDP and 27.4% to the overall agricultural production) in general and to agricultural economy in particular, also provides employment generation opportunities (8% of the labour force), asset creation, coping mechanism against crop failure and social and financial security (NLP, 2013 and BAHS, 2019). Goats have been an integral component of India's livestock economy, hence development of goat production is considered to be a pathway for inclusive agricultural growth as out of 138 million operational holdings, the small and marginal holdings (below 2.00 ha) together constituted 85% and these holdings are the main custodian (> 75% of total goat population). There is significant growth in population of goats across the agro-climatic regions in India. India is endowed with huge biodiversity of goats (34 breeds) distributed in different agro-ecosystems throughout the country, which were developed by our wise ancestors as per the climatic conditions and then requirement of people of those particular regions. In pastoral societies in India, goats are kept as a source of additional income and as an insurance against income shocks of crop failure. In addition, the rural poor who cannot afford to maintain a cow or a buffalo find goat as the best alternative source of supplementary income and milk. In recent years, goat enterprise has also shown promise of its successful intensification and commercialization. They are not only an important source of income and employment for them, but also a vital source of animal protein for the family. Considering the viability of above cited facts & many advantages from goat keeping various management practices should followed by the stakeholders to improve the productivity of goats.

Housing:

The main objective of housing is to confine the animals and protect them from predators and environmental extremes which would cause mortality and reduced growth, production and immune competence. A suitable house for goats must be secure, dry, well ventilated, free from parasites, draughts, clean, well lighted and facing east- west direction. The house should be able to provide protection from rain, cold, direct sunshine and winds. The inside temperature of house should remains between 15^0c to 25^0c. Sheds should be constructed on elevated area to prevent water stagnation. Mud floorings are suitable for most of parts of the country (except high rainfall area). Fodder trees around the shed provide good climate besides being source of feed. Where animals

are taken for grazing during the day and sheltered during night, the covered space will be enough. However, when animals are housed intensively, the pen and run system of housing is suitable. The optimum length and breadth of the shelter is 12 and 8 m, respectively, height at eves and ridge as 2.5 and 3.5 m with overhang as 1 m and height of chain link for open space as 1.2 m.

Floor space requirements suggested for up to 3 m, 3-6 m, 6-12 m, adult, male/ pregnant/ lactating goats are 0.2-0.25 and 0.4-0.5; 0.50-0.75 and 1.0-1.5; 0.75-1.0 and 1.5-2.0; 1.5 and 3.0; 1.5-2.0 and 3.0-4.0 m^2, for covered and open area, respectively. The floor space requirements as per BIS standards are 1.8 m^2 for buck in groups, 3.2 m^2 for individual buck, 0.4 m^2 for kid in group, 0.8 m^2 for weaner in group, 0.9 m^2 for yearling, 1.0 m^2 for doe in group and 1.5 m^2 for doe with kid.

Handling of goats:

Goats are seldom difficult to handle and frequently learn to come for feed and milking called. They dislike being handling by horns and ears and care should be taken not to disturb the nostrils. Tethering by the horns is unacceptable. Do not lift or drag goats by the fleece, tail, ears, horns or legs. Goat should be handled or restrained by placing one arm under the neck and the other around rump. The ideal handlings of goats are to hold them with neck or head.

***Disbudding*:**

The main objective of disbudding in goats is to safe handling of bucks and to prevent injuries to other animals. It should be practiced between 5-12 days of birth (4-5 days male kids and 7-10 female kids) by using caustic potash/ KoH stick.

Castration:

Castration of male kids is essential to prevents indiscriminate breeding, rapid gain in body weight, make the male kids more docile and to improve the skin quality. All the male kids except those to be used for breeding purpose must be castrated by burdizzo's castrator at the age of 2-4 weeks.

Marking of goats:

The main objective of marking of goats is the identification, to keep record and proper care and supervision of goats. Three methods for marking of goats- Ear tattooing, Ear tagging and Ear notching can be used. Among them ear tattooing is very common method of marking of goats. Marking should be carried within week after kidding.

Determining age of goats:

Age of goats is judged from the incisors teeth which are found in lower jaw only. Wearing of incisors just started from 30-35 months and teeth reduced to stubs or broken above 84 months of age. The eruption of permanent incisors are as follows:

Pair of incisors	**Age of kids in months**
Ist- central	12-14 months
IInd- middle	24-26 months
IIIrd-lateral	36-38 months
IVth-central	48-50 months

Care of doe after kidding:

Care of doe after kidding is more important for better health of doe and kids. Some points should be keep in mind at the time of care after kidding.

- Clean the place of kidding, disinfect dispose off the placenta.
- Wash the hind quarters of goats with antiseptic solution.
- Provide a warm bran mash containing a small amount of oat meal, ginger, a pinch of salt, mineral mixture and jaggrey. These mass will provide instant energy to doe and help retained of placenta.
- Two days after kidding provide a ration of her choice with a concentrate containing 15% DCP and 60% TDN @ 400 per day.

Care of lactating doe:

To improve the productivity, it is essential to provide the good quality greens and 250g concentrate mixture besides grazing. It is also advised to stake holder to supplementation of area specific mineral mixture @10g/ day/ doe.

Care of breeding bucks:

Buck is ''half the band", therefore, select purebred buck of good breeding ability. They should be housed separately to have enough movements and exercise. A minimum of 2.4 x 1.2sqm areas should be provided to a buck in the house. An adult buck can be used for 25-30 does for breeding purpose. Cleanliness and feeding plenty of greens will help to reduce ''goaty smell" Carry out grooming/ brushing every day to keep them clean, free from parasites and to make them docile. Average green fodder per buck per day should be provided @ 5-6 kg with 250-300g concentrate mixture per day besides grazing.

***Health Care*:**

The occurrence of disease causes great loss to the goat farmers. Death of animals results in direct loss whereas morbid condition causes indirect loss by affecting the production adversely. Sudden change in the ration, poor nutrition, un-hygienic conditions in the animal sheds, contaminated feed and fodder are some of the important reasons causing morbidity and mortality in goats. Therefore, it is important to watch the animals closely for their health status on regular basis. Animal showing abnormal behaviour should be immediately separated out from the flock for detailed clinical examination. Knowledge of symptoms of various diseases will help in deciding appropriate line of treatment. The common diseases of goats on the basis of their etiology can be divided in to Viral, Bacterial and Parasitic diseases. The important viral diseases of goats are Pox, Contagious echthyma, Foot and Mouth Diseases (F.M.D.), Blue tongue, Peste-des-petits ruminants (P.P.R.) and Pneumonia. Important bacterial diseases are Haemorrhagic Septecaemia (H.S.), Johne's disease, Enterotoxaemia (E.T.) and Brucellosis. The parasitic diseases are Coccidiosis, Haernonchosis, Ascariasis and Flukes. The non-specific diseases of goats include Scours, Navel ill and Constipation. It is better to have prevention against the ailments and diseases that to treat them. Goats must be vaccinated and dewormed from time to time. As a routine prophylactic measure fallow vaccination and deworming schedule for goats as:

Vaccination schedule for goats

Diseases	vaccine	month	dose& route
Enterotoxaemia	multi compound	February.	2.5ml s/c
FMD	polyvalent	June	2-3ml s/c
HS	Oil adjuvant	July	2.0 ml s/c
Pox	pox vaccine	September.	0.5 ml s/c
PPR	PPR vaccine	Any time	1.0 ml s/c

Prophylactic schedule for Endo and Ecto-Parasitic infections

Infection	Time	Duration
Coccidiosis	2-6 months of age	6 day in continuations
Gastro-intestinal worms	After 5 months of age	Pre and post monsoon
Lice infestation	Any time	Pre and post monsoon
Tick infestation	Any time	During monsoon

The following tips are suggested for prevention and control of diseases:

- Keep the animal sheds, equipments and portable items clean and disinfected.
- Avoid overcrowding by providing optimum floor space.
- Provide adequate and proper ventilation to keep the sheds clean and comfortable.
- Do not allow stray dogs and other animals to enter the farm area.
- Provide free choice mineral bricks/ supplementation 10g/ day / animal.
- Practice recommended vaccination, dipping, drenching and routine screening schedule.
- Ensure prompt and proper disposal of bedding material and carcass.
- Use quarantine for the purchased animals.

Maintaining proper records:

Records are helpful in evaluation, selection and culling of goats, improvements of flocks, systematic breeding programme, testing of bucks, economic feeding, maintaining history pedigree register, income and expenses of farm etc. Therefore proper records should be maintained properly at the farms.

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AMFI-SI-22

GENETIC REGULATION OF ISOZYMES AND ITS USES

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INTRODUCTION

Isozymes are now a common part of the scientific vocabulary, but their recognition is relatively recent, having been first announced in 1959 by Markert and Moller. Prior to that time, molecular heterogeneity had often been noted in enzyme preparations, but such heterogeneity was usually attributed to contaminants or to partially denatured or degraded enzyme molecules. During the 1950's there were occasional suggestions that this heterogeneity might not all be artifactual but might indeed reflect reality within the cell.

Isozymes are numerous and characteristic of many cells, tissues and organs, but what is their biological utility? Why are they such a ubiquitous aspect of the biochemical organization of cells? At one time it was believed that one gene coded for one enzyme, which was totally responsible for a single biochemical reaction. This simple molecular equation, one gene - one enzyme - one catalytic reaction, was a useful and stimulating generalization in the early days of biochemical genetics. But now we know that multiple varieties of an enzyme are needed to catalyze the same reaction, but under different metabolic conditions, or in different places in the same cell, or in different cells, or in the same cell at successive stages of differentiation. Apparently, isozymes have been tailored by evolutionary pressures to fit the fastidious requirements of the cell's metabolic machinery. Very few isozyme systems are well understood nowadays. One of the earliest contributions was the recognition that isozymes could exist in different cell organelles and in different metabolic compartments within a single cell. The location of isozymes in cell organelles is well illustrated by mitochondria.

Mitochondrial enzymes such as malate dehydrogenase are frequently different from the homologous enzymes in the cytosol even though both kinds of isozymes are encoded in nuclear genes. The distinction between organelle and metabolic compartments is not always sharp. RNA polymerases may fall in this ambiguous category; two isozymes are associated with the nucleolus and one at least with mitochondria, but the topographic location of the others is uncertain. All of them must have access to the DNA of the chromosomes or of the mitochondria.

ISOZYMES AS GENETIC MARKERS

Isozymes provide rich material for investigating the structure and function of enzymes and for examining their role in cellular metabolism. They can also facilitate studies in cell differentiation, population genetics and evolution because they serve as excellent markers of gene function. In the field of evolution, isozymes are now extensively used to measure the frequencies of alleles in population and thus to allow an assessment of selection pressures in evolutionary movement. They have also made possible the development of the provocative concept of neutral mutation and have stimulated considerable investigation on the significance in evolution of alternative protein structures as exemplified by different isozymes. Alternative protein structures may be equally advantageous to a cell, provided that complementary changes have occurred in associated macromolecules. In other words, the advantage of a given enzyme structure is only relative and depends upon the molecular environment in which it must function.

One area in the study of evolution in which isozymes may be of critical importance relates to the acquisition of new genetic information during evolution. The possibility of a completely new gene arising de-novo today seems infinitesimal. New information probably arises through the duplication of genes and their subsequent divergence through mutation. This procedure can lead to the evolution of one enzyme into another and probably most enzymes arose this way. It seems clear that isozymes can be generated by the duplication of loci. For example, in salmonid fish having more than 10 isozymes of LDH have been demonstrated by many researchers. This extraordinary multiplicity stems from the tetraploid nature of these fish, which of course involved the duplication of the LDH-A and LDH-B genes for LDH. Genes for other enzymes in salmonids have also been duplicated with the generation of a corresponding isozymic multiplicity.

It should be possible to study the retention of homologous properties in enzymes, encoded in duplicated loci, as these enzymes diverge by mutation of the controlling genes. Nowadays we cannot study the sequence of molecular events that has already occurred during evolution, but we can probably discover each type of change that has occurred by a detailed molecular analysis of contemporary groups of related enzymes.

USED AS MARKER IN SELECTION

IN SELF POLLINATED CROPS

- Pedigree method
- Bulk method
- Backcrossing and
- Single Seed Descent (SSD) method

IN CROSS POLLINATED CROPS

Isozyme can be used to estimate allozymes frequencies for calculating the amount of heterozygosity present in the population.

USED IN THE STUDY OF QUANTITATIVE VARIATION

I.To determine the degree of determination between taxa

II. Germplasm classification
III. Gene mapping
IV. Selection
V. Monitoring the genetic segregation and recombination in the distinct crosses
VI. Characterization of F_1 hybrid
VII. For detecting abnormal segregation
VIII. Alleles at most molecular loci are usually co-dominant and thus all possible genotypes can be distinguished in segregating populations.

ISOZYMES AS SELECTION CRITERIA IN HETEROSIS BREEDING

I. Difference – enzymes/proteins are composed of two or more peptide chain.
II. Functional activity – Multimer structure.
III. Gupta and Singh (1977) studied esterase isozyme pattern of F_1 hybrids and parents and found that four cathodal bands were correlated with grain weight.

MONITORING GENE INTROGRESSION

Isozymes can be used as tools for detecting alien introgression from wild germplasm to cultivated species. When isozyme polymorphism is observed between wild species and cultivated species, isozyme analysis can be used to detect the introgression genes from wild germplasm and recovery of the recurrent parent background.

ADVANTAGES OF USING ISOZYME AS MARKER

I. Isozymes rarely exhibit epistatic interactions so that a genetic stock containing an infinite number of markers could be constructed.
II. The process is non-destructive since only small amounts of plant tissue are needed.
III. Any plant tissue can be used as samples, including leaves, roots, pollen and callus, so that the technique is very versatile.
IV. It is also possible to screen plant at seedling stage and retains only desirable genotypes, therefore, save time and money.

LINKAGE OF ISOZYME GENES TO TRAITS

If the gene of interest is recessive, isozyme-based selection is particularly useful because the recessive gene can be followed without having to do progeny test. Indirect selection through isozymes can be of value in gene pyramiding i.e. for the incorporation of two or more independent genes, which give a similar phenotype. Several studies have determined linkage of isozyme loci to morphological, physiological and quantitative traits.

CONCLUSION

Isozyme technique is simpler than that of other molecular techniques. As direct products of genes, isozymes would be better makers than that of molecular markers that are not the genes of interest.

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AMFI-SI-23

GHG EMISSION REDUCTION FROM WETLAND PADDY FIELD

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Introduction

Natural shifts in global temperature had occurred throughout human history in the past. The Fourth Assessment Report Working Group I (WG1) of the Intergovernmental Panel on Climate Change (IPCC, 2007a) concluded that 'Warming of the climate system is unequivocal' and that discernible human influences now extended to other aspects of climate including ocean warming, change in continental-average temperature, occurrence of temperature extremes and change in wind patterns. The report also assessed the likely range of future climate that happen. The Working Group II (WGII) report (IPCC, 2007b) documented that the impact of climate change is already being observed based on 75 studies with some 20,000 observations documented on physical and biological systems.

The IPCC predicted that the pace of climate change was 'very likely' (> 90 per cent probability) to accelerate with continued GHG emission at or above current rates, with globally averaged surface temperatures estimated to rise by 1.8°C to 4.0°C by the end of the 21st century. Changes in temperatures and other climatic features would vary globally (IPCC 2007b). Carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O) were important drivers of this anthropogenic greenhouse effect.

GHG emission from agriculture:

Agricultural practices release significant amount of greenhouse gases (GHGs) like carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O), which play a vital role in global warming and its related climate change. The Intergovernmental Panel on Climate Change (IPCC) reported that the atmospheric CO_2 would rise from current concentration of 381 to 550 ppm by 2050 (Yang, 2009). Agriculture accounts for 10 to 12 per cent of total global anthropogenic emission of GHG.

According to a report of Indian Network for Climate Change Assessment, the major sources in the agricultural sector are enteric fermentation (63.4 per cent), rice cultivation (20.9 per cent), agricultural soils (13.0 per cent), manure management (2.4 per cent) and on-field burning of crop residues (2.0 per cent). Agricultural soils especially rice soils with continuous submergence up to six months contribute towards the emission of CH_4, N_2O and CO_2.

The rising demand for food commodities including rice also causes increasing pressure on agriculture and consequently on the climate system. It is therefore, pertinent to develop technologies to reduce emission of GHGs from agriculture. This will not only

postpone climate change but also reduce the consumption of costly inputs by enhancing their use efficiency and increase farmers income. The rice fields are a major source of CH_4 and emit N_2O emissions as well. Global CH_4 emission estimates from paddy ranges from 29 to 61 Tg/yr. Rice cultivation has been noted globally as a GHG emitter.

Methane emission and mitigation – rice field:

CH_4 had a global warming potential of about 25 relative to CO_2 and responsible for approximately 25 per cent of the anticipated warming. The biogenic CH_4 is mostly produced from the anaerobic decomposition of organic compounds by Methanogenic archaea under highly reduced rice soil conditions, where CO_2 acts as inorganic electron acceptor.

Since flooding creates anaerobic conditions that favours the growth and multiplication methanogens direct sowing of rice, rainfed and aerobic cultivation reduces methane emission. Also System of Rice Intensification (SRI) reduces the emission of methane by 40-50 percent when compared to that of conventional flooded system.

After flooding of rice field soils, common electron donors such as acetate and hydrogen are present in excess for anaerobic respiration and methanogenesis occurs, in parallel to iron and sulfate reduction. When electron donors for microbial respiratory processes become limiting methanogenesis could be suppressed by supplementing alternative electron acceptors such as ferric or sulfate, which may result a combination of inhibition effects and competitive effects with different microorganisms for the common electron donors. The mechanism behind this could be the competition between CH_4 producing bacteria (methanogens) and sulfate reducing bacteria for the same substrate. The application of neem coated urea, coated calcium carbide, neem oil and dicyandiamide (DCD) reduce the emission of methane by suppressing microbial activities. Application of sulphate-containing amendments is a mitigation option for reducing CH_4 emission from rice fields.

Some of the possible mitigation and adaptation strategies to minimize the global warming potential of rice fields are

i. Water management.
ii. Direct seeding.
iii. Choice of chemical fertilizers, method and time of application and soil amendments.
iv. Use of different rice cultivars.
v. Improved tillage and crop residue management practices.
vi. Use of Phytosynthetic Blue Green Algae in rice cultivation.
vii. Dual cropping of azolla in rice.

Nitrous oxide emission and mitigation:

Nitrous oxide is primarily produced by microbial processes in the soil. Nitrous oxide also participated on the destruction of stratospheric ozone in addition to its role as GHG.

Three sources of N_2O were direct emission from agricultural soils, emission from animal production and emission indirectly induced by agricultural activities.

Agricultural anthropogenic sources of N_2O emission were proved to arise from fertilization of soils with mineral N, fertilization with animal manures, N derived from biological N fixation, N from atmospheric deposition and N from enhanced soil N mineralization.

In conventional cropping systems, N_2O emission was generally lower in organic cropping systems, while some other studies showed that N_2O emission could be significantly different or greater from organically farmed soils relative to conventionally farmed soils and N_2O emission could be mostly produced in upland fields and also pronounced as a result of the mid season drainage and dry–wet episodes in paddy fields.

Improving the efficiency of N can reduce emission of N_2O from rice fields. Nitrogen applied through fertilizers and manures is not always used efficiently by crops. Practices that improve N use efficiency include slow-release fertilizer like neem treated urea, coal tar treated urea, urea super granules could reduce the emission of nitrous oxide from the rice fields even under unflooded conditions.

Conclusion:

The emission of the GHG from rice field could be reduced by integrated approaches so that it does not compensate the rice productivity. Increasing the water and fertilizer use efficiency also increases the yield and reduces the methane and nitrous oxide emission from the rice field. Environmental sustainability should also be considered along with the increasing the productivity.

AMFI-SI-24

HEAVY METALS AND THEIR EFFECTS ON AQUATIC ORGANISMS

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Introduction

Water is one of the most valuable natural resources. Industrial and urban wastes generated by human activities contaminate soil and water. A wide range of inorganic and organic compounds cause contamination including heavy metals, combustible and putrescible substances, hazardous wastes, explosives, petroleum products, Phenol, and textile dyes. Heavy metal toxicity is becoming an alarming threat to aquatic organisms as well as to humankind. Heavy metals are defined as metals with a density greater than 5g/ cm^3. The eight most common pollutant heavy metals listed by the Environment Protection Agency (EPA) are arsenic, cadmium, chromium, copper, mercury, nickel, lead, and zinc. The exposure of these metals has risen significantly due to the increase of their use in several industrial, agricultural, domestic and technological applications. These elements have a negligible biological role in aquatic organisms but their toxicity leads to the malfunctioning of the different organ systems. The different source of heavy metal includes geogenic, industrial, agricultural, pharmaceutical, domestic effluents, and atmospheric source. Weathering and volcanic eruption are the major natural process leading to environmental contamination. Heavy metals occur naturally and are found throughout the earth's crust but exposure to aquatic organisms results from anthropogenic activities such as mining and smelting operations, industrial production and use, and domestic and agricultural use of metals and metal-containing compounds. The industrial sources of heavy metal include metal processing in refineries, coal burning in power plants, petroleum combustion, nuclear power stations, high tension lines, plastics, textiles, microelectronics, wood preservation, and paper processing plants. The extent of metal toxicity to an aquatic organism depends on the absorbed dose, route of exposure, and duration of exposure. Heavy metals affect cellular organelles and components such as cell membrane, mitochondrial, lysosome, endoplasmic reticulum, nuclei, and some enzymes involved in metabolism, detoxification, and damage repair. These metals bind with protein sites by displacing the original metals from their binding sites and causing malfunctioning of cells leading to toxicity. The binding of heavy metals to the DNA and nuclear proteins leads to oxidative deterioration of biological macromolecules. These metals build up in the food chain and are responsible for adverse effects and even the death of the organisms in the aquatic ecosystem. In response to above mentioned reason, Heavy metals are significant environmental pollutants and their toxicity is a problem of increasing significance for ecological, evolutionary, nutritional and environmental reasons. These metals are also considered as trace elements as their concentration is in ppb range to less than 10ppm in various enevironmental matrices. The bioavalaibility of these metals are influenced by physical,chemical and biological factor. The physical factor includes

temperature,phase association, adsorption and sequestration while species characteristics,trophic interaction and physiological adaptation. The chemical factor is influenced by factors that influence speciation at thermodynamic equilibrium, complexation kinetics, lipid solubility and octanol/water partition coefficient.

2. Different Heavy Metal

2.1 Arsenic

Arsenic is a ubiquitous element that is detected at low concentrations in virtually all environmental matrices. The major inorganic forms of arsenic include the trivalent arsenite and the pentavalent arsenate while the organic forms are monomethylarsonic acid (MMA), dimethylarsinic acid (DMA) and trimethylarsine oxide. Volcanic eruptions, soil erosion, and anthropogenic activities are the factor leading to environmental pollution by arsenic. Arsenic is used to manufacture different products such as as insecticides, herbicides, fungicides, algicides, sheep dips, wood preservatives, and dye-stuffs. Arsenic-based drugs are still used in treating certain tropical disease. Inorganic trivalent arsenite (As^{+3}) is 2–10 times more toxic than pentavalent arsenate (As^{+5}). Arsenic exerts its toxic effect is through impairment of cellular respiration by the inhibition of various mitochondrial enzymes, and the uncoupling of oxidative phosphorylation. The ability to interact with sulfhydryl groups of proteins and enzymes, and to substitute phosphorous in a variety of biochemical reactions make arsenic highly toxic.

2.2 Cadmium

Cadmium is of considerable environmental and occupational concern being widely distributed in earth crust at an average concentration of 0.1mg/kg. Production of alloys, pigments, and batteries are the major industrial application of cadmium. Cadmium is a severe pulmonary and gastrointestinal irritant and can be fatal if inhaled or ingested. Acute ingestion of cadmium have symptoms such as abdominal pain, burning sensation, nausea, vomiting, salivation, muscle cramps, vertigo, shock, loss of consciousness and convulsions. Acute cadmium ingestion also leads to gastrointestinal tract erosion, pulmonary, hepatic or renal injury and coma, depending on the route of poisoning. Chronic exposure to cadmium has a depressive effect on levels of norepinephrine, serotonin, and acetylcholine. Cadmium causes damage to cells primarily through the generation of reactive oxygen species (ROS) which causes single-strand DNA damage and disrupts the synthesis of nucleic acids and proteins.

2.3 Chromium

Chromium (Cr) is a naturally occurring element present in the earth's crust, with oxidation states ranging from chromium (II) to chromium (VI). Chromium compounds are stable in the trivalent form and the hexavalent form is the second-most stable state. Chromium enters into various environmental matrices (air, water, and soil) from a wide variety of natural and anthropogenic sources with the largest contribution coming from

industrial establishments. Metal processing, tannery facilities, chromate production, stainless steel welding, and ferrochrome and chrome pigment production are the industries releasing chromium. The increase in the environmental concentrations of chromium in aquatic waterbody has been linked to wastewater release of chromium, mainly from metallurgical, refractory, and chemical industries. Chromium released into the environment from anthropogenic activity occurs mainly in the hexavalent form and is classified as human carcinogen by several regulatory and non-regulatory agencies. The toxicity of chromium is governed by its oxidation state and solubility. Hexavalent chromium are powerful oxidizing agents and thus tend to be irritating and corrosive.

2.4 Lead

Lead is a naturally occurring bluish-gray metal present in small amounts in the earth's crust. It occurs naturally in the environment but anthropogenic activities such as fossil fuels burning, mining, and manufacturing contribute to the release of high concentrations. Lead has many different industrial, agricultural and domestic applications like used in the production of lead-acid batteries, ammunitions, metal products (solder and pipes), and devices to shield X-rays. Lead's ability to inhibit or mimic the actions of calcium and to interact with proteins is the major mechanism by which it exerts its toxic effect through biochemical processes. It binds to sulfhydryl and amide groups of enzymes, altering their configuration and diminishing their activities and also compete with essential metallic cations for binding sites, inhibiting enzyme activity, or altering the transport of essential cations such as calcium.

2.5 Mercury

Mercury is a heavy metal which belongs to the transition element series of the periodic table. It is unique in that it exists or is found in nature in all three forms (elemental, inorganic, and organic), with each having its own profile of toxicity. Elemental mercury exists as a liquid at room temperature having high vapor pressure and is released into the environment as mercury vapor. Mercury also exists as a cation with oxidation states of +1 (mercurous) or +2 (mercuric). The two most highly absorbed species are elemental mercury and methyl mercury. Methylmercury is the most frequently encountered compound of the organic form found in the environment, and is formed as a result of the methylation of inorganic (mercuric) forms of mercury by microorganisms found in soil and water. Methyl mercury is highly toxic as it is readily absorbed in the gastrointestinal tract and because of its lipid solubility, can easily cross both the placental and blood-brain barriers. Mercury is utilized in the electrical industry (switches, thermostats, batteries), dentistry (dental amalgams), and numerous industrial processes including the production of caustic soda, in nuclear reactors, as antifungal agents for wood processing, as a solvent for reactive and precious metal, and as a preservative of pharmaceutical products. The major mechanism of toxicity of mercury is through production of oxidative damage through the accumulation of reactive oxygen species (ROS).

2.6 Toxicity of Heavy metals

Metal	Toxic Response
Lead (Pb)	Anemia and disruption of hemoglobin synthesis, damage to nervous system and kidneys, brain damage. Acute lethal dose to man is 300-700 mg/kg. In mild cases, insomnia, restlessness, loss of appetite- and gastrointestinal problems.
Mercury (Hg)	Brain damage.
Cadmium (Cd)	Disorder of respiratory system, kidney and lungs, cadmium salt consumption causes cramps, nausea, vomiting and diarrhea, general decline in health.
Chromium (Cr)	Occupational hazards of chromium (Cr^{+6}) cause skin and respiratory disorder, ulceratin of skin, inhaled Cr^{+6} can cause cancer of respiratory tract.
Arsenic (As)	Skin cancer, hyper-pigmentation, black foot disease.

3. Effects on aquatic organism

Water polluted with. heavy metals inhibits the and contaminated sediments can threaten creatures in the benthic environment, exposing worms, crustaceans and insects to hazardous concentrations of toxic chemicals. These contaminants in the sediment are taken up by benthic organisms in a process called bioaccumulation and and aquatic organisms, such as fish, accumulate pollutants directly from contaminated water and indirectly via the food chain. The toxic sediment due to presence of these heavy metals leads to killing of the benthic organisms and thus reducing the food availability for larger animals such as fish. These contaminants in form of heavy metal in the sediment are taken up by benthic organisms in a process called bioaccumulation and when larger animals feed on these contaminated organisms, the toxins are taken into their bodies, moving up the food chain with increasing concentrations in a process known as biomagnifications. Heavy metals in water are particularly dangerous for fish juveniles and may considerably reduce the size of fish populations or even cause extinction of entire fish population in polluted waterbody. They also cause behavioral anomalies (such as impaired locomotors performance resulting in increased susceptibility to predators) or structural damages (mainly vertebral deformities).

4. Conclusion

Pollution of the aquatic environment by heavy metal impact physiology, development, growth and survival of aquatic organism and finally, affects human the top of the food chain, through consumption of these organism.consume fish. The accumulation of heavy metals in the tissues of organisms results in chronic illness and potential damage

to the population. Effective monitoring environmental levels of heavy metals is a subject of interest and development of chemical and biological methods is a critical step for environmental waste management. Monitoring the exposure and probable intervention for reducing additional exposure to heavy metals in the environment and in humans can become a major step towards prevention from ill effects of these contaminants. National as well as international co-operation is vital for framing appropriate laws to prevent heavy metal toxicity.

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HONEY BEES AS POLLINATORS

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Introduction

In India, about 80% of the crop plants depend or stand benefited from insect pollination. About 750 to 1000 bee floral plants are estimated to be growing in India. Of the 160 million hectares of the cropped area, more than 55 million is under bee dependent crops. Nectar is secreted by insect pollinated flowers to attract the insects. As they visit flowers for nectar the pollen gets dusted all over the body and transferred to the stigma of the flower next visited. Thus cross pollination is brought about.

The potentialities of honey bees as efficient pollinators become evident when it is recalled that members of a colony visit about 100 flowers during a field trip and make about four million field trips, every year. Fruit crops like apple, plum, back berry, rasp berry, strawberry, citrus, grapes, papaya and cherry, vegetables like lady's finger, brinjal, tomato and cucurbits, and field crops like cotton, alfalfa and clover depend upon honey bee for pollination. Realizing the importance of honey bees in pollination of crops bee colonies are being hired out in western countries to orchard growers in the flowering seasons.

Honey bees are the most efficient pollinators because of the following characteristics

- ✓ Their body parts are specially modified to pick up many pollen grains
- ✓ They exhibit floral fidelity and constancy
- ✓ Their potential for long working hour
- ✓ Micro – manipulation of flower
- ✓ Maintainability of high populations when and where needed
- ✓ Adaptability of different climate and niches

Effects of bee pollination on crops

- It increases yield in many crops
- It improves the quality of fruits and seeds
- Bee pollination is must in some self-incompatible crops for seed set, e.g. sunflower, niger, mustard, safflower and gingelly.
- Bee pollination increases the oil content of seeds in sunflower

Advantages of bee pollination

- Stimulates germination of pollen on stigma of flowers improving fertilization
- Increases viability of embryos and seeds
- Increases nutritional value
- Increases vegetative mass and stimulates faster growth of plants
- Enhances resistance to diseases and other adverse environmental stresses
- Increases nectar production in the nectarines of plants

- Early and uniform seed set

Pollination in horticultural crops

Bees mediate cross pollination in apple, peach. Plums, apricot, litchi greatly increasing the fruit set. Sweet lime needs bees for pollination. Mandarin oranges are generally benefited from cross pollination. Honey bees are the main visitors of jujube. *Apis dorsata* is the dominant visitor of *Vitis* spp. Bees collect pollen from the male and hermaphrodite flowers of papaya. *A. florea* is a common visitor of mango inflorescence and all the varieties are not attractive to bees. Honey bees are the most credited pollinators of cole crops that are cross pollinated to the extent of 95%. Bees visit cauliflower for nectar and pollen. Honey bees are found rarely in brinjal but in bhendi they increase the seed set, yield and germination significantly. Bee pollinated tomato crop can produce 80 per cent of first quality fruits. In cucurbits, the male and female flowers are separate on the same plant and the bees visit them to collect large sized pollen grains.

Pollination in field crops

Crops like sunflower, cotton, gingelly, mustard, safflower, millets and legumes are pollinated by bees. In some crops, the expected increase in yield due to bee pollination will be as follows

Crops	% increase in yield	No. of hives/ ha
Sunflower	20	2 – 4
Cotton	20	2 – 6
Sesamum	10	2 – 3
Mustard	20	3 – 5

Sunflower

Sunflower has a medium source of nectar and has enormous amount of pollen. It requires insect pollination for a fully filled head. Bee hives in sunflower field will increase the number of seeds per head, weight of head, oil content and also the nutritional value. They need to be placed on the field periphery approximately at 200 meter interval at the rate of one colony per acre. Adequate number of hives is required for proper pollination. In Punjab and Haryana, where *A. mellifera* is abundant the sunflower yield is more (1500 kg/ha) than in Andhra Pradesh, Karnataka, Maharastra and Tamil Nadu where bee pollination is not ensured (400- 600 kg/ha). Sunflower yield can be increased three times if we provide optimum bee pollination.

Cotton

Cotton a cross pollinated crop, is the second most important crop pollinated by bees and its flowers are visited by honey bees as it is a rich source of nectar. Cotton is an important late season nectar source when other sources are scarce. Upland cotton did not show an increase in yield but fruit set is earlier. By reducing the insecticide usage in cotton, it is possible to maintain the population of pollinators, especially honey bees.

Sesamum

Sesamum is an important source of both nectar and pollen. Flowers have nectarines and extra-floral nectarines on the base of flowers. Bee hives are placed in sesamum field to increase yield through pollination by 25 per cent.

Legumes

Among the legumes, bees pollinate crops like broad beans, field beans and soy bean. In broad bean and field bean, the extra- floral nectarines are present on the underside of the stipules. These nectarines function throughout the vegetative period of plants and repeated removal of the nectar stimulates further production.

Conclusion

Many species of pollinators are in decline around the world due to destruction of natural habitat. This is especially true in industrialized countries. Bees and other pollinators are a vital part of the natural system. Besides humans, many other species rely on pollinators. Plants need pollination in order to reproduce, and many species of wildlife depend on pollination in order to find their food as well. Gardeners and homeowners can plant a variety of trees, shrubs, and flowers to attract pollinators. By choosing a variety of flowers that provide blooms continuously throughout the growing season, you can ensure that pollinators will return regularly.

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IMPACT OF NUTRIENT OMISSION ON GROWTH AND YIELD OF MAJOR CEREALS

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Introduction

Adequate supply of plant nutrient decides optimum productivity of any crop & cropping system. Even if, all other factors of crop production are in the optimum, the fertility of a soil largely determines the ultimate yield. When the soil does not supply sufficient nutrients for normal plant development and optimum productivity, application of supplemental nutrientsis required. Fertilizer is one of the most important sources to meet this requirement. Indiscriminate use of fertilizers may cause adverse effect on soils and crops both nutrient toxicity and deficiency either by over use or inadequate use. Thus, a nutrient omission trial aims to find out the most limiting factors to the growth of a crop plant. If any element is omittedwhile other elements are applied at suitable rates and plants grow weakly, then the tested element is a limiting factor for crop growth. Conversely, if any element is omitted but plants are healthy, then that element is not a limiting factor for crop production.

Nutrient Omission Plot Technique

In an omission plot adequate amounts of all nutrients are applied except for the nutrient of interest (*i.e.*, the omitted nutrient). The nutrient omission plot technique used to estimate fertilizer requirements. The yield in an omission plot is related to the indigenous soil supplying capacity of the omitted nutrient. Omission plots make any nutrient limitations visible.

Scope of nutrient omission plot technique

Major cereals are an important staple food of India and continues to play a vital role in the National Food and livelihood security system. However, productivity is lower than World'saverage productivity. Lower productivity of major cereals is because those are grown in the country under various agro-ecologies in both irrigated and rainfed systems and also deficiencyof some macro, micro and secondary nutrients is one of the major causes for stagnation in crop productivity. Exploitive nature of modern agriculture involving use of high analysis NPK fertilizers, free from micronutrients as impurities, limited use of organic manures and restricted recycling of crop residues are some important factors having contributed towards accelerated exhaustion of secondary and micronutrients from soil. At several places, normal yield of cropscould not be achieved despite balanced use of NPK due to micronutrient deficiency in soils.

Principles of Nutrient omission plot technique

- Reaching toward optimum productivity based on soil indigenous level in specific area.
- Dynamic adjustments in fertilizer N.

- Effective use of indigenous nutrient.
- Use to determine the requirements for P and K.
- Efficient fertilizer N management through the use of LCC.
- It helps us to know nutrient interactions in the soil and plant crop and deficiency symptoms can be easily identified.

Nutrient interactions

Nutrient interactions is defined as interaction between nutrients in crop plants occurs when the supply of one nutrient affects the absorption and utilization of other nutrients. This type of interaction is most common when one nutrient is in excess concentration in the growthmedium. Nutrient interactions can occur at the root surface or within the plant. Nutrient interactions may be positive or negative and also possible to have no interactions. When nutrients in combination results in growth response that is greater than the sum of their individual effects, the interaction is positive which is called as Synergistic and when the combine effect is less, the interaction is negative which is called as Antagonistic. If there is nodeviation from two nutrients additive response when applied separately, absence of interaction.

a) Nitrogen interaction

Nitrogen plays a pivotal role in the plant metabolism and hence in determining growth. Increasing N supply enhances the growth, and consequently, increases the demand for other nutrients. This demand can translate into plant concentrations less or greater than that needed for sufficiency, depending on the nutrient supply in the root zone. Positive interaction between N and P which leads to increase in P absorption and higher yields. Nitrogen interactions with micronutrients occur due to change in pH in the rhizosphere with the forms of N used. If N form is NH^{4+}, due to cationic absorption, soil pH may decrease and uptake of some micronutrients increases. If the N form is NO^{3-}, due to higher uptake of anion, soil pH may increase and uptake of most micronutrients decreases. Assimilation of N and sulphur in plants is closely associated. Nitrogen nutrition has a strong regulatory influence on S assimilation and vice versa.

b) Phosphorus interaction

Phosphorus deficiency is a principal yield limiting factor for annual crop production in acid and alkaline soils of temperate as well as tropical regions. This means, evaluating interaction of phosphorus with other nutrient is very important to maintain a balanced nutrient supply for improving crop yields. Generally, phosphorus has positive significant interaction with N absorption and plant growth. Positive interactions between P and Mg are expected since Mg is a activator of kinase enzymes and activates most reactions involving phosphate transfer. Large P inputs decrease soil Zn diffusion rates and enhance Fe immobilization. Positive interaction between P and Mn and is assumed to be attributed to the soil acidifying effect of P, which increase the Mn uptake. Application of phosphatic fertilizers at a high dose increases the severity of such deficiencies in soils that are low or marginal in available Zn. There is antagonistic interaction between P and Fe. Iron deficiency induced by heavy applications of phosphorus. Interaction of

Phosphorus and Ferrous leading to Fe chlorosis appears to be caused by an internal immobilization of Fe probably due to formation of Fe phosphate.

c) Potassium interaction

Potassium is the unique essential nutrients in the diversity of role it plays in plant metabolism processes. Activation of enzymes, acting as an osmoticum to maintain tissue turgor pressure, regulating the opening and closing of stomata's, and balancing the charges of anions are physiological functions of K in plant cells. Adequate K level is essential for the efficient use of N in crop plants. Potassium has antagonistic effects on the absorption of Ca^{2+} and Mg^{2+}at higher concentration which depends on plant species and environmental conditions. The application of potassium consistently decreased the manganese and iron content in the rice plant.

Conclusion

Nutrient omission plot technique overcomes the constraints of Liebig's law of the minimum. Omission technique helps to assess the relative importance of each nutrient in crop production. Thus, nutrient omission technique determines the indigenous nutrient supplying capacity of soil and determines the productivity, nutrient use efficiency of crop plants.

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AMFI-SI-27

IMPORTANCE AND SCOPE OF AGROMETEOROLOGY

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Agricultural production is dependent on weather and climate despite the impressive advances in agricultural technology over the last decades. All agricultural endeavors are influenced by weather and climate events. Weather and climate is a resource and considered as basic input or resources in agricultural planning, every plant process related with growth development and yield of a crop is affected by weather. Similarly every farm operation such as ploughing harrowing, land preparation, weeding, irrigation, manuring, spraying, dusting, harvesting, threshing, storage and transport of farm produce are affected by weather.The benefits of understanding these events help in the establishment of techniques and that look after a healthier agricultural industry. It is therefore very important for farmers, researchers or persons interested in agriculture, to know that there are daily, seasonal, and annual variations that play a vital role in crop response and survival.

The scope of Agricultural Meteorology can be illustrated through the following few applications.

1. Characterization of agricultural climate: For determining crop growing season, solar radiation, air temperature, precipitation, wind, humidity etc. are important climatic factors on which the growth, development and yield of a crop depends Agro-meteorology considers and assess the suitability of these parameters in a given region for maximum crop production and economical benefits. To delineate agro-ecological zones for efficient use of resources and fast transfer of technology and to study climatic resources of given area for effective production. To develop crop/animal growth simulation models for prediction of productivity in advance and also obtaining potential yield in different agric- ecological zones.

2. Crop planning for stability in production: To reduce risk of crop failure on climatic part, so as to get stabilized yields even under weather adversity, suitable crops/cropping patterns/contingent cropping planning can be selected by considering water requirements of crop, effective, rainfall and available soil moisture.

To quantify favorable weather normal for effective farm operations. To develop crop/animal weather relationships for estimation of animal/crops productivity as well as to prepare crop weather diagrams and crop weather calendars for timely operations by farmers

3. Crop management: Management of crop involves various farm operations such as,

sowing fertilizer application. Plat protection, irrigation scheduling, harvesting etc. can be carried out on the basis of specially tailored weather support. For this the use of operational forecasts, available from agro met advisories, is made

e.g. 1) Weeding harrowing, mulching etc are undertaken during dry spells forecasted. 2) Fertilizer application is advisable when rainfall is not heavy wind speed is<30 km/hr and soil moisture is between 30 to 80%

3) Spraying/dusting is undertaken when there is no rainfall, soil moisture is 90% and wind speed is<25km/hr.

4. Crop Monitoring: To check crop health and growth performance of a crop, suitable meteorological tools such as crop growth models. Water balance technique or remote sensing etc. Can be used. To study weather- crop pest and disease relationships.

5. Crop modeling and yield –climate relationship: Suitable crop models, devised for the purpose can provide information or predict te results about the growth and yield when the current and past weather data is used.

6. Research in crop –climate relationship: Agro-meteorology can help to understand crop-climate relationship so as to resolve complexities of plant process in relation to its micro climate. To modify micro climatic for increasing agricultural productivity.

7. Climate extremities: Climatic extremities such a frost floods, droughts, hail storms, high winds can be forecasted and crop can be protected.

8. Climate as a tool to diagnose soil moisture stress: Soil moisture can be exactly determined from climatic water balance method, Which is used to diagnose the soil moisture stress, drought and necessary protective measures such as irrigation, mulching application of antitranspirant, defoliation, thinning etc. can be undertaken.

9. Livestock production: Livestock production is a part of agriculture. The set of favorable and unfavorable weather conditions for growth, development and production of livestock is livestock is studied in Agril. Meteorology. Thus to optimize milk production poultry production, the climatic normal are worked out and on the suitable breeds can be evolved or otherwise can provide the congenial conditions for the existing breeds.

10. Soil formation: Soil formation process depend on climatic factors like temperature, precipitation, humidity, wind etc, thus climate is a major factor in soil formation and development.

Agricultural meteorology is concerned with meteorological, hydrological and pedological factors affecting agricultural production and also with agriculture's interaction with the environment. Its objectives are to elucidate such effects, and then

to assist farmers to apply this supportive knowledge and information in agrometeorological practices and services.It spatially extends from the soil layer of deepest plant and tree roots(pedosphere), through the air layer near the ground in which crops grow and animals live, to the higher levels of the atmosphere in which processes such as the transport and dispersal of seeds and pollen take place. Its fields of interest go from agricultural (including horticultural) production, forestry, animal husbandry, fisheries and other forms of outdoor and indoor production, agricultural planning, processing, transport and storage to agrometeorological components of food security, poverty reduction and sustainable development aspects of the livelihood of farmers/producers as well as of the use of their products. In addition to large scale climate and its variations, operational agricultural meteorology concerns itself with small scale climate modifications as brought about for example by wind breaks, irrigation, mulching, shading and frost and hail protection. Other important subjects are agroclimatic characterisation, pests and diseases and their safe control, covered agriculture, quality of agricultural products, animal comfort aspects, plant production for other than food purposes, including biomass as a renewable energy resource, and ecological considerations. Much attention is paid to the impacts of climate change and climate variability, including monitoring, early warning and estimation of changes of the risks of extreme events such as drought, desertification and flooding. Specialised agriculture can be inimical to biodiversity while intensive agriculture affects the environment through the generation of air pollutants, greenhouse gases (CO_2, methane and nitrous oxide), ammonia and tropospheric ozone. Other modes of production cause soil erosion by wind and water. Thus agricultural meteorology has a major role to play in understanding of emissions and pollutions from various unsustainable production systems. Water management to ensure adequate supplies while maintaining the quality of surface and groundwater is a key topic. Applications to aquaculture and fisheries (food aspects) range from site climatologies, hydrodynamics of rivers/reservoirs, estimation of contamination from agricultural run - off and of other ecosystem stresses, to using meteorological factors to predict the occurrence of toxic algal blooms.

Support systems to agrometeorological practices and services comprise data (so quantification), research, training/education/extension and policy environments. Especially in industrialized countries mathematical models are increasingly used in operational agricultural meteorology, inconjunction with Geographic Information Systems (GISs) to provide inputs to Decision Support Systems (DSSs). These models have utilised meteorological observations but now there are also the outputs of operational numerical weather prediction and of climate prediction. These forecasts may be exploited to increase the utility of models to decision makers. Remote sensing provides access to additional biophysical parameters, e.g. vegetation indices and surface temperatures. Incorporation of such data into models is being undertaken. The enormous potential of agrometeorological information and services makes the training of farmers and environmental managers in the use of agrometeorological practices and

services a matter of great importance.

Major goals of Agrometeorology are

- To provide weather related information to farmers, in order to reduce weather-related hazards that agriculturalists may face, with the ultimate intention of improving the nation's food security situation.

- To carry out research in collaboration with Agriculturalists and other scientific disciplines in order to establish ways in which various aspects of weather affect agriculture, such that the best advice on weather related issues may be rendered to the agricultural community.

THE SCOPE OF "MODERN" AGROMETEOROLOGY

Agrometeorology deals with all the weather-sensitive elements of agriculture production. The spectrum of subjects is thus rather wide. It includes pollination, animal migration, trafficability, transport of pathogens by wind, irrigation, climate manipulation and artificial climates, weather risk assessments, the use of weather forecasts in farming, crop yield and phenology forecasts and particularly advice to farmers as well as the required data and methods. They include data acquisition techniques (ground observation, aircraft and satellite), data transmission techniques (including the Internet) and data analysis (models and other software).

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INTEGRATED APPROACHES FOR THE MANAGEMENT OF SUGARCANE NEMATODES

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The nematodes are generally found in all type of environment, from ocean depths to tops of mountains, from hot water springs to icy arctic and Antarctic, from barren lands to cultivated fields, and from meadows to tropical forests. Nematodes thus occupy any conceivable habitat on this earth. They constitute the largest groups of animal kingdom, comprising 80 to 90 per cent of all multicellular animals. The nematodes are basically aquatic animals but they have adopted terrestrial habits. They are mostly found in the soil and rarely any crop is free from their attacks. It has been estimated that one gram of soil habitats the following numbers of organisms: bacteria 108, actinomycetes 105, fungi 105, micro algae 103, protozoa 103, nematodes 101 and other invertebrates 105. Plant parasitic nematodes are recognized as potentially serious constraints to crop productivity. Rarely is any crop free from nematode attack, whether in the field, the orchard, kitchen garden or poly house, yet growers are unaware of the presence of nematodes mainly due to their microscopic size and protected condition within the soil.

Plant parasitic nematodes are one of the important biotic constraints in sugarcane production in subtropical and tropical regions of the world. It is estimated that nematodes cause an average annual yield loss of 15.3% worldwide in sugarcane. Among the 20 life sustaining crops of the world, highest monetary loss due to nematodes is reported in sugarcane. In India nematodes are reported to cause about 10-40 % yield loss in sugarcane. However, losses may become still higher if nematodes are associated with other biotic and abiotic stresses in the field. Plant parasitic nematodes are soil inhabiting, microscopic roundworms that feed on plant roots. Nematode damage symptoms are often confused with symptoms of nutrient deficiencies even in the presence of optimum moisture and nutrients in the soil or other physiological disorders making diagnosis very difficult.

Over 15 genera and 50 species of plant parasitic nematodes have been reported from sugarcane, but most records are of nematodes extracted from soil, or from mixed root and soil samples, and therefore evidence of their feeding and reproducing on sugarcane. In India five genera *viz*, *Pratylenchus*, *Meloidogyne*, *Hoplolaimus*, *Tylenchorhynchus* and *Helicotylenchus* are found widely prevalent in sugarcane ecosystem. Of these, lesion nematode *Pratylenchus* spp. Is the most predominant and economically important genus. This nematode is widely prevalent in both subtropical and tropical regions and reduces yield and quality of cane in both light and heavy soil types. Root knot nematodes *Meloidogyne* spp. are a problem mainly in light sandy loam

and sandy soils. The damage threshold level for root knot and lesion nematodes in sugarcane is one nematode/g of soil. Nematodes are generally slow in establishing and inflicting economic damage. It is often thought that sugarcane, being a relatively hardy crop, may not succumb to these tiny worms. Sugarcane is cultivated in a long duration of one year followed by 2-3 ratoons with little disturbance of soil facilitate the build up of high nematode population in just 2-3 crop cycles which results in yield decline in subsequent crops. Further, monocropping of sugarcane to meet the cane demands of increasing number of sugar factories makes phytonematodes a constraint to sustainable sugarcane production in many parts of India.

Root knot nematode, *Meloidogyne* spp.

They cause galls or knots of varying sizes along the root, usually near the root tips, resulting in chlorosis and stunting. The leaves are rolled and appear short of moisture. This is more accentuated in ratoon crops, where the foliage has a yellowish colour, which resembles that of nitrogen-deficient plants. As in other grasses, root galls on sugarcane are small and may take the form of nodules and elongated curled thickenings at or near the root tips, which can be easily overlooked. In heavily infested plants, signs of yellowing and stunting are seen, and the leaves are characterized by waxy golden yellow bands extending from the tip to the sheath. The juveniles enter the root through the region of root tip. Heavy larval infections stop the root growth by affecting the meristematic zone. The pressure from the expanding giant cells, maturing nematodes, and egg masses causes mechanical damage to the root tissues, such as blockage or malformation of the xylem vessels. Lateral root proliferation in sometimes, but not always, associated with gall formation, but pronounced root curvature is associated with nematode infection.

Lesion nematode, *Pratylenchus* spp.

Leaves turn pale, yellowing, chlorosis in patches, and general stunting are common symptoms. Nematodes invade the cortical parenchyma. The cells adjacent to the nematodes become brownish and often collapse. The cane roots are thickened with a few fine roots and show dark, round or elongated lesions. Reduction in the yield of sugarcane increases as the nematode population densities.

Lance nematode, *Hoplolaimus* spp.

Stunting of the plant and loss in both fresh and dry weight of the tops, root growth retardation, and sparse and stubby roots may lead to decay gradually. Cell necrosis leads to the damage of root parenchymatous tissue, which may further result in weakening of the roots. At heavy infestation, the infected clumps can be easily pulled out.

Spiral nematoede, *Helicotylenchus* spp.

Severe stunting and chlorosis are the main symptoms and induces brownish, reddish lesions on adventitious roots, leading to disorganization and collapse of the cells of cortical tissue. This results in sloughing of the epidermis. The nematodes may penetrate deep into the cortex and stele. Blunt, malformed roots and small branch root reduction is also caused.

Stunt nematode, *Tylenchorhynchus* spp.

The nematodes feed mainly on the epidermal cells and root hairs, they make the root bare, giving it a coarse appearance. The roots become stubby, blunt, irregular, and sparse resulting in poor growth.

Management of nematodes

Deep summer ploughing and soil solarisation

During the onset of summer, the infested field is ploughed with disc plough and exposed to hot son, which in turn enhances the soil temperature and kills the nematodes. Soil solarisation using plastic mulch during summer months further increases the efficacy of the treatment. This approach also helps in suppressing weeds and other soil borne pathogen

Crop rotation and intercropping

Rotation with legumes, soybeans, sunflower, paddy, mustard, coriander, and marigold is effective. Rotation with trap/antagonistic crops like sun hemp and sesame can minimise the nematode population in soil. Intercropping with short duration legumes like soybean and green gram reduces the population of lesion and root knot nematodes infecting the sugarcane.

Green Manuring

Green manuring is a conventional practice of growing plants like sun hemp or daincha and ploughing them *in situ* to provide nutrition to the main crop after proper decomposition and reduces the population of plant parasitic nematodes. This process not only changes the soil environment during the decomposition, but also affects the soil micro fauna. It also improve the organic matter and nitrogen status of the soil. It could be sown along ridges at the time of planting sugarcane and incorporated in soil 45 days after planting.

Organic Amendments

Adding decomposable organic matter to the soil is recognized as a very efficient method for changing the environment of soil and rhizosphere, thereby adversely affecting the life cycle of nematodes. Application of cured press mud at 15 t/ha during the field preparation helps in suppression of plant parasitic nematodes. Press mud being rich in nutrients and organic matter serves as a good substrate for the multiplication of nematode antagonistic fungi and bacteria in soil. Apply poultry manure @ 2 t/ha or neem cake @ 2 t/ha before last ploughing reduces the nematode population.

Trash Mulching

Mulching with cane trash @ 5t/ha and its incorporation into soil during earthing-up operation will bring down the population of nematodes by increasing the organic matter and population of nematode antagonistic microbes in soil. Besides reducing nematode population trash mulching also helps in suppressing weeds and conserving soil moisture.

Biological Methods

Application of biocontrol agents like *Pochonia chlamydosporia*, *Purpureocillium lilacinum or Trichoderma viride* @ 20 kg/ha at the time of planting mixed with moist FYM

or cured press mud and distributed uniformly will help in suppressing the plant parasitic nematode.

Resistant varieties

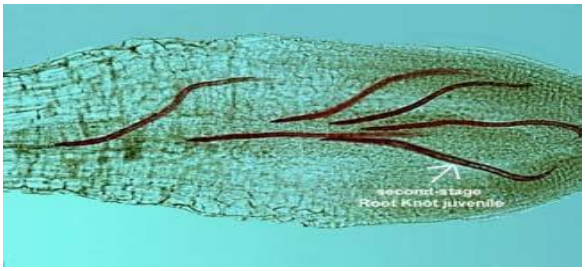
Resistant/tolerant varieties are Co 290, Co 527, Co 1001, Co 726, Co 927, Co 711, Co 997 will help in suppressing nematode in sugarcane fields. If one particular variety is resistant/tolerant to some nematodes, it need not be fully resistant/tolerant to other species also.

Chemical methods

Apply Carbofuran 3G @ 33 kg/ha at the time of planting or 2 months after planting or Cartap hydrochloride 3 kg/ha to be effective against sugarcane nematodes.

A typical plant-parasitic nematode

Invasive stage of root knot nematode



Root Knot Nematode in sugarcane roots

Lesion Nematode

AMFI-SI-29

INTERCROPPING APPROACHES FOR INTEGRATED PEST MANAGEMENT

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Introduction

Intercropping, one of the cultural practices in Integrated Pest Management,which involves growing of two or more different crops in the same field. Growing of different crops in the same field provide co-existence of several organism and beneficial interaction between the organisms that can empower the agro-ecologically stable environment. Intercropping enhances the benefits of on farm diversity, increased productivity, resource distribution balance and weed and insect pest control and also maintains ecological balance.

Importance of Intercropping

- Intercropping give additional income to the farmers
- Intercropping with green manure crops is used as mulching, that provide more nutrients to the crops that in turn reduces the usage of fertilizer in the field.
- Intercropping with floral plants invites more natural enemies *i.e.*, parasitoids and predators.
- Intercropping provide ecological sustainability
- Intercropping suppress the pest population by delaying colonization of pests or by reducing the reproduction rate of insects
- Intercropping reduce the weed population and helps to conserve the properties of soil.
- Intercropping lowers the application of pesticides and improve the crop quality also.
- Intercropping protect the land from soil erosion and solarisation.
- The selected intercrop should not compete with the main crop.

Repellent intercropping

An intercrop which have repellency effect can also used for insect pest management. The repellent intercrop can masks or deters insect pest from the main crops. The chemical produced or the physical/morphological characters of the intercrop repels the insect pest.

An example of repellent intercrop is that when onion intercropped with carrot as main crop, repels carrotfly, *Psila rosae* and reduces the incidence in the main crop.

Trap intercropping

Trap intercropping is a practice of cultivating attractant crops close to the main crop. The intercrop is more attractive to the insect pest than the main crop, so that insect is easily drawn to the trap crop. An example of trap intercropping is cowpea intercropped with cotton to check the *Helicoverpa* sp. population.

Push – pull cropping

This is the combination of repellent and trap intercropping system. The trap crop will attract the insect, act as pull component and the repellent crop deter the insect, act as a push component. Example in maize ecosystem napier and sudan grass grown in border to attract the stemborer pest and intercropped with Molasses grass and silver leaf will repel the stemborer population.

Here, some successful examples of intercropping system, that can manage the major pest population of main crops are listed (Table.1)

Table 1. Successful examples of intercropping system

S.No.	Main crop	Intercrop	Pest controlled
1.	Apple	Buck wheat	Leaf roller pest, *Epiphyas postvittana*
2.	Bengal gram	Marigold	*Helicoverpa* sp.
3.	Brinjal	Coriander or Marigold	Leafhopper and Whitefly
4.	Cotton	Chick pea	*Helicoverpa* sp
5.	Ground nut	Sorghum, Bajra,Maize	Leafhopper, *Empoasca kerri*, Aphids, *Aphis craccivora* and Thrips, *Scirtothrips dorsalis*
		Cowpea	Leaf folder
6.	Maize	Beans and legumes	Leaf hoppers,Leaf beetle, Stalk borer
7.	Mustard	Cabbage	Cabbage head borer
8.	Oats	Carrots	Thrips
9.	Onions	Ragweed	Oriental fruit moth
10.	Pigeon pea	Sorghum	Leafhopper
11.	Potato	Marigold	Nematodes
12.	Radish	Cabbage	Flea beetle,Root maggot
13.	Rye	Soybean	Corn seedling maggot
14.	Soybean	Green beans	Mexican bean beetle
		Maize	*Helicoverpa* sp.
15.	Tomato	Cabbage	Diamond back moth
		Marigold	Tomato fruit borer and Root knot nematode
		Coriander	Whitefly, *Bemisia tabaci*

Conclusion

Selecting the right intercrop is very much important to determine which combination will suppress the pest population because not all the combinations of crops will reduce the pest population. Integration of intercropping as a component in integrated pest management strategy is a better approach to manage the pest population but its needs detail knowledge about the combination of plants, whether they will influence the behaviour of pests, beneficial organism and ecological sustainability.

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AMFI-SI-30

IRIDESCENCE IN INSECTS

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INTRODUCTION:

Goniochromism ascribes several creatures from sparkling terrestrial beetle *Charidotella sexpunctata* to marine *sapphrinid copepods* in the Blue Planet. Iridescence provides the ability to produce short reflecting wavelengths ranging from blue to green, enabling the job ease. Iridescence is the property of changing surface colour with viewing angle and one of the quintessential phenomena in animal kingdom evolution, predominantly in Insects. For the survival of the fittest, these six-legged engineers retain the crown of puzzling physics phenomena over the last million years, and these miniatures perfected to harvest a wide variety of hues independent of illumination intensity, leveraging broad techniques such as reflection, interference, diffraction, dispersion, refraction, etc., by exploiting its structural and pigmentary integument for aposematic display and attract a mate in the ambient spectral environment. Besides opalescence, some butterflies are believed to generate a neural image, based on the relative percentage of polarization reflectance and ultraviolet pattern from their environment for location and acquisition of food resources, appropriate oviposition sites and conspecific as well as interspecific communication (Weiss and Papaj, 2003). Earlier scientists claimed that iridescence attracts the potential sex and warns predators by Mullerian and Batesian mimicry. Nevertheless, a counterintuitive hypothesis was proposed as they also act as camouflage (Kjernsmo *et al*., 2018) this notion was emphasized by the experiment's findings at the University of Bristol School of Biological Science. Due to the pigments and nanomorphology of integumentary tissues, the iridescence mechanism is broadly categorized.

PIGMENTARY COLOURS:

The chemical compounds coin the pigmentary colours, which are accentuated in many species and materials. Blue pigments were hardly present in animal taxa except for some molluscs, crustaceans, and arachnids. These principle compounds scatter the unabsorbed light from its surface and comparatively less effective than structural phenomena due to their diffuse scattering. In comparison, the colour remains non-iridescence, however promoting heterotherm insects and ideal camouflage. Owing to the cumulative geometric effect of scales, selective absorption or selective reflection of light by a pigment creates matte colours distinct from the vivid metallic appearance of *Lycaena phlaeas*. The shorter wavelengths were scattered, whereas the longest being transmitted and eventually absorbed by the deep layers in the case of *Lycaenidae*, contrary to *Pierida* (Berthier, 2017). Papilionid butterfly wing scales harbour a distinctive class of pigments, the papiliochromes, which act as a spectral filter (Wilts *et al*., 2015). The chemical structures of these pigments are often vulnerable to environmental pressures. *Polyommatus icarus* butterflies ventral wing experiences

colour alteration relative to its frosty environment (Kertész *et al*., 2017). Some insects are also described for fluorescence and bioluminescence, as in *Sternotomis virescens* and Firefly respectively.

STRUCTURAL COLORS:

The chitin molecule in the integument consists of long-chain N-acetylglucosamine monomers forming microfibrils coated with a proteinic matrix, resulting in layers parallel to the epicuticle (Berthier, 2017). This framework, including helicoid structures and photonic crystals, appears to form complex configurations. The dazzling structural colours are designed by the interaction of light on the boundary between the media of differing refractive index, made up of a stunning plethora of nanoarchitecture arrangement, reflecting and refracting light directionally by interference or diffraction. Diffraction is the product of periodicity gratings and the incident wavelength. Sometimes the lateral flanges in scales function as thin-film stacks to produce iridescence. Also, structural colours rely on the thickness, orientation and optical index of single or multilayer scales. *Lycaena phlaeas* scales – cover and ground scales differ in length with the same thickness. Incidence of absolutely unpolarised light on the anisotropic mesoscale structure on or above the Brewster angel results in reflection of completely polarised light whereas polarised incident light tends to transmit or reflect based on the arrangements, facilitating in conspecific and interspecific communication. Also, the higher refractive index (RI) of structure positively correlated to higher wavelength reflection. The surface becomes transparent when the index of two mediums is merely equal, which can be accomplished either by optical impedance matching or direct matching. Some Insects have localized nanostructure and a relatively thin film of chitin layer to mould the transparency-Dragonflies and cicadas (Schroeder *et al*., 2018). Generally, quite similar properties were observed between the iridescent scale and thin-film colour. Spectacular outcomes always proceed from a subtle mix between the two phenomena, the two reinforcing each other (annihilating or combining). Eg. Upper lamella hides the iridescence of lower lamella when the incidence approaches grazing angle in *Lycaena icarus*. *Morpho godarti* structural scales hardly contain any pigment and when an index match is achieved, they turn transparent, revealing ventral side patterns (Berthier, 2017).

CONCLUSION:

The iridescent and non-iridescent structural colours are fundamentally formed from the coherent scattering but vary significantly in their nanostructural origin (Prem, 2006) and intensively effective than pigmentary colours under varying circumstances. Gleaming insects surfaces are often seen as synonymous with elegance, which potentially teaches the researchers and engineers over time for numerous innovations. Still, the roots and evolution of these nanostructural integuments of their progress remain anonymous. Apart from lighter, more robust and flexible properties of insect covering, Insect taxonomy is a fortune to grip the source of crucial iridescence to helps in attracting partners, camouflage, thermoregulation by absorption or heat dispersion (e.g. *Koscuiscola*), gender superiority as in *Phanaeus vindex* horned dung beetles to

highlight the size of the iridescent horn and prothoracic shield, water repellent and ward off predators. These motifs are evolutionarily correlated with their surroundings, making insects omnipresent in our diversified ecosystem.

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AMFI-SI-31

LIGHT INTERCEPTIONAND BEER'S LAW

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Introduction

Solar radiation is a primary driver of most plant biophysical processes, in cluding energy transfer, turbulent transport, evapotranspiration, photosynthesis, and phenology. Light interception by the leaf canopy is a key aspect of plant photosynthesis in higher plants and in turn the yield of the crop. Absorption of sunlight by photosynthesis occurs within a well-defined spectral band (400–700 nm) and matches a peak in energy distribution across the wavelength spectrum of sunlight transmitted to the earth's surface through our atmospheric window. This range is called as photosynthetically active radiation and the attenuation in the quantum of light within the canopy obey the Beer- Lambert's law. The most commonly used approach for estimating light interception treats the canopy as a homogeneous medium of unresolved vegetation (i.e., a "turbid" medium), which allows for the use of a simple exponential model for radiation attenuation commonly known as Beer's law, Beer-Lambert law, or Beer-Lambert Bouguer law

Beer's law

The Beer's law is originally formulated by August Beer in 1852, the las states that the light absorbed by the solution is directly proportional to the concentration of the solution.

Beer's Law may be written simply as:

$A = \varepsilon bc$

where A is absorbance (no units)

ε is the extinction coefficient (molar absorptivity) ($L\ mol^{-1}\ cm^{-1}$)

b is the path length of the sample (cm)

c is the concentration of the compound in solution, ($mol\ L^{-1}$)

Importance of Beer's Law

The Beer's law has proven its importance in measurement of solution concentration, analyse oxidation, and used to measure degradation of polymer in chemistry; in case of physics the law is used in the measurement of loss of particle beam (neutron), and in fluid dynmics. The amount of solar radiation reaching the earth surface crossing through the atmosphere can be described using this law. In agricultural meteorology, the relationship between the light interception and the leaf area of the canopy is governed by this law.

Lambert's law:

The law was discovered by the French mathematician, geophysicist, geodesist, and astronomer, Pierre Bouguer in 1729 and by Swiss-French polymath, Johann Heinrich

Lambert in the same year which was even in his *Photometria* in 1760. The law states that absorbance is directly proportional to path length.

Difference between beers law and lamberts law:

The key difference between Beer's law and Lambert's law is that Beer's law states that the amount of absorbed light is proportional to the solution concentration, whereas Lambert's law states that the absorbance and path length are directly proportional.

Beer-Lambert Law

The light interception and leaf area of the plant canopy is governed by the beer lamberts law. The combined Beer-Lambert law, states that the

$I=I_0e^{-\mu(x)}$

Where,

I is the intensity

I_0 is the initial intensity

x is the depth in meters

μ is the coefficient of absorption

Other names:

The Law goes by many names, including the Beer-Lambert Law, Lambert-Beer Law, and Beer-Lambert-Bouguer Law.

Application in Agriculture:

The law calculates the probability of radiation interception as an exponentially increasing function of the leaf area projected in the direction of radiation propagation and the distance travelled through the canopy

Distribution of light with in plant community obeys Beer's law. Beer's law describes the light penetration into a crop canopy if the foliage distribution is uniform in horizontal line. The law states that the light intensity decreases exponentially with increasing leaf area. That is, the intensity of light falls exponentially with the path length through the absorbing layers.

According to Beer's law the absorbance at some wavelength is proportional to the concentration of the absorbing substance, to its absorption coefficient at that wavelength, and to the optical path length A

$I=I_0e^{-kA}$

$I/ I_0= e^{-kA}$

$K=1/A(\ln (I/ I_0))$

The equation can also be written as

$$\mathbf{I = Io\ e^{-KA}}$$

Where

I = light intensity at a given height

Io = initial light intensity at the surface

e = base of natural log (2.7183)

K = extinction coefficient

A = leaf area index from top to the height in question

Extinction coefficient:

The extinction coefficient is the ratio between the light loss through the leaf to the light at the top of the leaf). The extinction coefficient describes the absorption properties of a particular type of foliage. It is mainly affected by the variation of leaf angle. Typical values for *k* are in the range of 0.5 to 0.9. K is lower when canopy leaves are erect and therefore higher PFD transmitted in to lower layers of the canopy

Beer's law is also called the Beer-Lambert law, and also Bouguer-Lambert- Beer law.

RADIATION AND LIGHT DISTRIBUTION WITHIN THE CANOPY

The distribution of light within a plant community can be expressed by Beer's law:

$I=I_0e^{-kF}$

where

I is the light intensity at a given height within the plant community;

I. is the light intensity at the top of the plant community;

e is the base of natural logarithm;

k is the extinction coefficient;

F is leaf area index from the top to the height in question.

The extinction coefficient is primarily determined by the inclination and arrangement of leaves, and only secondarily by leaf transmissibility. In an herbaceous community, the extinction coefficients are usually 0.3 to 0.5 in stands with upright leaves, and 0.7 to 1.0 in stands with more or has horizontal leaves (Saeki, 1960).

The linear relationship between the logarithm of relative light intensity and the leaf area index is illustrated in Figure 20 from the work by Takeda (1961) on rice plants. With a leaf area index of 7, 95 per cent of the light is intercepted by the leaf assemblage. The leaf area index required to intercept 95 per cent of the light varies with crops. Brougham (l958b) found the following values: ryegrass, 7.1; timothy, 6.5, and white clover, 3.5. Other things being equal, the higher the leaf area index required to intercept the same fraction of radiation, the more efficient the crop is in utilizing radiation energy.

Monteith in l965 proposed a somewhat different relationship to characterize the light distribution within the canopy. The equation is a binomial expansion of the form:

$I= [s+(1-s)\tau]^v I_0$

where I is the light intensity at a given height within the plant community;

I_0 is the light intensity at the top of the plant community; s is the fraction of light passing through unit leaf layer without interception;

I is leaf transmission coefficient; and

F is the leaf area index.

Monteith gave values of s ranging from 0.4 for crops with predominantly horizontal leaves (e.g., kale, clover), to 0.8 for crops with nearly vertical leaves (e.g., cereals, grasses).

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AMFI-SI-32

THE WONDERFUL LYCOPENE

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Discovered by Millardet in 1876 from Tomato, the red coloured pigment has been named as lycopene by Schunck, a carotenoid hydrocarbon. The lycopene found in the food matrix are commonly reported to be present in papaya, pink grapefruit, pink guaya, red carrots and watermelon in addition to tomato. However, lycopene is not present in strawberries and cherries. Highly accepted by food industry as food additive and for health benefits the demand of lycopene is increasing manifold as it acts as red colorant and as well as antioxidant agent. Keeping in view the increasing world consumption of lycopene the alternative sources for its production are warranted in order to take out the best from the application of Lycopene.

1. How Lycopene gets into Human body?

Lycopene, like other carotenoids, is a tetrapene (a class of natural products consisting of compounds with a formulae $(C_5H_8)_n$) which is symmetrical in nature and is insoluble in water. The red colour of lycopene is due to its eleven double conjugated double bonds (Fig.1) and owing to its colour it is useful as food colouring.

The bioavailability of lycopene to humans largely depends on the isomeric shape and the *cis* form is more absorbable than *trans* one. The heating of lycopene enriched products changes the *trans* isomer of lycopene to *cis* form and even the sun dried and olive fried turns *cis* form of lycopene into *trans* isomer so that the absorption rate increases manifolds in the human digestive tract. The absorption of the lycopene is more in small intestine than larger one in the human digestive system. Lycopene follows the same absorption process as dietary fat as being the fat soluble compound. The lycopene once in duodenum part of small intestine separated from the food matrix and gets dissolved in the lipid phase which prior to absorption via passive or diffusion process from lipid droplets

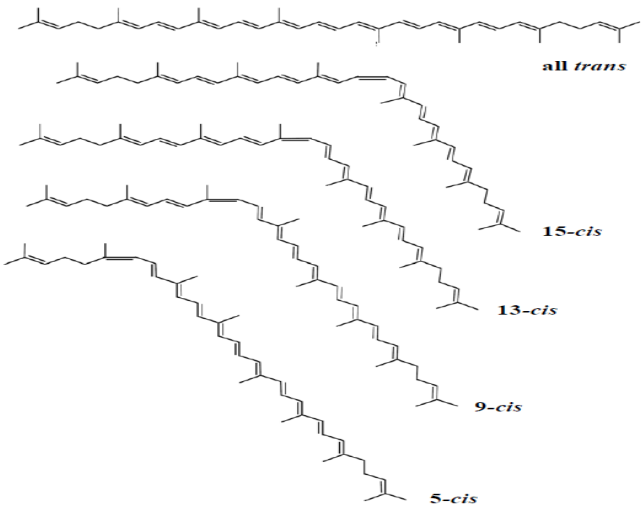

Fig 1: Outline structurer of Lycopene (Source: Agarwal and Roa 1998)

The lycopene is parcelled into triacylglycerol-rich chylomicrons and secreted into lymph transport system, and lastly transferred to the liver, however the presence of lycopene in other tissues has also been reported and lycopene concentration was the highest in human testes, followed by adrenal gland > prostate > breast > pancreas > skin > colon > ovary > lung > stomach > kidney > fat tissue > cervix within the concentration range of 0.2–21.4 nmol/g tissue

2. Lycopene in service to human race

Although not considered as the essential nutrient but the dietary intake of lycopene is recommended because of the reason that it protects lipids, proteins and DNA from oxidative damage, stimulate the modulation of cell growth and also help in increasing immune system and reduce inflammation.

Molecular formula	$C_{40}H_{56}$
Molecular weight	536.85 Da
Melting point	172–175 °C
Crystal form	Long red needles separate from a mixture of carbon disulfide and ethanol
Powder form	Dark reddish-brown
Solubility	Soluble in chloroform, hexane, benzene, carbon disulfide, acetone, petroleum ether and oil; Insoluble in water, ethanol and methanol
Stability	Sensitive to light, oxygen, high temperature, acids, catalyst and metal ions

Table 1: Physical properties of Lycopene (Source: Shi *et al* 2002 In Functional Foods-Biochemical and Processing Aspects: CRC Press: USA, 2002; pp. 135–168)

i. As Antioxidant

Lycopene being prone to oxidation is one of the best antioxidant based on electron transfer reaction. In electron transfer reaction the carotenoids like lycopene generate the radicals, anion radical or alkyl radical, but the Nitrogen dioxide radical and oxidant chloromethylperoxyl may convert lycopene to radical cations as well. Since lycopene lies in close vicinity to the surface membrane thus it is expected that the lycopene be a poor antioxidant due to its limited interaction with the aqueous phase radicals in the lipid bilayer as compared to more polar carotenoids. However, the role of lycopene as a lipid phase antioxidant have its own importance and combinations of other antioxidants with lycopene lycopene has exhibited higher scavenging activity in scavenging of reactive species and also gave a better inhibiting effect towards certain chemicals to reduce their activity which erstwhile are considered not for health system and thus have wide potential for human health and also help in the development of nutritional products which has been in favour for their health benefits. Lycopene as the first defence system of cells is important in inhibiting lipid radicals at membranes.

ii. **Effect of Lycopene toward Diseases**

Lycopene has been shown to have the protective effects on oxidative stress, cardiovascular disease, hypertension, atherosclerosis, cancers, diabetes and others. Reports have been put forth regarding lycopene-rich diet and lycopene supplementation provided protective effects against DNA damage in both normal and cancerous human cells. Study has shown a high plasma level of lycopene was associated with a decreased risk of Cardiovascular diseases particularly in women. The circulating plasma lycopene is believed to atherosclerosis in smokers, reduced the formation of atherosclerotic plaques significantly in the aorta and improved lipid profiles in high-fat diet. Lycopene is reported to reduce the risk of cancer incidences worldwide and has also shown chemopreventive effects of in liver and ovary cells. The other beneficial health related actions of lycopene in improving the impairment of other diseases are indicated in table 2

Lycopene doses	Method	Impairment	Improvement
0.2 mg/kg b.w. daily	*In vivo*–rats	Cataract	Significant delayed in the onset and progression of galactose cataract and reduced the incidence of selenite cataract.
2.5, 5 and 10 mg/kg b.w. daily	*In vivo*–rats	Cognitive function	Significant improved in memory.
60 mg/kg b.w. daily	*In vivo*– hyperlipemia rabbits	Lipid peroxidation injury	Significant reduced in the levels of serum TG and MDA, increase serum SOD activity, increase serum NO.
0.1, 0.5, 1, 2 g/kg b.w. daily	*In vivo*– mouse ear oedema model	Swelling	Decreased swelling of the croton oil-induced ear.
0, 5 and 10 µg/mL carried by liposomes	*In vitro*–Calu-3 cells	Inflammation of cells infected by rhinovirus or exposed to lipopolysaccharide	Reduced the release of interleukin-6 and interferon-gamma induced protein-10.
8 or 16 mg/kg/day by i.p. injection	*In vivo*–murine model of asthma	Ovalbumin-induced inflammation	Significant inhibition of the infiltration of inflammatory immunocytes into the bronchoalveolar lavage.
2 mg twice daily	*In vivo*–primigravida women	Pre-eclampsia and intrauterine growth retardation	Significant reduced in pre-eclamsia incidence and intrauterine growth retardation in the lycopene group compare to placebo group.
9 mg/kg b.w. twice a day for 2 weeks	*In vivo*–rats	Chronic bacterial prostatitis	Significant decreased in bacterial growth and improvement of prostatic inflammation.
0.025–2 mg per 20 mg b.w.	*In vivo*–white heterozygote mouse	X-ray radiation lesions	Moderate curative effect on the radiation lesions and increased survival rate

Table: 2: Action of lycopene in improving the impairment of other diseases (Source: Kong et al., Molecules 2010, 15, 959-987; doi:10.3390/molecules15020959)

3. Market trend of Lycopene

Due to increasing number of benefits offered by lycopene in preventive healthcare, dietary, food products, personal care, cosmetics and pharmaceuticals, and its rising applications in various industries across the globe are driving the lycopene market and the lycopene market is estimated to be valued at USD 126 million in 2020 and is

expected to grow USD 161 million by 2025. Besides the increasing demand and usage of lycopene is exposing its widespread properties, thus, empowering manufacturers to bring more innovation to the products to increase the market share. With the result the Asia Pacific region is projected to be the fastest-growing market although the European region dominated the market in 2019. There are different factors which are driving the Asia Pacific market growth. The Lycopene-Rich By-Products from Food Processing is also providing a helping hand to cope the market of the lycopene and providing a healthy competition in the market.

4. Future Strategy

With the advent of target delivery carriers the application of several of novel lycopene delivery carriers are on the rise including nanoemulsions, nanostructured liposomes, and polymer nanoparticles for various diseases prevention like cancer with future needed development. In addition, the synergistic mechanism between lycopene and other nutrients or drugs and novel delivery systems of lycopene are now deeply investigated to improve its clinical application in various diseases intervention in the future and are the need of an hour.

Note: The contents of this articles have majorly reproduced from the documentary literature available in the references as mentioned in this article.

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AMFI-SI-33

MANAGEMENT OF THRIPS IN CHILLI

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Chilli (*Capsicum annam* L.) is one of the important condiment cum vegetable crop used as ingredient in culinary preparation especially in South India and Sri Lanka. The world production of chilli crop sums up to 7 million tonnes that is cultivated on approximately 1.5 million hectares of land. India is the world leader in context of chilli production followed by China and Pakistan. The bulk share of chilli production is held by the Asian countries, though it is produced throughout the world. India is also the largest producer and exporter of chilli in the world. It contribues to ¼th share in the total quantity of chilli exported in the world. Its production level hovers around 1.1 million tons annually. The major states where chilli is cultivated in India are Andhra Pradesh, Karnataka, Maharashtra, Orissa, Rajasthan and Tamil Nadu. These states contribute around 86% of total area for the chilli crop cultivation in the country and 90% of the total Indian produce. Indian dominance is due to India's variable supply and high domestic consumption. China ranks next to India in chilli export. World trade in chillies account to an approximate of 16% in the total spice trade in the world. In India, chillies are produced throughout the year. Two crops are produced in the year in each dry (March - July) and wet season (August - December). Insect pests are the major menace in chilli cultivation, among the various insect pests, thrips (*Scirtothrips dorsalis* H.) is prime importance in causing severe infestation and yield reduction.

Biology

The life cycle of *Scirtothrips dorsalis* consist of an egg stage, two nymphal stages, a prepupal stage and a pupal stage. The eggs are microscopic (0.075 mm long and 0.070 mm wide), kidney shaped and creamy white in colour. Females insert eggs inside plant tissues above the soil surface. The eggs hatch between two to seven days, depending upon temperature. Nymphs entering in to the metamorphic processes and the pupa is formed on plant crevice such as bark, leaves and flowers. The pupal duration can range from 2-7 days. Adults are about 1.2 mm long with dark wings and dark spots forming incomplete stripes on the abdomen. The shaded forewings are light in color with straight fringed hairs.

Symtomatology:

Thrips possess piercing and sucking type of mouthparts and cause damage by extracting the contents from individual epidermal cells leading to necrosis of tissue. This changes the tissue color from silvery to brown or black. It prefers to feed on new and young plants. Both nymph and adults of chilli thrips tend to gather near the mid-vein or borders of the host leaf lacerate the leaf tissues and feed on oozing sap and create damaging

feeding scars, distortions of leaves, discolorations of buds, flowers and young fruits. Farmers can easily identify the symptom by observing the upward rolling of the leaf margins, elongated petiole and leaf size reduction. A severe infestation of chilli thrips makes the tender leaves and buds brittle and leaf margins curled upwards, heavy infestation of chilli thrips changes the appearance of the plant to what is called "chilli leaf curl" or "chilli murda complex". The severe infestation leads to stunted growth of the plants, flower formation, bud dropping and poor fruit setting.

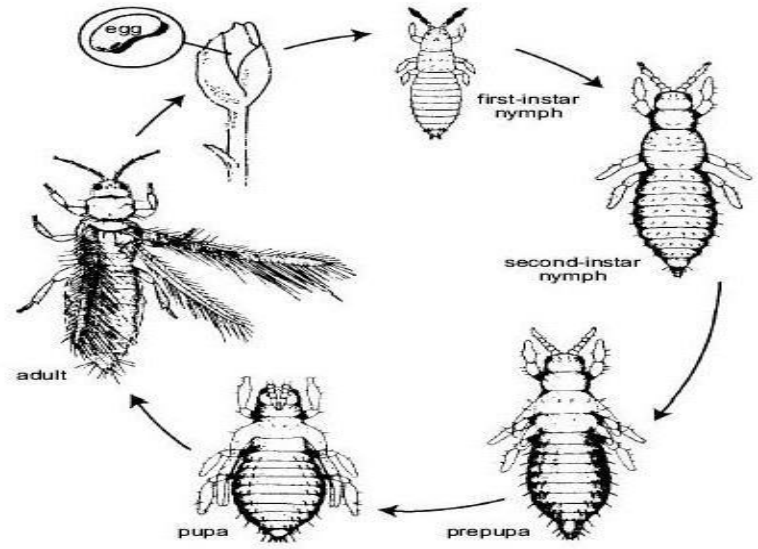

Fig. Life cycle of chilli thrips

Limiting Factors:

- Chilli thrips characterised by relatively short life cycles, can complete several generations on a crop. Adult and nymphs of these pests suck sap from the leaves and growing shoots.
- Monocropping of chilli in traditional growing tracts of Tamil Nadu, Andra Pradesh and Karnataka resulting it to become regular pest and led to qualitative and quantitative crop loss.
- The indiscriminate and continuous usage of any inorganic insecticides and synthetic pyrethroids have led to resurgence, insecticide resistance and secondary pest outbreaks in addition to upsetting the natural ecosystem.
- The presence of pesticide residues in chillies is a major non-tariff barrier against export. Lack of awareness among the farmers in diagnosing the symptom of thrips attack in early stage to take up preventive measures.

Management:

- Sprinkling of water in nursery and seedlings helps to avoid reduce and multiplication of thrips population.

- Application of increased level of potash (45kg/ha) with recommended dose of nitrogen (160kg/ha), phosphorous (60kg/ha), farm yard manure (25 tonnes/ha) and Zinc sulphate (21kg/ha).
- Seed treatment with imidacloprid 70 WS 12g/kg of seed is effective up to 25 days.
- Cultivation of chilli followed by thrips susceptible crops like sorghum or onion should be avoided.
- Mixed crop cultivation of chilli with onion crop must be avoided since both the crops attacked by thrips and encourages the mulplication.
- Intercrop with agathi, *Sesbania grandiflora* to provide shade which regulates and minimize thrips population.
- Application of any one of the following insecticides if the population exceeds ETL (1thrips/leaf), Carbofuran 3 G @ 33kg/ha or Phorate 10 G @ 10kg/ha or spray with any one of the following insecticide *viz*., Dimethoate 30 EC @ 1.0ml/lit, Thiocloprid 21.7 SC @ 0.5 ml/lit, Imidacloprid 17.8 SL @ 0.3ml/lit, Emamectin benzoate 5 SG 0.5g/lit, Fipronil 5 SC @ 1.5 ml/lit, Spinosad 45 SC @ 0.5 ml/lit.

Fig. 2. Upward curling of leaves due to thrips attack

Fig. 3. Thrips damage leads to malformed and under developed fruits

AMFI-SI-34

METHODOLOGY FOR IDENTIFICATION OF RESISTANT RICE GENOTYPES AGAINST BROWN PLANTHOPPER

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Importance of Host Plant Resistance in Rice:

Rice crop (*Oryza sativa* L.) is the staple food for about three billion people of the world and providing more than 20 to 80 per cent of daily calorie intake. The world population is projected to increase 9–10 billion by 2050 with the predicted water scarcity, decrease in arable land and the impending global climate change. The major hindrance for increasing the productivity of rice crops is biotic constraints and among which insect pests are of prime factors in reducing yield. Of over 100 species of insects reported as pests of this crop, 20 are of major economic significance (Prakash *et al*., 2007). Among them the Brown planthopper (BPH), *Nilaparvata lugens* (Stal) is a typical phloem sap feeder that has emerged as the threat to rice production in Asia (Heong and Hardy, 2009). The crop suffer 40 to 70 per cent yield loss if attacked by 100–200 first instar nymphs of BPH at 25 days after rice seedling transplanting. Both nymphs and adults of BPH suck sap from the lower portion of the plant, which results in yellowing leaves, reducing tiller number and plant height, and increase in unfilled grains

Host plant resistance is the most effective and environment friendly approach to control the damage caused by insect and increase yield potential of cereal crops (Jena *et al*., 2006). Screening rice germplasm at global level and breeding BPH resistant rice varieties were initiated during 1970s, and several resistant varieties have been released for cultivation (Khush and Brar, 1991). The limitation to the success of resistance varieties is the potential threat of emergence of new biotypes of the insect. The resistant varieties released became susceptible in few years, due to adaptation of BPH and outbreaks continue to occur. Most of the host plant resistance studies in rice against planthopper came out with the resistance confirmed at seedling stage screening or mass screening methods. The level of resistant at seedling stage may be not carried out at adult plant stage and also vice versa. It is essential in recent times along with seedling screening, adult plant screening and mechanisms of resistance need to be studied (Soundararajan *et al*., 2005).

Mass culturing of BPH in glass house:

Before screening for plant resistance studies, culturing of insects are extremely important to carry out the research activities. A well developed mass culture techniques is available for BPH. Usually population of BPH is reared in the glass house on the susceptible rice variety Taichung Native 1 (TN-1). The temperature and relative

humidity in the glasshouse should be maintained at 29° to 35° C and 60 to 80 %. Initial BPH population has to be collected from unsprayed rice fields. The adult insects is confined on 30 days old potted plants of TN-1 and kept in oviposition cages of size 45x45x60cm having wooden frames, glass top and door and wire-mesh side walls (Fig.1). The insects can be removed three days later and plants with eggs are taken out of cages, placed in separate cages for the nymphs to emerge. The emerged nymphs are then transferred to 10 to 15 day old TN-1 seedlings raised in 10 cm diameter clay pots placed in galvanized iron trays of size 64x47x15cm containing 10 cm depth of water and permitted to feed for 3-4 days. The developed second and third instar young nymphs are used for seedling screening experiments (Fig.2). The remaining second and third instar nymphs can be used for further multiplication on grown up TN-1 plants. Continuous pure culture of the BPH has to be maintained in the glasshouse during the experimentation. The temperature and relative humidity in the glasshouse ranged from 29° to 38° C and 42 to 80 % respectively. The plants need to be observed periodically and the natural enemies should be removed regularly along with the dried leaves and dried plants.

Standard Seed box Screening method:

Seeds of genotypes to be tested have to be soaked in water for 24 h and then the water have to be drained off. Seeds are allowed to sprout by keeping in darkness for a day. Now the pre-germinated seeds of test genotypes are obtained for sowing. These seeds are sown 3 cm apart in a plastic seed box filled with 5-10 cm depth of clay soil (Fig. 3). Each genotype is sown in a row across the width of the seed box in such a way so as to have at least 20 plants per row.

Concept of the method:

Two rows of the susceptible check variety (TN-1) at both the ends and one row of resistant check variety (PTB-33) at the middle should be sown in the seed box (Fig.4). The seed box is then transferred to a galvanized iron tray filled with water on third day. The BPH populations cultured on TN-1 plants are used to infest the seedlings at 7th day by just tapping seedlings on the seed box (Fig.5). The nymphs which fall on water or on plants take few hours time and then settled on the plants. During the period nymphs will search for their susceptible host plant. The susceptible genotypes will had more BPH population for feeding. The idea of variety PTB-33 to grow on the middle of the seed box is to disperse the nymphs to other genotypes to identify the susceptible types. The nymphs which accidentally falls on PTB-33 seedling will not continue its feeding as it has toxins and secondary compounds which will not allow to feed. So the dispersal will be happened within the box. Apart from this concept, growing of TN-1 plants at both the end of seed box will attract nymphs towards the seedling. The susceptible volatile compound emanated from TN-1 seedling attracts the BPH nymphs. The nymphs slowly move towards the end and during this process if any other susceptible genotypes found and if found suitable for its feeding it will settle on the plants. Once settled it start its feeding by sucking sap continuous until the plant wilted. Average population, 6-8

nymphs in each seedling has to be maintained and that has to be ensured. If necessary some more nymphs has to be released from the mass cultured plants.

After infestation, each seed box is covered with a nylon net mesh cage to prevent any escape of nymphs and to prevent entry of natural enemies. The test genotypes have to be observed daily for the damage symptom expression by BPH. Damage grading of test genotypes should be done when 90 per cent of the seedlings in the susceptible check (TN-1) or in any test genotypes shown symptoms of wilting and drying (Fig.6).

Grading of genotypes:

Standard Evaluation System (SES) has to be followed to grade (Heinrich *et al*., 1985) the genotypes for their resistant or susceptibility based on 0-9 scale as given below.

Grade	Criterion	Category of resistance
0	No visible damage	Immune
1	Very slight damage	Highly Resistant (HR)
3	First and second leaves with yellow orange tips, slight stunting	Resistant (R)
5	More than half of the leaves with orange tips and pronounced stunting	Moderately Resistant (MR)
7	More than half of the plants dead and remaining plants severely stunted and wilted	Moderately Susceptible (MS)
9	All plants dead	Susceptible (S)

Based on grading the genotypes which are scored 1 and 3 will be taken for further studies. The seedling stage resistance in the genotypes can be ensured by repeating the methodology two or three times. After confirming the resistance the rice genotypes can be further utilized for other studies such as yield parameters, grain quality, mechanisms of resistance and marker analysis.

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Fig.1. Mass culturing of BPH

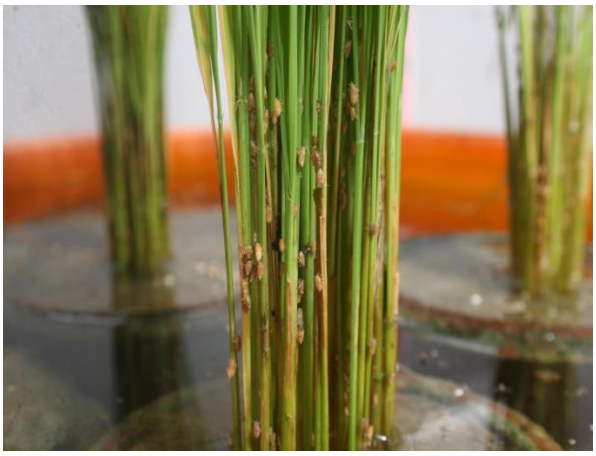

Fig.2. Nymphs of BPH on TN-1 plants

Fig.3. Sowing for seed box screening

Fig.4. Standard seed box layout

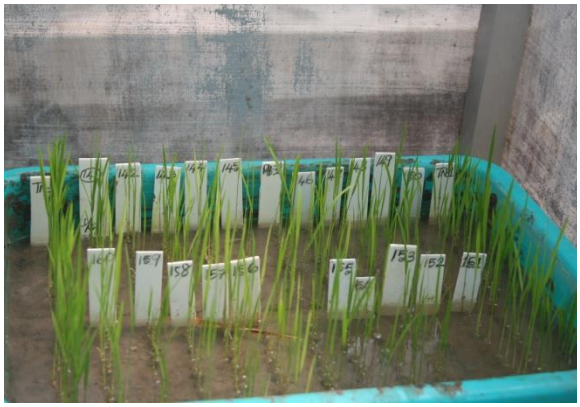

Fig.5.Stage of seedling to release BPH

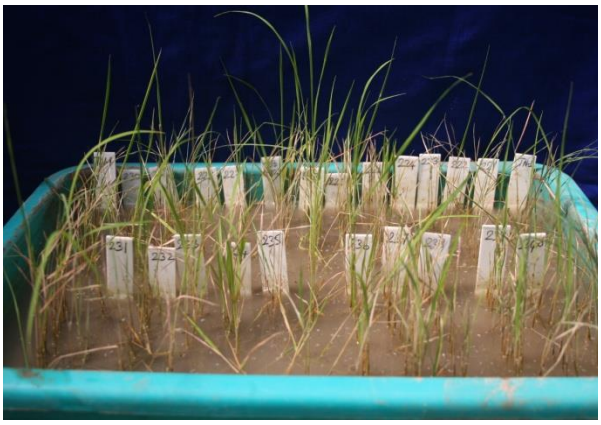

Fig.6. Stage of seedling for grading the damage

AMFI-SI-35

MUTATION: KEY FOR ENHANCING PRODUCTIVITY AGAINST CLIMATECHANGE

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ABSTRACT

Crop modification techniques must be increasingly accurate in creating smart crop varieties given the foreseeable risk that climate change poses to crop yield and the continuously rising needs of agricultural production. This paper analyses the history, present, and projected developments in mutant breeding for agricultural enhancement. It offers background information on plant mutation breeding tactics, basic and sophisticated methodologies, and a critical evaluation of this strategy in relation to other approaches for the genetic improvement of crops. A vital and extremely effective strategy in the global agricultural effort to feed a growing and nutrient-demanding human population is mutation breeding. The consequences and applications of the physical and chemical mutagens are examined. There has been an induction of mutations and these would result in the quick enhancement of crops with enhanced yield, biotic and abiotic stress, and decreased agronomic inputs. Thus, the development of designer crop varieties to address the dangers of global climate change and difficulties of global food insecurity will greatly benefit from mutation-assisted plant breeding.

Key words: developmental mutants, genetic diversity, molecular markers, and in vitro mutagenesis

INTRODUCTION

The fundamental prerequisite of plant breeding in creating plant varieties for sustainable food supply is the exploitation of natural and induced genetic variation. Because desired genotypes are few or do not exist, plant breeders are handicapped. The thirst for food to feed the world's expanding population continues to be a top priority, and plant breeders are under pressure to maintain food supply. Additionally, the unpredictable climate change has increased pressure to create sustainable solutions because of its direct impacts on agricultural production and food security. Although plant breeders are working tirelessly to maintain food production and nutrition and genetically improve plants using both traditional and contemporary methods, the solution doesn't seem to be very promising. However, they have successfully developed new cultivars with desirable features like high yield and resilience to biotic and abiotic stress by sexually hybridising the necessary genes from the existing available gene pool and the related plant species. Induced mutations are created with the intention of

increasing the mutation frequency rate in order to choose the best variants for plant breeding. The frequency of spontaneous mutations is quite low, making it challenging for plant breeders to take advantage of them. Both physical (like gamma radiation, x rays) and chemical (like EMS, MMS) mutagen treatments can cause mutations in crops grown from seeds and vegetatively propagated crops. The mutagen therapy damages the nuclear DNA, and new mutations are haphazardly and heritably introduced during the DNA repair procedure. To choose advantageous mutants with traits like flower colour, flower form, disease resistance, or early flowering types, plant breeders can pick changes in cytoplasmic organelles as well as genomic abnormalities (like Chromosome 1, 2, 3). When one or a few characteristics of an exceptional cultivar need to be changed, the ability to produce unselected genetic variation through mutation induction can improve vegetatively propagated plant. According to www-mvd.iaea.org, more than 3000 mutant varieties have already been formally approved in more than 60 countries. These varieties include those for rice,

wheat, barley, sorghum, legumes, cotton, edible oil, ornamental plants, and fruits. To feed their continuously expanding populations, China and India are the two countries that create the most mutant types. Rice is the crop with the greatest number of mutant types that have been released. The maintenance of food and nutrition security is the top priority of plant breeders and geneticists, which is why choosing the key crops has become essential for achieving these goals under the conditions of limited arable land and climate change. A major concern and challenge to maintaining food supply globally are new issues like climate change and population expansion, among others. Terrestrial ecosystems and local temperatures will shift, frequently endangering human lives. Climate change will have a more negative impact on food and fibre production, environmental services, and rural lives in poorer nations. In addition, a significant portion of the population of poor countries—up to 80%— depends on agriculture for a living, making them more susceptible to climate change. The effects of other stressors, such as economic globalisation, urbanisation and its impact on the availability of rural labour and land, population growth and its impact on the availability of water and other resources, crop pests and diseases, land degradation and low soil fertility, poverty, etc., must also be taken into account when evaluating climate-related changes. Additionally, there is no longer any possibility of increasing arable land; rather, it is slowly being lost to other human growth activity. In order to sustain food production and feed the globe, plant breeders will turn for new, cutting-edge tools like mutation breeding.

Crop	Name of Variety	Country	Important Traits
Cotton	MCU 5, MCU 7	India	High Yielding (HY), Earliness
	Rasmia	India	
	Indore 2	India	
	Pusa Ageti	India	
Wheat	Lewis	USA	HY, lodging resistant, earliness Early maturity
	Stadler	USA	Better grain quality
	Sharbati Sanora	India	
Rice	KT 20-74	China	HY, Earliness
	SH 30-21	,,	,,
	Reimei	Japan	Low temp tolerant
	IIT 48 and 60	India	Early maturity

Table: List of varieties released by mutation breeding.

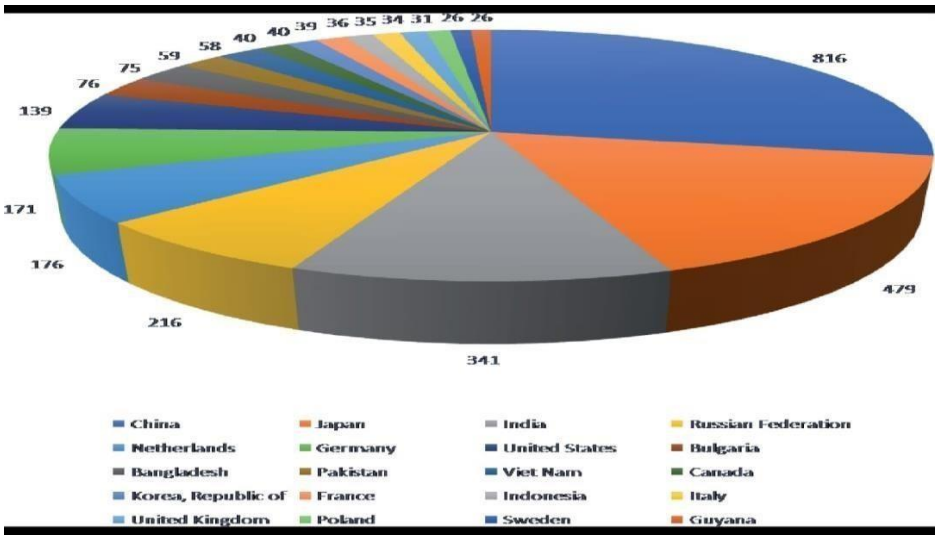


Figure: Number of mutant varieties released in 20 countries

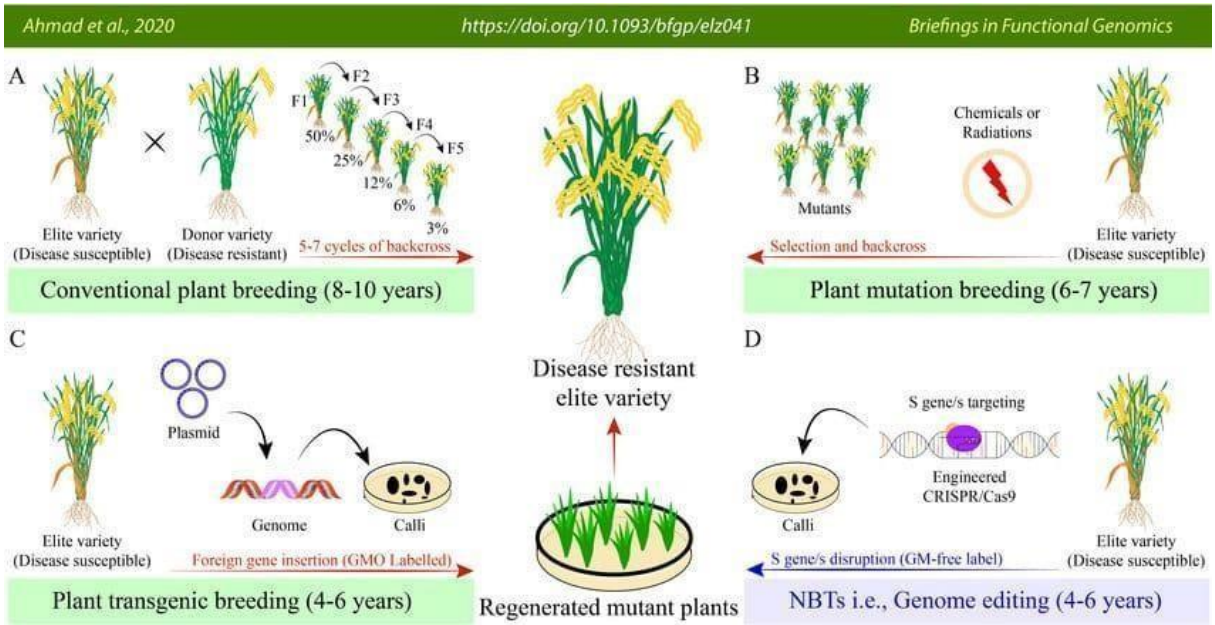
IMPACT OF CLIMATIC CHANGES ON AGRICULTURE

Resources, weather, and climate are absolutely necessary for agriculture. The existing water resources, arable land, environment, germplasm resources, and sustainable forestry practises areincreasingly being put under a tremendous deal of stress as a result of massive industrialization andthe continued rise of the human population. The adverse effects on global food production and the increase in food prices are clearly evident. The effects of climatic changes such as gaseous pollution, loss of atmospheric ozone, increase in UV-B radiation, increase in atmospheric CO2, extreme variability of rainfall time and location, irregular lengths of growing seasons, intermittent dry spells, global warming, high temperatures, and degradation of water and soil resources could be one of the main causes of this issue. Additionally, it is a difficult task for planners to

overcome complex inherent uncertainties like our inability to make region-specific predictions of the rate, nature, and extent of climatic change, especially rainfall patterns, the threat of irreparable ecosystem damage, a very long planning horizon, long time lags between greenhouse gas emissions and climate effects, wide regionalvariation in causes and effects, the global scope of the problem, and the nascent nature of the issue. Due to the emergence of new pests, illnesses, and insects as well as the potential extinction of certain already present ones, global warming could have severe effects on agricultural production. The yieldof a number of significant crops is also decreased by the ambient ozone concentration, either alone or in conjunction with other contaminants.

TECHNIQUES FOR MINIMISING THE EFFECTS OF CLIMATICCHANGES

Plant breeders are under pressure to maintain food production in the face of climatic changes. Worldwide food prices have already increased, and both developed and developing nations arecurrently experiencing economic hardship as a result of rising food and fuel costs. However, the poor world is currently experiencing the most economic hardship. The global food crisis cannot be solved in the short term with a magic formula. Find the most suitable and economical strategies to maintain food production. Targeted breeding varieties may not be very helpful, and conventional breeding in combination with other methods such as mutagenesis, biotechnology, genetic engineering, or molecular breeding utilises local genetic resources to develop new cultivars that could handle frequentclimatic changes.

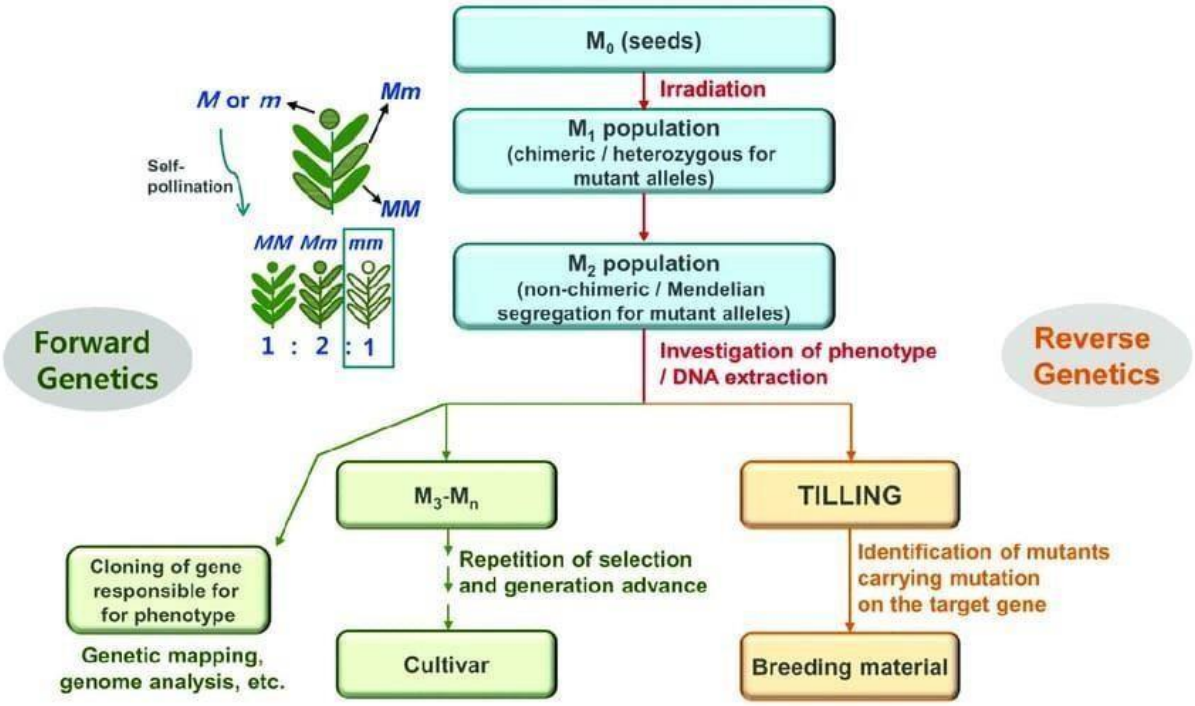


MUTATION INDUCTION FOR QUALITY AND NUTRITIONIMPROVEMENT

Hugo de Vries (1901) first introduced the term "mutation" to describe a sudden heritable alteration in an organism's DNA that was induced artificially by radiation, chemicals, viruses, transposons, or chromosomal abnormalities that happen during the reproductive process. These alterations, which include gene mutations, chromosomal mutations, and genomic mutations, can be passed down to the progeny. The most

popular method for creating new, enhanced germplasm in crop plants is now induced mutation. Applying mutagens to plant cells in order to breed new crops is known as mutation breeding. The cornerstone of both breeding and evolution is genetic variation. Mutagenesis was embraced by plant breeders in 1940 as a method that produces mutations in plants more quickly. Techniques for induced mutation breeding are now the most effective, swiftly adopted, and commonly used strategies for crop improvement globally.

One of the key benefits of mutation breeding is the ability to identify mutants with various features. Under rapidly changing environmental conditions, mutant variants have substantially higher odds of surviving. Before any new cost-effective procedures are discovered that are publicly availablewithout too many constraints, in my opinion, using nuclear technology to develop new varieties under changing climatic conditions would be the best course of action. Quality and nutritional components of food are equally vital to human diets as agricultural productivity increases. Enhancing essential minerals and amino acids for humans and animals, changing protein and fatty acid profiles for nutritional and health reasons, altering the physicochemical properties of starch for various end uses, increasing phytonutrients in fruits, and lowering anti-nutrients in staple foods are all necessary. Inducing mutations that improve the nutritional value of crop plants may be a significant function of induced mutations. 776 mutants have been induced for nutritional quality out of the 3000 mutant varieties internationally (www-mvd.iaea.org).In order to significantly lower the ongoing expenses associated with fortification and supplementing, methods should be focused on producing plants that can hold high quantities of minerals and vitamins in their edible sections (Shetty 2009). Success of this technique will depend on farmer acceptance of these varieties, customer acceptance of the edible sections of these varieties, and the body's ability to absorb the inserted micronutrients (Bouis, 2002). Before a plant breeding strategy can be implemented to tackle micronutrient deficiency, some issues must be resolved in order for it to work and be widely adopted, especially in developing nations (Bouis 2002).



MUTATION INDUCTION METHODS

Globally, genetic enhancement of seed and vegetatively propagated crops has profited considerably from nuclear technology. Mutations can be induced using both chemical and physical mutagens. Gamma rays and ethyl-methane sulphonate (EMS) are two of them that are frequently utilised for inducing mutations. The ideal dose for inducing mutations is based on the initial determination of the LD50 dose.

1. **PHYSICAL MUTAGEN:**-The most popular technique for creating direct mutant varieties has been radiation-induced mutation induction, which accounts for 90% of variations produced (64% with gamma rays and 22% with X-rays). UV radiation and ionising radiation (X-rays, gamma rays, alpha and beta particles, protons, and neutrons) are the two forms of radiation that can be used to induce mutagenesis. Compared to ionising radiation, ultraviolet light (250–290 nm) has a moderate ability to permeate tissues. Ionising radiation can cause a wide range of distinct chemical alterations since it can reach deeper into the tissue. Physical mutagens have several advantages over chemical ones, including accurate dosimetry, sufficient repeatability, and, in the case of gamma rays, a high and homogeneous penetration in plant tissues. A recent report revealed the reemergence of a putative banana mutant,designated DPM25, with better output and fruit size as well as some resistance to Fusarium wilt, a potentially fatal disease that can spread throughout the world. The isolation of black Sigatoka disease putative resistant mutants by gamma irradiation from the susceptible banana variety "Grande Naine."

2. **CHEMICAL MUTAGENS :**-Chemical agents are useful because they offer high rates of mutation and mostly point mutations. The alkylating agents, such as ethyl methanesulphonate (EMS), diethyl sulphate (dES), ethyleneimine (EI), ethyl nitroso

urethane (ENU), ethylnitroso urea (ENH), and methyl nitroso urea (MNH), as well as azides, are the chemical mutagens that are most frequently used to induce mutations. By adjusting the treatment's concentration and duration, solvent (such dimethyl sulfoxide (DMSO)), or solution pH, the dose assessment for substances can be calculated. Banana shoot tips were also treated with chemical mutagens (EMS, DES, and sodium azide) to create variations for tolerance to

Fusarium wilt. Chrysanthemum has been successfully subjected to EMS, with a frequency of 5.2% mutants.

3. **ION BEAM TECHNOLOGY :-** Gamma rays, X-rays, and neutrons, which have primarily been used for mutation induction in plants , are replaced by heavy ion beams (HIB), which are responsible for linear energy transfer (LET). As LET increases, higher biological effects, such as lethality, chromosomal aberration, etc., are induced as compared to most commonly used physical mutagens.A variety of mutants have been induced in maize and rice, wheat, anda number of different ornamental plants .

ACHIEVEMENTS

Genetic enhancement of rice

The improvement of rice varieties through mutation breeding serves as the greatest illustration of the impact of induced rice mutants in applied research. The first rice varieties, KT 20- 74 and SH 30-21, which were created through induced mutation, and the first variety, Yenhsing-1, which was created through a cross-breeding scheme with a mutant, were both introduced in China in 1957. Soon after, the lodging-resistant semi-dwarf mutant Reimei was released in Japan, which has greatly enhanced changed the production of rice in the USA and Pakistan, respectively. A new variety of Basmati known as "Kashmir Basmati" was developed in Pakistan from the induced mutation of Basmati 370. Kashmir Basmati develops early, is cold tolerant, and keeps the aroma and

cooking quality of the parent.'PNR- 381' and 'PNR- 102' are two early-ripening, aromatic mutation-derivedrice varieties that are widely cultivated in Haryana and Uttar Pradesh. Over the course of ten years, more than 10.6 million acres of land in China were used to grow the rice mutant "Zhefu 802." The 'RD6' fragrant indica rice variety was introduced to Thailand in 1977 with the help of gamma ray irradiations. Designing the strategies for the generation of hybrid rice types has greatly benefited from the induction of the thermosensitive genetic male-sterile (TGMS) mutant in the Japonica rice mutant

PL-12, which is regulated by a single recessive gene. These mutations are crucial to the breeding of two line heterosis.

Enhancing the barley crop's resilience to lodging

The development of 'Diamant' and 'Golden Promise,' a gamma-ray induced semi-dwarf mutant, changed the brewing business in Europe. Mutation breeding has been utilised very successfully in the breeding of barley. In Europe, 'Diamant'-based crosses resulted in the development of a significant number of different barley cultivars. The 2006 release of Centenario, a high yielding crop with high protein content, early maturity, and resistance to yellow rust, has made a substantial contribution to the nation's food security. The gamma ray-induced mutants "Luther" and "Pennrad," respectively, had a 20% increase in yield, improved tillering and lodging resistance, and winter hardiness, better lodging resistance, and early ripening.

Developing drought and salinity tolerance in wheat crops

The mutant variety "Sharbati Sonora," which is semi-dwarf and doesn't lodge, has significantly increased wheat productivity in India. By gamma irradiating the red-grained Mexican cultivar "Sonara 60," "Sharbati Sonora" was created at the Indian Agriculture Research Institute in New Delhi, India. Ahigh producing mutant Stadler that was created in Missouri, USA, has greater lodging resistance, early maturity, and resistance to leaf rot and loose smut. Due to the cold-tolerant mutant types, the area under cultivation of durum wheat in Italy was greatly increased.

Developing early-maturing peanut varieties

A number of gamma-radiation-induced peanut mutants, including Yueyou No. 5, Yueyou No. 22, Yueyou No. 33, Yueyou 551, and Yueyou 187, were released in China as high yielding varieties under the name "Yueyou." Some of these (Changua No. 4, Lainog, Yueyou 551-38 and Yueyou 551) were early maturers with higher yields. TG 26 is a mutant type of peanut that was created at the Bhabha Atomic Research Centre in Bombay. It has a semi-dwarf plant habit, matures quickly, sets its pods compactly, bears more pods, has a higher harvest index, and is field-tolerant to serious diseases.

Chickpea mutants with increased production and resistance to wilt disease

Pusa - 408 (Ajay), Pusa - 413 (Atul), Pusa - 417 (Girnar), and Pusa - 547 are a set of High Yielding and Wilt Disease Resistant Chickpea Mutants that were created at I.A.R.I., New

Delhi, and are based on the direct usage of induced micro-mutants in a legume crop worldwide. Mutant variety Pusa-547, released in 2006, performs well under late-sown circumstances in India's North-Western area, withthin testa, appealing bold seeds, better cooking quality, and high yields.

CASE STUDY

1. Developing nations are hardest hurt in satisfying food demands of their people due to the dual constraints of high population growth and catastrophic weather occurrences, with millions of people unable to get appropriate and nutritionally balanced food. To meet the increasing food needs of a population that is projected to reach 9.6 billion people by 2050, crop production must be raised by 70%. The best food crops for boosting agricultural production and achieving sustainable development objectives are legumes. Warm-season grain legume known as cowpea is frequently regarded as an underutilised crop with significant potential for genetic advancement. Increased seed yield and genetic diversity in the agro-economic attributes of two cowpea varieties treated with various dosages of gamma rays and sodium azide (SA) were the goals of a multi-year field experiment using induced mutagenesis. The study also sought to maximise the various SA and ray doses used singly and in combination.

From M2 to M3 generation, the largest increase in seed yield was found using quantitative trait analysis. Among the 10 quantitative variables examined, seeds per pod and seed weight had a significant direct effect on yield and were positively associated. New high-yielding and nutrient-dense mutant lines were isolated after an extended phenotypic selection cycle from M2-M4 generations. These genetically diverse, high-yielding biofortified mutant lines could act as a source of elite genes and be an important genetic resource for upgrading low-yielding warm-season grain legumes.

2. Faba beans are one of the most significant grain legumes in the world due to their numerous applications and adaptability to a variety of climatic conditions. This study's goal was to compare the effects of single and combined doses of gamma radiation and ethyl methane sulphonate (EMS) on two different faba bean cultivars. There are few studies on gamma rays and EMS-induced mutagenesis in faba beans. Vikrant and PRT-12 seeds were genetically pure, uniform, dry, and dormant before being exposed to four different gamma radiation doses (100, 200, 300, and 400 Gy) and EMS doses (0.01, 0.02, 0.03, and 0.04%).It is vital to evaluate the effectiveness and efficacy of mutagens since the utility of a mutagenic agent is determined by its capacity to cause a high frequency of beneficial mutations as opposed to undesired ones. The results showed the following trend: EMS > gamma rays+EMS > gamma rays, demonstrating that EMS is more successful at generating mutations than gamma rays. However, gamma rays were more effective than EMS in terms of mutagenesis efficiency as determined by seedling harm, with the trend being gamma rays > gamma rays+EMS > EMS.

CONCLUSION

Induced mutagenesis is one of the most crucial methods for increasing the genetic diversity and variation in crops to get beyond the bottleneck conditions that have been created by traditional breeding methods for a long time. Despite being a nearly seven decades old approach, induced mutagenesis has shown to be able to help unlock the genetic potential of plants and provide plant breeders with the raw materials they need to create the envisioned smart crop kinds. Crop varieties created through the use of mutation breeding are crucially improving livelihoods and ensuring global food and nutritional security. Additionally, mutagenesis has the benefit of isolating mutants with a variety of features that, ideally, would make them the best plants to grow in a changing climate. Use of mutagenesis in conjunction with plant tissue culture and the length of the culture period, particularly in cereals, may boost genetic variety for plant breeders to take advantage of.

Before genetic engineering becomes a common and dependable method in plant breeding, it could be used more regularly. The developing nations with rapid population increase cannot wait for high yields from genetic engineering. As a result, plant breeders can use genetic variability produced by mutation breeding.

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AMFI-SI-36

NATURAL FACTORS CAUSING CLIMATE CHANGE

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Abstract

The shift in the long term averages is termed as climate change. This is being predominantly noticed from the early 20th century due to rapid industrialization and its pollution. The reason behind the changing climate is reported to be mainly from the anthropogenic activities but there exist some natural reasons too. The natural causes are change in earth's orbit, axial tilt, and precession of the axis, changes in solar activity, volcanic eruption and ocean currents. Eventhough the change is happening naturally, anthropogenic activities have accelerated the change. The natural changes follow a cyclic pattern and it ranges from decades to millennium.

Keywords: natural causes, earth's orbit, solar activity, climate change

Introduction

Climate Change is a shift in climate relative to a given reference time period of 30 years. Climate variability and climate change differs by the time period used, since climate change is referred to shift in long term averages. All the sectors are vulnerable to Climate Change because change in temperature, change in rainfall pattern, intensity, frequency and forms of precipitation, light intensity (global dimming), more frequent weather extremes, increase in Green House Gas and aerosols, etc., effect all the sectors as well as human health and survival.

The past climatic data are derived from the paleo-climatological data like corals, tree rings, glaciers, rocks, etc and from the observed data from the satellite, ground level observatories, pilot balloons, historical records, etc., The future data are predicted using the process based models.

Natural Factors of Climate Change:

The earth revolves around the sun in an elliptical orbit at a distance between the sun and the Earth varies over the course of a year. The Earth rotates around an axis (imagine a line that joins the north and south poles) but the Earth's axis is not upright, it leans at an angle which changes with time (41000 years), it moves from22.1 degrees to 24.5 degrees and back again. There exists a cyclic change and interaction among the shape of the Earth's orbit around the sun and the Earth's tilt. In the sun there are a number of spots seen that Sun rose and fell in a regular 11 year cycle and these sun's spots leads to variation in the solar activity. When a volcano erupts a large volume of ash, sulphur di oxide, water vapour and dust into the atmosphere and these components can influence the earth's climate for years.

Earth orbital changes

Changes in the Eccentricity of the elliptical orbit, obliquity of the earth's axis (angle of tilt of the axis- 22.1 to 24.5 degree) and the precession / wobble of the earth's axis

(direction of wobble) are known to cause 25 % of the change in the amount of insolation reaching the mid latitudes.

The earth's gyration around the sun is not a perfect circular path, but s slight ellipse. The changes in the orbit's shape are measured in terms of **eccentricity**. The earth reaches the closest position to the sun approximately during January 3 (Perihelion) and the farthest position during July 4 (Aphelion). The variation in the distance is about 3.4 per cent. This shows that the insolation is more during January 3 than during July 4 (by about 6.8 per cent). This is the reason behind the uneven distribution of the length of season of the earth. The change in eccentricity (from almost circular to elliptical) take place cyclical span of about 100,000 years. The impact of this variation on seasonal, annual or decadal scale is very small and hence could not cause much variation.

The main cause for the formation of seasons is the angle of tilt and it is called as **obliquity** of the earth's axis. The tilt changes from 21.3 to 24.5 degrees. More the tilt, more will be the insolation and hence the extremes in seasons. This impact could be noticed predominantly only in the higher latitudes whereas the lower latitudes shows minimal changes. At present the oblique is about 23.4 degree. The time period for the changes from 21.3 to 24.5 degree is about 41,000 years.

At present the north star of our planet is Polaris Australis and Polaris but it was not so years before. The twin stars, Kochab and Pherkad were the pole stars during the 1500 BC to 500 BC. This shows that the axis shifts its direction and it denoted as **precession** of the axis or earth's wobble. This change happens in a cyclic pattern with a time span of 26,000 years. This kind of change also has its impact on seasons. The seasons may be preponed or postponed. Also the difference in the nature of the seasons between the hemispheres is due to the wobble of the Earth's axis.

These three are collectively called as Milankovitch Cycles. Based on this theory, Milutin Milankovitch formulated the occurrence of Ice ages at a cyclic pattern of 41000 years. There exists a debate between scientists related to this theory.

These changes may seem to be very small but important when considered over a long span of time.

Solar activity:

Being the primary source of energy for the earth, changes in its activity influences the climate of the planet. There exist controversial statements between the physicists and climatologists regarding the correlation between the solar activity and the earth's climate change. When the solar spots are more, the sun's irradiance is also more. The activity of the sun is related to the cyclic pattern of the solar spots by a period of 11 years. The variation in solar output such as changes in UV radiation, solar wind and cosmic rays were accounted for causing climate change. But the relationship is not proved by any means but related to the atmosphere-ocean linkages.

Volcanic eruptions and ocean currents:

The volcanic blast lasts for few days releasing a massive amount of gases and dust particles. The wallop of these particles on the climate system lasts for years. The Sulphur

dioxide released gets converted into sulfate aerosol and affects the radiative forcing. This kind of impact

Conclusion:

The natural change occurs over long term but the human activities have aggravated the changes leading to more often and intensive climatic events. Rapidly changing climate also leads to many indirect issues on health, sustainability and livelihood of the vulnerable group.

AMFI-SI-37

PESTICIDES IN AQUATIC ENVIRONMENT: TYPES, EFFECT AND MODE OF ACTION

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1. Introduction

Any substance or mixture of substances, intended for preventing, destroying, or mitigating any pest, or intended for use as a plant growth regulator, defoliant or desiccant is called pesticide (FIFRA). Pesticides are those substances that help to repel, or control certain organisms that are harmful to plants. Public perception to farmed fish is that they are "cleaner" than comparable wild fish. However, some farmed fish have much higher body burden of natural and man-made toxic substances, e.g., antibiotics, pesticides, and persistent organic pollutants as compared to wild fish. Generally, pesticides tend to move from application site to the wide environment including surface and ground water through surface runoff, leaching, erosion from agricultural fields, spray drift and deposition. Three major phenomena facilitate the mechanism of the movement of pesticides in ground water: drain flow, leaching, and spray drift. Fate of pesticides is governed by two major factors: persistence and mobility after initial application in different matrices. The persistence of pesticide refers to its half-life. Based on half-life in sediment, pesticides are divided into three types such as non-persistent (<30 days), moderately persistent (30-100 days) and highly persistent (>100 days). Pesticides are either adsorbed in sediments or degraded in the water column. Different types of degradation such as photodegradation, chemical degradation, and microbial degradation affect pesticide persistence depending on its structure and environmental conditions. The present article focuses on types of pesticides, their mode of action and effect on aquatic organisms.

2. Toxicological effect of pesticides

Application of pesticides used for control a wide variety of insectivorous and herbaceous pests which would otherwise diminish the quantity and quality of food production. Sadly, in spite of advantages, the synthesized chemical compounds have significant drawbacks, as well as insecticides threaten the long-term survival of major ecosystems disorder environmental relations between organisms, and the loss of biodiversity. The major Chemical groups of insecticides that are usually applied Organophosphate, Carbamate, Chlorinated Hydrocarbons, Pyrethroids and Nicotinoids. Contamination of water with insecticides is mainly due to intensive agriculture combined with surface runoff and surface drainage, usually within a few weeks after application. Fishes are particularly sensitive to the environmental contamination of water. Pesticides alter behavioural response, histopathological and biochemical enzymes in fish, causing immunosuppression which results in higher susceptibility to pathogenic infection. Hence, pollutants such as insecticides may affect

significantly certain physiological and biochemical processes that different kinds of insecticides can cause serious impairment to health status of fishes. Some compounds from PCB's which used as insecticides considered estrogenic and anti-estrogenic contaminants in environment causes endocrine disruption and affect fish reproduction.

Sl. No	Pesticides	Fish	End point	Effect
1.	Cypermethrin	Rainbow trout Bluegill sunfish *Daphnia magna*	Acute Toxicity	90 h LC_{50} -0.82 ppb 90 h LC_{50} - 1.78 ppb 90 h LC_{50} - 0.2 ppb
2.	Prethroids	Rainbow trout Bluegill sunfish and salmon		48 h LC_{50} - 5.4 µg/L 90 h LC_{50} - 1.8 µg / L
3.		*Channa striatus*		Significant reduction in the LDH and cytochrome oxidase activity while upregulation in succinate dehydrogenase activity
4.	Fenvalerate	*Garra mullya*		96 h LC_{50} - 0.147 ppm Behavioural disorder
5.	Cypermethrin	*Labeo rohita*	Chronic Toxicity	Reduction in alkaline phosphatase and acetylcholinesterase activities.
6.	Dimeron	*Heteropneustes fossilis*		Decrease in Hb%, RBC number, HCt% and O_2 carrying capacity of blood.
7.	Endosulfan and Diazinon	*Channa punctatus*		Histological alterations
8.	Chlorphyrifos	*Cyprinus carpio*		Significant inhibition of acetylcholinesterase activity
9.	Carbofuran	*Channa punctatus*		Alterations in gonadal development
10.	Aldrin, Dieldrin, BHC and DDT	*Cyprinus carpio*		Histological alterations in gill tissue

3. Types of pesticides

3.1 On the basis of the Target Group, pesticides are classified as:

Pesticide	Target	Pesticide	Target
1. Algaecide	Algae	2. Avicide	Birds
3. Bactericide	Bacteria	4. Defoliant	Crop Foliage
4. Desiccant	Crop Plants	5. Fungicide	Fungi
6. Herbicide	Plants (weeds)	7. Insecticide	Insects
8. Miticide	Mites	9. Molluscicide	Molluscs
10. Nematicide	Nematodes	11. Plant Growth Reg.	Crop Plants
12. Rodenticide	Rodents	13. Piscicide	Fish
14. Lampricide	Lamprey	15. Wood Preservative	Wood Destroying Pests

3.2 On the basis of chemical structure, pesticides are grouped into:

Chemical group	Examples
Chlorinated hydrocarbons/	Aldrin, Dieldrin, BHC, DDT
Organochlorines	Chlordane, Toxaphene
Organophosphates	Diazinon, parathion, malathion
Carbonates	Carbonyl, carbofuran
Pyrethroids	Cypermethrin
Phenoxyalkyl acids	2,4-D; 2,4,5-T
Phenylureas	Diuron
Carbonates	Butylate
Di-pyridyl	Paraquat, Diquat
Triazineas	Atrizines, simazine
Thio-carbamates	Ferbam, Maneb
Mercurial	Ceresin
Others	Copper sulphate etc

4. Mode of Action

Sl. No	Pesticides	Mode of action
1.	Organochlorine	Act on neurons by causing sodium/potassium imbalance and accumulation of acetylcholine at neuromuscular junction (NMJ) causing rapid

		twitching of voluntary muscles and eventually paralysis (tremors and convulsion)
2.	Organophosphate	Cause acetylcholinesterase inhibition and accumulation in NMJ, muscle twitching and paralysis
3.	Carbamates	Cause ACHE inhibition causing CNS effects (rapid twitch of voluntary muscles and eventually paralysis), highly toxic to fish and other aquatic animals
4.	Pyrethroids	Open the sodium channels in neuronal membrane, affecting both PNS & CNS, causing hyperexcitability, incoordination, paralysis, extremely toxic to fish
5.	Benzoylureas	Act as growth regulators by interfering chitin synthesis, very toxic to fish.
6.	Pyrazoles	Inhibit mitochondrial electron transport, very toxic to oyster and shrimp.
7.	Lindane	Lindane is a neurotoxin that interferes with GABA gated chloride channel complex. Effect of lindane is much faster than DDT; within hours treated insect shows tremors and convulsions
8.	Botanicals: Pyrethrum, Nicotine, Rotenone, Limonene	effect on PNS & CNS. It mimics ACH in CNS ganglia causing twitching, convulsion and death act on respiratory enzyme inhibitor effect on sensory nerves of PNS---slightly toxic to fish

4. Conclusion

It can be summarized that chronic exposure of pesticides pose a serious threat to fishes and other aquatic organisms. Further, consumption of such fish by humans is highly hazardous. Therefore, judicious use of pesticides is the need of the hour because of their continuous release from anthropogenic sources.

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PHYTOREMEDIATION OF POLLUTANTS IN AQUATIC ENVIRONMENT

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1. Introduction

Contaminants derived from anthropogenic activities can adversely affect aquatic life and impact human health even at low levels. Organic contaminants are usually xenobiotic to plants, but inorganic contaminants such as metals are commonly found in low concentration in the soil. Metal uptake by plants generally takes place by specific transporters (channel proteins) or H^+ coupled carrier proteins located on the cell membrane of the root. Phytoremediation basically refers to the use of plants and associated soil microbes to reduce the concentrations or toxic effects of contaminants in the environment. Phytoremediation is widely accepted as a cost-effective environmental restoration technology. It is an alternative to engineering procedures that are usually more destructive to the soil. Phytoremediation technologies are available for various environments and types of contaminants. These involve different processes such as *in situ* stabilization or degradation and removal (*i.e.*, volatilization or extraction) of contaminants. Among the various aquatic plant species, *Azolla*, *Eichhornia*, *Lemna*, *Potamogeton*, *Spirodela*, *Wolfia*, and *Wolfialla* have been reported as phytoremediators and are highly efficient in reducing aquatic contamination through bioaccumulation of contaminants in their body tissues. Water hyacinth (Eichhornia) is highly resistant and can tolerate the toxicity of heavy metals, phenols, formaldehydes, formic acids, acetic acids and oxalic acids even in their high concentrations. Likewise, some other species of the family Lemnaceae are very efficient to reduce the percentage of biochemical oxygen demand (BOD), chemical oxygen demand (COD), as well as impact of heavy metals, and various ionic forms of nitrogen and phosphorus. The present article focuses on types of phytoremediation, advantages and disadvantages and example of recent technology developed for phytoremediation in India.

2. Types of Phytoremediation

2.1 Phytoaccumulation

Phytoaccumulation is the process by which plants accumulate pollutants in their roots, shoots, or leaves above ground. The roots absorb elements from the soil or water and concentrate them in the plant biomass above ground. Hyperaccumulators are organisms that have a high capacity for absorbing pollutants. Factors affecting phytoextraction are bioavailability of metals, rate of uptake by roots and tolerance to toxic form of metals. For effective remediation process, plant should able to extract higher quantity of metals in their roots, translocate to produce large amount of plant biomass.

2.2 Phytotransformation

Phytotransformation, also known as phytodegradation, is the transformation of organic pollutants from soil, sediments, or water into a more stable, less hazardous, and less mobile form. The plant roots secrete enzymes that break down the organic chemicals, which are subsequently taken in by the plant and expelled by transpiration. It is used in the removal of chlorinated derivatives, herbicides, heavy metals in contaminated soil, sediment and groundwater.

2.3 Phytostabilization

Phytostabilization is a process in which plants limit contaminated soil movement and migration and is referred to as 'in-place inactivation'. Pollutants are adsorbed and bonded into the plant structure; leachable elements form an unstable mass of plant from which toxins cannot re-enter the environment. By attaching contaminants to soil particles, the plant immobilizes them, making them less available for plant or human uptake. It occurs through different mechanisms *viz.* sorption, precipitation, complexation, or metal valence reduction. It is used to remove heavy metals like Pb, As, Cd, Cr through rapid immobilization. The major advantages of this process are reduction of bioavailability of pollutants to food web, restricts the movement to ground water and reduces soil erosion.

2.4 Rhizodegradation

Rhizodegradation, also known as phytostimulation, is the breakdown of pollutants through rhizosphere activity. The presence of proteins and enzymes produced by plants or soil organisms such as bacteria, yeast, and fungi are responsible for this action. It is documented that rhizosphere soil contains 100 times more microorganisms than outside rhizosphere soil. These bacteria may degrade dangerous contaminants like polycyclic aromatic hydrocarbons, petroleum hydrocarbons, polychlorinated biphenyls, benzene, toluene, ethylbenzene, and xylenes into harmless products.

2.5 Rhizofiltration

Rhizofiltration is a method of removing harmful chemicals and surplus nutrients from water by filtering it through a mass of roots. Pollutants are absorbed by the roots or transferred on them. This method is frequently used to clean up contaminated groundwater by either planting directly in the contaminated area or extracting the contaminated water and delivering it to these plants off-site. In rhizofiltration, both terrestrial and aquatic plants can be used and there is no requirement of translocation of metals to shoots unlike phytoextraction. This method can be used in surface water, ground water and waste water for removal of heavy metals such as Pb, Cd, Cu, Ni, and Cr.

2.6 Phytovolatilization

It involves uptake of pollutants from soil and converting them into volatile forms and transpiring into atmosphere. It also includes the diffusion of pollutants in different parts

of plant tissue before finally reaching leaves for evaporation. This process is primarily used for the removal of mercury (Hg) from toxic to elemental form. It can be also used to remove some inorganic pollutants such as selenium, arsenic, trichloroethane.

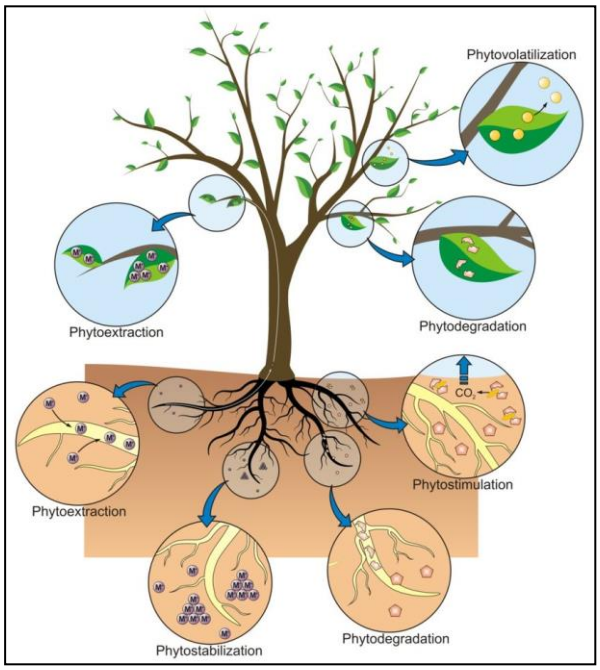

Fig. 1: Different types of Phytoremediation (Favas et al., 2014)

3. Advantages of Phytoremediation

- It is an environmentally friendly approach as it can limit pollution exposure to the environment and ecosystem.
- This method can be applied over a large-scale field and easily disposed of.
- It prevents erosion and metal leaching by stabilising heavy metals, reducing the risk of contaminants spreading.
- It can also improve soil fertility by releasing various organic matter to the soil.

4. Disadvantages of Phytoremediation

- Phytoremediation relocates hazardous heavy metals rather than removing them from the environment.
- The surface area and depth occupied by the roots are the only areas where phytoremediation can occur.
- Because of the slow growth and limited biomass, a long-term commitment is required.
- It is impossible to totally avoid pollutant leaching into groundwater using plant-based remediation techniques.

5. Example of Technology developed for phytoremediation in India

Budding scientists of Indian Institutes of Technology, Ropar and Kanpur and Faculty of Management Studies of Delhi University have developed a living-plant based air purifier "Ubreathe Life" that amplifies the air purification process in the indoor spaces. These indoor spaces can either be hospitals, schools, offices and domestic purpose. The technology works through the air-purifying natural leafy plant. The room-air interacts with leaves and goes to the soil-root zone where maximum pollutants are purified. The novel technology used in this product is 'Urban Munnar Effect' along with patent pending "Breathing Roots" to exponentially amplify the phytoremediation process of the plants. 'Ubreathe Life' effectively improves indoor air quality by removing particulate, gaseous and biological contaminants while increasing the oxygen levels in the indoor space through specific plants, UV disinfection and a stack of Pre-filter, Charcoal filter and HEPA (high efficiency particulate air) filter fitted in a specially designed wooden box. The specific plants tested for air-purification include Peace Lily, Snake Plant, Spider plant etc. and all have given good results in purifying indoor-air.

6. Conclusion

Laboratory research and limited field trials are being done to define processes and refine methods for phytoremediation technologies, which are still in the early stages of development. Future research needs to be carried out including genetic engineering to increase plants' inherent capacities to perform remediation tasks and to examine alternative plants with phytoremediation uses.

AMFI-SI-39

PROSPECTS OF ORGANIC FARMING IN INDIA

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Organic farming is gaining momentum across the world. Awareness of human health and environmental issues in agriculture has demanded production of safe and environmentally friendly food as an attractive source of farm income generation. While there are trends of rising consumer demand for organic food in India among the wealthiest consumers, sustainability in production of crops has become the prime concern in agriculture development. Even though organic food production has several advantages and growing demand, there are many constraints for its adoption in a country like India. India has potential for organic production and agriculture is the main sector of the economy. The growing and large population limits organic farming, as some say it cannot provide enough food to meet this demand. Use of organic farming in India is therefore a topic of debate.

Definition

According to Codex Alimenarius "organic agriculture is a holistic production management system which promotes and enhances agro ecosystem health, including biodiversity, biological cycles and soil biological activity". The primary goal of organic agriculture is to optimize the health and productivity of interdependent communities of soil life, plants, animals and people (Scialabba and Hattam, 2002). There are many other definitions for organic farming (Lieberhardt, 1989; Lampkin *et al*., 1999). For a farmer to certify a product an organic he/ she should not use any synthetic input including genetically modified crops. Both organic farming and conservation agriculture are different forms of sustainable agriculture which aim to meet the future food demand without degrading the natural resources. The difference between these two is organic farming restricts the usage of some commercial inputs and use of genetically engineered crops whereas CA does not have such restrictions.

Principles of sustainable farming:

- To maintain the long-term productivity of soils.
- To produce foodstuffs of high nutritional quality and sufficient quantity.
- To increase the efficiency of fossil fuel use and research alternative sources of energy.
- To give livestock conditions of life that conforms to their physiological need.
- To make it possible for agricultural producers to earn a living through their work and develop their potentialities as human beings.
- To reduce and minimize environmental degradation by controlling soil erosion and desertification.

Ecological profit of organic agriculture

The impact of organic agriculture on natural resources favors interactions within the agro eco system that is vital for both agricultural production and nature conservation. Ecological services derived include soil forming and conditioning, soil stabilization, waste recycling, carbon sequestration, nutrient cycling, predation, pollination, habitat and biodiversity conservation and clean water (IFOAM, 1998). Organic farming systems have reportedly better performance in all the environmental impact indicators (floral diversity, faunal diversity, habitat diversity, landscape, soil organic matter, soil biological activity, soil structure, soil erosion, nitrate leaching, pesticide residues, GHG emissions, nutrient use, water use and energy use) than conventional systems. There is also a higher consumer health cost with conventional agriculture, particularly in the use of pesticides (Conway and Pretty, 1991).

Safety and quality of organically produced food

There is a growing demand for organic foods driven primarily by the consumer's perceptions of the quality and safety of these foods and to the positive environmental impact of organic agriculture practices (Pell, 1997). There have been many claims that eating organic foods increases exposure to microbial contaminants (Avery, 1998). But studies investigating these claims have no evidence to support them (Pell, 1997; Jones, 1999). Organic foods must meet the same quality and safety standards applied to conventional foods. These include the CODEX General Principles of Food Hygiene and Food Safety Programmes based on the Hazard Analysis and Critical Control Point (HACCP is a management system in which food safety is addressed through the analysis and control of biological, chemical, and physical hazards from raw material production, procurement and handling, to manufacturing, distribution and consumption of the finished product). Analysis of pesticide residues in produce in the US and Europe has shown organic products have significantly lower pesticide residues than conventional products (Rutenberg, 2000; Woese et al., 1997; Benbrook and Baker, 2001). Some studies have shown increases in vitamin C, minerals and proteins (Lampkin, 1990), sweeter and less tart apples (Reganold et al., 2001) in organic products than conventional one. Organic crops had significantly higher levels of all nutrients analyzed compared with conventional produce including vitamin C (27% more), magnesium (29% more), iron (21% more) and phosphorous (14% more) (Worthington, 2001). Generally, organic crops are not protected by pesticides and research has shown that organically produced fruit contain higher levels of phenolic compounds than conventionally grown fruit and contain 10% to 50% more antioxidants than conventional crops (Brandt and Molgaard 2001). Scope of organic farming in India Green revolution and monoculture The need for organic farming in India arises from the unsustainability of agriculture production and the damage caused to ecology through conventional farming practices. It is true that the green revolution saved India from starvation. But the negative consequences include the use of plant protection chemicals like fungicides, insecticides, and herbicides farmers used to protect crops from pest and disease problems. Scientific surveys and sampling indicate that pesticides sprayed on crops leave harmful residues

that are transferred to human and other living bodies through grains, vegetables, fruits and grasses, causing a number of diseases, ailments and harmful effects on our health (Bhattacharyya, 2004). It is not also the amount of pesticides but also the time of application and LD 50 value (LD50 is the amount of a material, given all at once, which causes the death of 50% of a group of test animals) is also important. The other issue is the practice of monoculture (growing the same crop year after year) that can lead to build up of pest outbreaks. But monocropping may be the only option, for example deep water rice in flooded areas. Except for this practice croprotation is recommended. It is also better to rotate a leguminous crop with a non leguminous one. This has the advantage of shifting the pest and disease problem, and the different root architecture in both will help in bringing nutrients deep in the soil to the upper layer (in most of the cases). Another issue is the manufacture of fertilizers and a pesticide, two major inputs, which need energy from fossil fuels to produce, as well as their association with environmental and health issues. Increasing population Increasing global population and decrease in the availability of non renewable resources such as energy, land, and water, creates a real challenge for farmers in the coming years. We are in need of a production system that can meet the growing food demands without degrading the natural resources needed for food production. A sustainable way of crop production is the only way to achieve this target.

Indiginous Traditional knowledge of organic farming

India has a long history of traditional agriculture. It was initiated thousands of years ago when farmers started cultivation using only natural resources. Every farmer used this convention until the introduction of fertilizers and pesticides in the 20th century. This is said to be the traditional agriculture of a country. There is a brief mention of several organic inputs in India's ancient literatures like Rigveda, Ramayana, Mahabharata, Kautilya, etc. India is endowed with various types of naturally available organic forms of nutrients in different parts of the country and they can be used for organic cultivation of crops. There is diversity in environments- climates with respect to rainfall, flat and hill areas, deserts, areas with strong traditional farming systems involving crops, trees and animals, many innovative farmers, vast rainfed lands (approximately 60% of the agriculture land), and areas that use very few chemical inputs. In fact, the rainfed, tribal, north east and hilly regions of the country where negligible chemicals are used have practiced subsistence, organic agriculture for a long period (Bhattacharyya, 2004).

Present status organic farming in India

India of Progress in Organic farming India is bestowed with lot of potential to produce all varieties of organic products due to its various agro climatic regions. In several parts of the country, the inherited tradition of organic farming is an added advantage. This holds promise for the organic producers to tap the market which is growing steadily in the domestic market related to the export market. According to the "Agricultural and Processed Food Products Export Development Authority" (APEDA) India ranks 10th among the top ten countries in terms of cultivable land under organic certification. The certified area includes 15% cultivable area with 0.72 million Hectare and rest 85% (3.99

million Hectare) is forest and wild area for collection of minor forest produces. The total area under organic certification is 4.72 million Hectare (2013-14).

Table 2: Data for Organic Products (2013-2014)

Total production	**1.24 MMT**
Total quantity exported	194088 MT
Value of total export	403 Million USD
Total area under certified organic cultivation	4.72 Million hectares
Increase in Export Value over previous year	7.73 approx.

Organic products are exported to US, European Union, Canada, Switzerland, Australia, New Zealand, South East Asian countries, Middle East, South Africa etc. Soybean (70%) lead among the products exported followed by Cereals & Millets other than Basmati (6%), processed food products (5%), Basmati Rice (4%), Sugar (3%), Tea (2%), Pulses and Lentils (1%), dry fruits (1%), Spices (1%) and others.

Constraints in organic farming

Lack of knowledge: Most Indian farmers lack organic crop management knowledge. Many farmers in the country know little about organic farming and its advantages compared to conventional farming methods (Singh et al., 2001). Knowledge about the availability and usefulness of an integrated organic approach to enrich the soil is also vital to increase productivity. Farmers lack the knowledge of recent technologies in compost making. Largely small farmers lack knowledge in proper certification requirements.

Inadequate infrastructure: In spite of the adoption of the NPOP (National programme on Organic Production) during 2000, state governments in India are yet to formulate policies and a credible mechanism to implement them (Narayanan, 2005). There are only four agencies for accreditation and their expertise is limited to fruits and vegetables, tea, coffee and spices. The certifying agencies are inadequate, the recognized green markets are non-existent, the trade channels are yet to be formed and the infrastructure facilities for verification leading to certification of the farms are inadequate (Narayanan, 2005). Farmers adopting organic production methods in India have difficulties to get certification (Certification is the assurance given to the consumer for its safety and quality). Often high amounts of money are involved in the process of certification which depends on the size of the farm, the cost of inspection, reorganization and paperwork done for accreditation which becomes expensive for small farmers. The high cost of certification hinders exports to international markets where higher profits could be obtained but not without being certified. On the other hand farmers have difficulties complying with the standards of certified organic production, especially when these require high initial costs of investment. In India there is no need of certification or labelling for the domestic market. But in the future this may be required. In the absence of regulation, there are many fakes stacked up with authentic ones. Some years back there was also a case of producing GM cotton in the name of organic cotton by the

farmers in some districts of Andhra Pradesh. All this happened because of the lack of proper certification.

Higher cost of production: The small and marginal farmers in India have been practicing organic farming in the form of the traditional farming system. They use local or own renewable farm resources and carry on their agricultural practices (Katyal, 2000). Often the larger farms need to get organic inputs from the market. The costs of the organic inputs are higher than those of industrially produced chemical fertilizers and pesticides including other inputs used in the conventional farming system (Kler et al., 2001). Organic inputs are bulkier than synthetic inputs in terms of nutrient content and so cost more labour to transport and spread on the fields. There is also a government subsidy on synthetic fertilizer making them cheaper per unit of nutrient. The groundnut cake, neem seed cake, vermi-compost, silt, cow dung, other manures, etc. applied as organic manure are increasingly more costly making them unaffordable to the small cultivators if they do not have sufficient of their own manure. The organic sources listed above also have other competing uses like cattle feed, fuel etc. which also hinders availability. Absence of appropriate agriculture policy Appropriate agriculture policy in India is vital for national food security including policies related to supply of inputs, promotion of organic farming for export and domestic markets, product and input supplies (FAO, 2003). These are serious issues and a solution for them along with a national consensus is essential for future growth. Formulation of an appropriate policy for organic agriculture that takes concern of these complexities is essential to promote organic agriculture in a big way in India.

Low yields: In many cases farmers experience some loss in yield when switching away from synthetic inputs or conversion of their farming method from conventional to organic. Restoration of full biological activity in terms of growth of beneficial insect populations, nitrogen fixating bacteria and other soil microbes, pest suppression and improved nutrient recycling will take time before these transition yield declines can be reversed (Hanson et al., 1997). It may also take years to make organic production profitable on the farm (Peters, 1994; Liebhardt et al., 1989). Small and marginal farmers cannot take the risk of low yields for the initial 2-3 years when converting to organic farming. There is a need for schemes to compensate them during this transition period if small farmers are to be encouraged to grow organic food. The price premiums on organic products will not be much help, as they will disappear once significant quantities of organic farm products are made available (Narayanan, 2005).

Poor marketing facilaties: There is a lack of a marketing and distribution network for organic produce. Often the retailers are not interested in buying organic produce from farmers because of the higher cost and less demand by Indian consumers. This is because the majorities of the people are poor and cannot afford to buy organic products because of its higher price. Lack of cold storage facilities is the other factor which is very important for perishable products like fruits and vegetables. Organic products like fruits and vegetables are more likely to find an organic market than other staple food crops

like cereals. India should concentrate on good marketing channels for fruits and vegetables.

Recommendation

To meet the human needs for food in a more efficient and ecologically friendly way it is important to combine both organic and inorganic approaches of crop production. To ensure food and nutritional security, rather than promoting organic farming universally, it would be desirable to carefully delineate areas for organic farming. At this point of time it is important to have a sustainable method of farming to meet the future food demand and at the same time be safe to the environment.To have a sustainable approach that meets food security needs it is better to have an integrated approach; a combination of both organic and inorganic farming.

- Formation of organic agriculture societies through registration.
- Small farmers with potential areas for organic production can increase through group farming system to better avail markets for organic products.
- High value crops like, spices, medicinal plants, fruits and vegetables should be produce.
- Increasing awareness for adopting organic crop production is needed.
- Knowledge in proper certification procedures is important for the future of organic food production.
- The certification process will be made easy so that small farmer can take advantage of it.
- Developed organized marketing system for organic products in rural areas.
- Motivation/ training of farmers for adopting improved organic crop production technologies.
- Provision of consultancy services to the organic agricultural producers.
- Intensification of transfer of technology and extension activities related to profits of organic farming in the rural area.
- Organic agricultural policies that combine increased income generation and improved domestic food production from organic farming are needed.
- Crop and area specific package of practices for organic cultivation should be developed and after thorough on farm validation, recommended for adoption. Such proven packages and practices need to be documented in regional languages. Participatory approaches where farmers can interact and learn in farmer school approaches need to be developed.

Conclusion

India is bestowed with a lot of potential to produce all varieties of organic products due to its various agro climatic regions and traditional knowledge. The export market potential is also increasing. But there are many constraints for organic production in a country like India. Depending upon organic farming to meet food security needs will not be sufficient to meet the food needs of more than 1 billion people. Overcoming constraints and identifying the prime areas and potential hotspots to produce organic products will help India emerge as a good exporter of organic products and increase

farm net revenues. To combine a sustainable production system to meet food security needs of India with a healthy environment an integrated approach that combines organic and inorganic methods of crop production is recommended.

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AMFI-SI-40

PROTECTION OF PLANT VARIETIES AND FARMERS' RIGHTS (PPV&FR) ACT-2001

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Introduction:

The Protection of Plant Varieties and Farmers' Rights (PPVFR) Act is an attempt by Indian legislation to fulfill its commitments under TRIPS Article 27.3(b). The Act, approved by the Indian Parliament in August 2001 and came in enforcement on 30th October, 2001 is arguably the only *sui generis* system for plant varieties protection other than the UPOV (International Union for the Protection of New Varieties of Plants) Convention currently enacted in law. It is an ''effective system for the protection of plant varieties, the rights of farmers and plant breeders, to encourage the development of new varieties of plants" and is the first amongst the various legislations that provide protection to farmers. It is an undertaking by the Indian Government to recognize the contribution of both commercial plant breeders and farmers in plant breeding activity and for granting rights to both breeders and farmers and also gives rights to traditional communities on their genetic resources. The act is based on the important principle of distributing ownership rights in a fair and equitable manner. It provides intellectual property protection of Farmers Variety as equivalent to plant breeders and can distribute benefits sharing proceeds from the sale of protected varieties.

Objectives of the PPV & FR Act-2001

1. To establish an effective system for the protection of plant varieties, the rights of farmers and plant breeders and to encourage the development of new varieties of plants.
2. To recognize and protect the rights of farmers in respect of their contributions made at any time in conserving, improving and making available plant genetic resources for the development of new plant varieties.
3. To accelerate agricultural development in the country, protect plant breeders' rights; stimulate investment for research and development both in public & private sector for the development new of plant varieties.
4. Facilitate the growth of seed industry in the country which will ensure the availability of high quality seeds and planting material to the farmers. Protection of Plant Varieties and Farmers' Rights Authority

To implement the provisions of the Act as well as to file the application for the registration of a plant variety, the Department of Agriculture and Cooperation, Ministry of Agriculture established the Protection of Plant Varieties and Farmers' Rights Authority on 11th November, 2005 and its Head Quarters is located at NASC Complex, New Delhi-110 012. The Authority consists of a chairperson and fifteen members. The Chairperson is the Chief Executive of the Authority. Besides the Chairperson, the

Authority has 15 members, as notified by the Government of India (GOI). Eight of them are ex-officio members representing various Departments/Ministries, three from SAUs and the State Governments, one representative each for farmers, tribal organization, seed industry and women organization associated with agricultural activities are nominated by the Central Government. The Registrar General is the ex-officio Member Secretary of the Authority. **Dr. K.V. Prabhu** is the present Chairperson of the Authority.

General functions of the Authority

- Registration of new plant varieties, essentially derived varieties (EDV) and extant varieties.
- Developing DUS (Distinctiveness, Uniformity and Stability) test guidelines for new plant species.
- Developing characterization and documentation of registered varieties.
- Cataloging facilities for all variety of plants.
- Documentation, indexing and cataloguing of farmer's varieties.
- Recognizing and rewarding farmers, community of farmers (from national gene fund), particularly tribal and rural community engaged in conservation, improvement, preservation of plant genetic resources of economic plants and their wild relatives.
- Maintenance of the National Register of Plant Varieties.
- Maintenance of National Gene Bank.

Varieties that can be protected:

1) New variety: A variety which is not in public domain in India earlier than one year before the date of filing; or outside India, in the case of trees or vines earlier than six years, or in any other case, earlier than four years.

2) Extant variety: A variety about which there is common knowledge or a farmer's variety or any other variety which is in public domain is considered as an extant variety. In case of an extant variety, if a breeder or his successor establishes his right, the Central Government and in cases where such extant variety is notified for a State or any area thereof under section 5 of the Seeds Act, 1966, the State Government is the owner of such right.

3) Farmers' variety : A variety which has been traditionally cultivated and evolved by the farmers in their own fields or a variety which is a wild relative or land race of a variety about which farmers possess common knowledge. Farmers' variety has provision to exempt from application/registration fees and his application need not be accompanied with fees, affidavit for terminator technology.

4) Essentially Derived Variety (EDV): A plant variety which is predominantly derived from such initial variety or from a variety that itself is predominantly derived from such initial variety while retaining the expression of the essential characteristics that result from the genotype or combination of genotypes of such initial variety; is clearly distinguishable from such initial variety.

Registration:

A variety is eligible for registration if it essentially fulfils the criteria of Distinctiveness, Uniformity and Stability (DUS). The Central Government issues notification in official Gazettes if found suitable specifying the genera and species for the purpose of registration of varieties. So far, the Central Government has notified 157 crop species for the purpose of registration. The PPV&FR Authority has developed "Guidelines for the Conduct of Species Specific Distinctiveness, Uniformity and Stability," tests or "Specific Guidelines", for individual crop species.

Conditions for protection:

The characteristics of the varieties that qualify for protection include - Distinctness, Uniformity and Stability (**DUS**). Thus, the legislation has followed the principles set by the UPOV Convention. A New Variety is judged on a criterion of Novelty, Distinctness, Uniformity and Stability, whereas Extant Variety is also judged on same criterion but not on novelty.

Fees for Registration:

Application for registration of plant varieties should be accompanied with the registration fee prescribed by the Authority. Registration fee for different types of variety is as under:

S. No.	Type of variety	Fees for Registration
1	Extant Variety notified under section 5 of the Seeds Act, 1966	Rs. 2000/-
2	New Variety/Essentially Derived Variety(EDV)/ Extant Variety about which there is common knowledge (VCK)	Individual Rs. 7000/- Educational Rs.10000/- Commercial Rs.50000/-
3	Farmer varieties	NO FEE

Rights under the Act:

Breeders' rights

Plant variety protection provides legal protection of a plant variety to a breeder in the form of Plant Breeder's Rights. Under the Act, breeder means a person or group of persons or a farmer or group of farmers or any institution, which has bred, evolved or developed any variety. A certificate of registration for a variety issued by the Authority under this act provide breeder with the following rights;

- Breeders will have exclusive rights to produce, sell, market, distribute, import or export the protected variety.
- Breeder can appoint agent/licensee and may exercise for civil remedy in case of infringement of rights.
- If the breeder's variety protected under the Act is an EDV from a farmers' variety, the breeder cannot give any authorization without the consent of the farmers or communities from whose varieties the protected variety is derived.

Researchers' rights:

Researcher can use any of the registered variety under the Act for conducting experiment or research. This includes the use of a variety as an initial source of variety

for the purpose of developing another variety but repeated use needs prior permission of the registered breeder.

Farmers' rights:

A farmer is any person who cultivates crops either by cultivating the land himself, or by directly supervising the cultivation of land through any other persons. A farmer can also mean any person who conserves and preserves any wild species or traditional varieties, or adds values to them through selection and identification of their useful properties.

- A farmer can save, use, sow, re-sow, exchange, share or sell his farm produce including seed of a variety protected under the PPV&FR Act.
- He has the same privilege with respect to a breeder of a variety.
- A farmers' variety shall be entitled for registration if a declaration has been made that the initial variety has been lawfully obtained.
- A farmer can claim damages if the seed of the protected variety does not give the yield as stated by the breeder.
- The farmer as such cannot sell branded seeds of a protected variety. 'Branded seed', according to the Act means any seed put in a package or any other container and labeled in a manner indicating that the seed is of a protected variety under this Act.
- Protection against unintentional and accidental use of the protected variety: There would be no infringement if the farmer was unaware of the existence of the rights but has to prove before court.
- The PPVFR Act also seeks to reward the farmer who is engaged in the conservation and preservation of genetic resources of land races and wild relatives of economic plants and their improvement through selection and preservation.

The following persons can apply for the registration of a plant variety

- Person claiming to be the breeder of the variety or his successor or assignee.
- A farmer or a group of farmers claiming to be the breeder of the variety.
- Any person authorized by any of the persons specified above to make application on their behalf.
- Any university or publicly funded agricultural institution claiming to be the breeder of the variety.

Duration of protection for a registered plant variety:

The certificate of registration issued shall be valid for 9 years in the case of trees and vines and 6 years in the case of other crops and may be renewed for the remaining period on payment of such fees, subject to the condition that the total period of validity shall not exceed -

1) In the case of trees and vines, 18 years from the date of registration of the variety;
2) In case of extant variety, 15 years from the date of notification of that variety by the Central Government under section 5 of the Seeds Act, 1966; and
3) In other cases, 15 years from the date of registration of the variety.

Certificate of Registration:

So far, the Central Government has notified 157 species of different crop for the purpose of registration. Applications which have fulfilled all requirements have been finally accepted by the Registrar for Registration. Total 3504 Certificates have been issued, out of which 480 have been issued for new varieties, 1437 for extant varieties notified under the Seeds Act, 1966, 1586 for farmers' varieties and 01 for Essentially Derived Variety (EDV) upto October, 2018 (plantauthority.gov.in).

National Gene Bank

The breeder shall be required to deposit such quantity of seeds or propagating material including parental line seeds of registered variety in the National Gene Bank as specified by the Authority for reproduction purpose.

Benefit sharing:

The Act provides for benefit sharing involving registered varieties in two circumstances. The first applies specifically to EDVs. In the second, any village local community can claim benefit for contributing to the development of a variety registered under the Act [Section 41].

Claim of benefit sharing shall only be submitted by any

- Person or group of persons, if such person or every person constituting such group is a citizen of India; or
- Firm or governmental or non-governmental organization, if such firm of organization is formed or established in India.
- Depending upon the extent and nature of the use of genetic material of the claimant in the development of the variety along with commercial utility and demand in the market of the variety, the amount of benefit sharing, if any, would have to be deposited in the National Gene Fund by the breeder of the variety.

Compulsory License:

If seeds of a protected variety are not available after 3 years of registration in adequate quantity, and at reasonable price, the Authority may grant license to a third party to (a) Undertake production. (b) Distribution and sale of the seed on reasonable royalty. The duration of compulsory licenses shall not exceed the total remaining period of the protection of that variety.

Conclusion:

Indian seed industries are now growing fast in current scenario with the aims to provide healthy and pure seeds to the farmers which ultimately results in good crop stands to the farmers field and results in good economy to the country. In connection to this, a legal law must be there for healthy practices in the market which is fulfilled by PPV&FR Act-2001 in terms of quality seeds as well as recognition to the breeder as well as farmers of the variety.

References:

Compendium of Registered Varieties under PPV& FR Act, 2001. Protection of Plant Varieties and Farmers' Rights Authority, Department of Agriculture and Co-operation,

Ministry of Agriculture, Government of India, NASC Complex, New Delhi-110 012. www.plantauthority.gov.in

AMFI-SI-41

RAINFALL AND CROP PRODUCTION

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Introduction:

Even though the technologies such as vertical farming, hydroponics and protected cultivation have emerged big, the food security of Indian population is mainly dependant on the distribution of weather parameters. Among the factors that govern the agricultural production and productivity, weather is the foremost factor. It can be said that the food security is tightly bonded to the changes in weather parameters. Each and every weather parameter has its own effect on the productivity of the crops. But, rainfall is considered to be the most affecting factor since it shows an eminence in crop planning to harvest as well as post-harvest planning. Rainfall is the variable that shows higher spatial as well as temporal variability. The rainfall is the prime source of soil moisture in case of rainfed agriculture which occupies the 60 per cent of Indian cultivable land area, in which 48 percent is under food crops and remaining under non food crops. All the operations in agricultural production, plant growth and health are primarily linked to soil moisture. The cheapest source of water for agricultural purpose is rain if received at timely intervals and appropriate quantities our national productivity would reach its potential. Rainfall has its role from crop planning till marketing. In simple words it could be said that rainfall determines the livelihood of the agrarian population in the semi-arid regions like India. Hence in countries like India, where rainfall decides the economic status of the nation, long term rainfall analysis and potential future planning is essential.

Rainfall and agriculture:

Rainfall is the sole parameter that expresses vast variability –spatially as well as temporally. It is an erratic and uncertain event but have a greater importance in agricultural production. The distribution and intensity of rainfall is of greater importance in addition to that of amount of rainfall.

Temporal variability of rain fall over a region is crucial in selection of crop, variety, sowing window, introduction of new crop or variety, cultural practices, water shed planning and so on. Not only the rainfed region but also cultivable area under tank, canal and even well irrigation is rainfall dependent. Deficit as well as excess rainfall has its impact on agricultural production. In many regions flood is a major disaster that wash away the crop. For example this is experience in Cauvery delta areas of Tamil Nadu every year.

Rainfall pattern:

Even with advancement in agricultural production technology, the crop planning mainly depends on the rainfall pattern and the season of the locality, except controlled

environment farming practices. The success or failure of the crop is mainly determined by the rainfall characteristics. A detailed knowledge on the onset of cropping season is needed and this could be arrived based on the rainfall pattern. Hence, rainfall pattern at a place is an important prerequisite for agricultural planning and management.

Dealing with study on the rainfall pattern of a region includes assessing the intra seasonal, inter-seasonal and annual rainfall variabilities. Beyond quantity of rainfall over a region its distribution during the cropping period is most important. Not only for better crop planning but also for determining irrigation, facilitating drainage, planning for water and soil conservation structure understanding the rainfall characteristics is important.

Wet and dry spell analysis:

In order to stabilise the productivity and use the available sources of rainfall over a rainfed region beyond proper rainfall forecast, it is essential to programme the agricultural practices based on the scientific analysis of the past data. The rainfall in the semi-arid tropics is a seasonal phenomenon that too with higher variability (intra seasonal, interseasonal and interannual). The shorter scale variabilities are characterized by wet and dry spells of continuous rains or no rains. Mainly in the dryland regions assessment of dry spells is very much essential to attain the maximum potential of the region. This demands for the analyses of the wet and dry spell over an area to prepare contingency crop planning based on the probability of their occurrence.

In case of rainfed cultivation, irrigation planning and in many other decision making process, the start and length of dry spell and wet spell plays a vital role. The identification the chance of occurrence of dry and wet spells is a basic analysis for successful crop planning, formulation of water conservation techniques, identification of suitable crops and varieties, construction of water harvesting structures.

Rainfall trend analysis:

In the present scenario of climate change knowing the changes in rainfall trends is inevitable. Rainfall received over the locality decides the amount of water availability over the region. In case of agriculture, any small changes in the natural phenomenon would have large impact on the production and health of the crops. Hence, it is indispensable to study the change in amount of monthly, seasonal and annual rainfall over a region to frame and suggest the possible adaptation strategies.

Rainy day analysis:

A day with more than 2.5mm of rainfall is termed as rainy day. The rainy days are of chief importance because it is the minimum amount of rain fall that can be useful for the crop. The number of rainy days distributed over a month, season and annual period has its significance in planning for a crop and cultural practices. Rainy days are of utmost importance for farmers, since it is the minimum amount of rainfall that can reach the swallow root zone of the crop to meet the water requirement of the crop. The distribution of rainy days over the month, cropping season and year is necessary to planning the crop production activities.

Length of growing period:

In the region where majority of area is under rainfed condition it is necessary to analyse the past data to plan the future in terms of rainfall availability to be in co-ordination with that of water requirement. This can be done by identifying the length of growing period. Length of growing period is the duration between the onset and cessation of agriculturally usable rainfall. Each crop has its own characteristics in terms of water requirement. Length of growing period depends on the rainfall distribution, stored soil moisture, temperature and inturn evapotranspiration. The short term rainfall analysis viz., pentads or over weeks is necessary for crop planning. The onset and cessation of a growing season based on rainfall distribution helps in selecting the crop and variety based on the duration of the growing period.

Conclusion:

Among the various factors affecting the agricultural production, weather is the most important one. Every phase of growth and development in plant is affected by weather. Among the weather parameters, rainfall and its distribution fluctuates greatly than other parameters. Any variability in the rainfall during the crop season, such as delay in onset of monsoon, excessive rains and prolonged dry spells would affect the crop growth and finally the quality and quantity of the produce. Adoption of real time contingencies in crop management based on weather forecasts can minimize crop losses. Hence, planning of agricultural activities based on the rainfall pattern that prevail over a region is necessary for successful farming.

AMFI-SI-42

ROLE OF FLAVONOIDS IN NEMATODES

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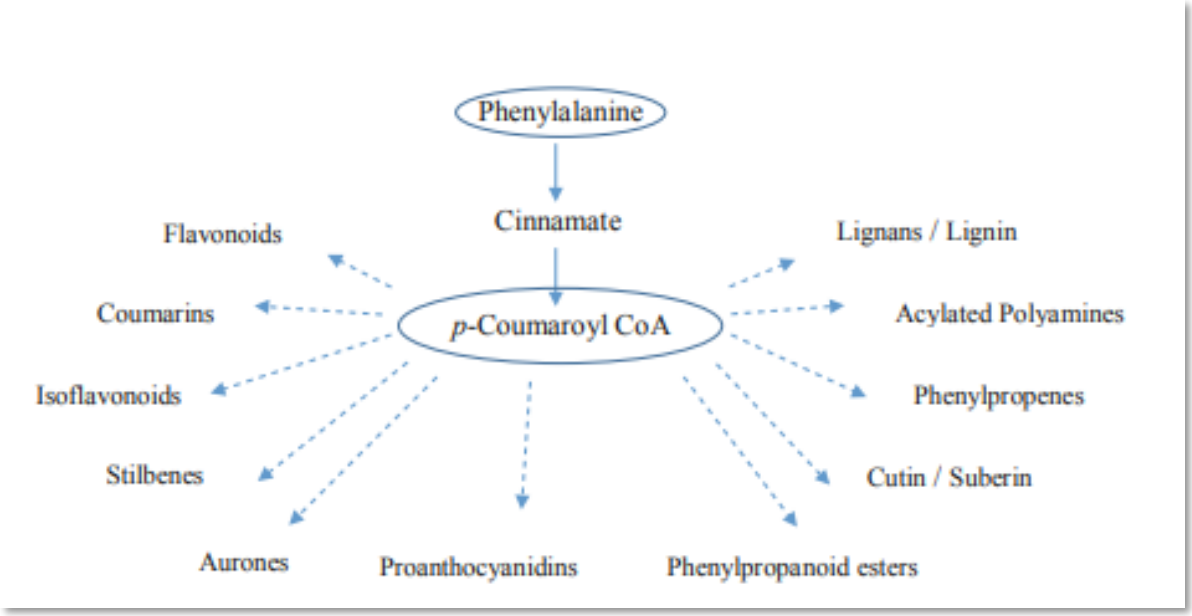
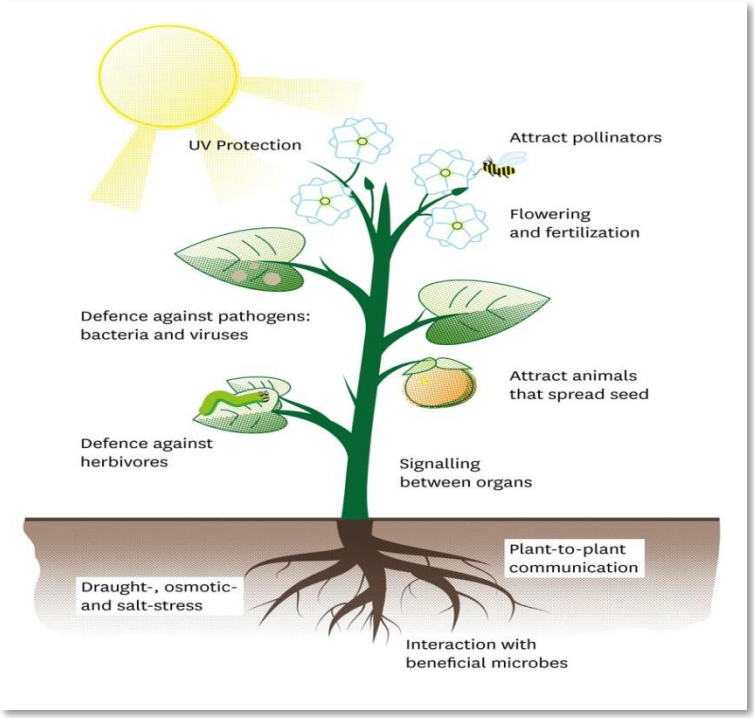
Flavonoids:

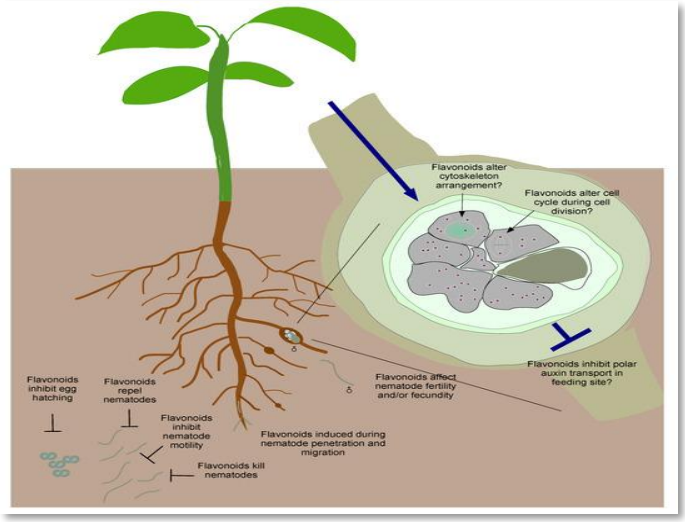
Flavonoids constitute a large class of secondary carbon-based metabolites present in all land plants. More than 10,000 different types of flavonoids have been described from a variety of plant species. It constitutes large class of secondary carbon-based metabolites and present in all plants. More than 10,000 different types of flavonoids had identified from a different plant species. Flavonoids are a class of phenylpropanoids derived from the shikimate and acetate pathways. There are several flavonoid subgroups - chalcones, flavones, flavonols, flavandiols, anthocyanins, condensed tannins, aurones, isoflavonoids, and pterocarpans. The functions of individual flavonoids are plant development via the control of auxin transport, flower pigmentation, as antioxidants (ROS scavengers), as defense compounds, chemoattractants, signals for plant–microbe interactions (notably nodulation), male fertility in some species and help in nutrient mining.





Role of flavonoids in nematode defenses:

Flavonoids inhibits nematode egg hatching. It also induces quiescence by slowing down their movement, modify their migration towards the roots by repelling them and finally kills the nematodes. Flavonoids can affect adult stages of nematodes by altering their fertility and fecundity.



Examples:

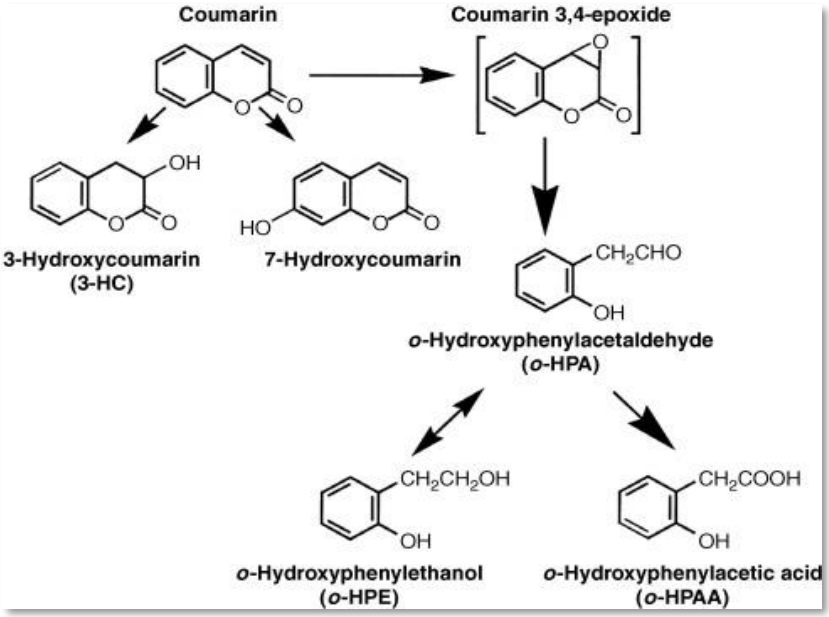
✓ Flavonols kaempferol, quercetin, and myricetin repelled and slowed *M. incognita* juveniles at micromolar concentrations.

✓ Kaempferol inhibited egg hatching of Radopholus similis .

Coumarin:

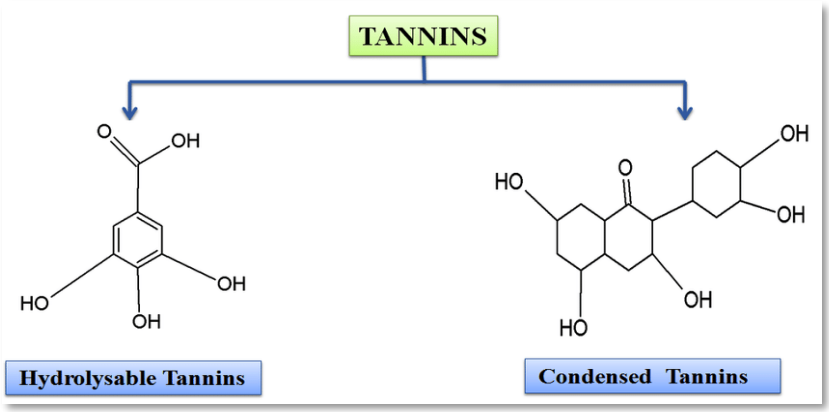
Coumarins are ubiquitously found in higher plants where they originate from the phenylpropanoid pathway. They are found in monocots and dicots plants. During plant-

nematode interaction, coumarins (8-geranyloxypsoralen, imperatorin, and herclenin) causes lethal effect to Pine wood nematode, *Bursaphelenchus xylophilus* in white leaf hog weed, *Heracleum candicans* Coumarins from *Ficus carica* leaves (psoralen and bergapten) also exhibited a strong effect on *B. xylophilus* with a mortality rate of 91% within 72 h at 1.0 mg/mL. Furanocoumarin from parsley exhibits significant nematicidal activity against *M. incognita*, *M. hapla* and *M. arenaria*.



Tannin:

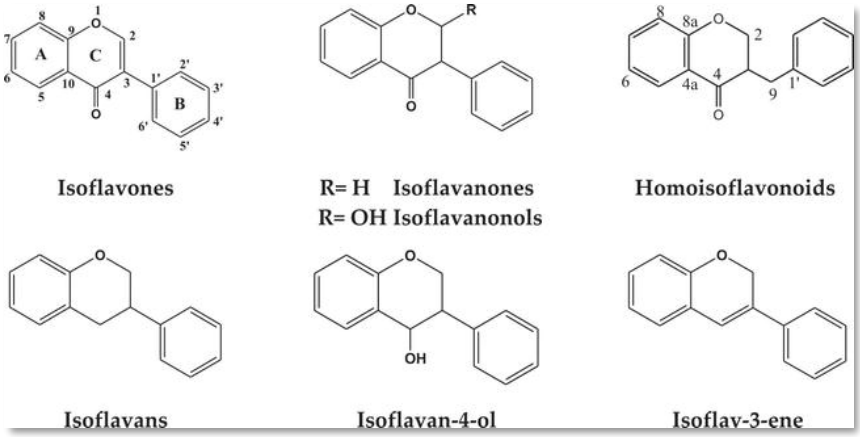
Tannins are a group of condensable and hydrolysed polyphenolic compounds. Tannins from chestnut significantly reduced egg hatching of the root-knot nematode *M. javanica*. Low concentration of tannic acid (less than 40 mg/L) increased hatching of *H. glycines* eggs. Tannins in the extract of *Fumaria parviflora* have been shown to have strong nematicidal effects on J2 and eggs of *M. incognita*.



Isoflavonoids:

Isoflavonoids plays an important role in plant-nematode interaction. Isoflavonoids are produced in infected roots of both *H. glycines*-resistant variety of hartwig and

susceptible variety essex of soybean. Isoflavonoids are elicited in high amounts in *Medicago truncatula* in response to *M. javanica* infection. Isoflavonoid compound glyceolin was found to accumulate close to the nematode's head in a resistant cultivar but not in susceptible plants.



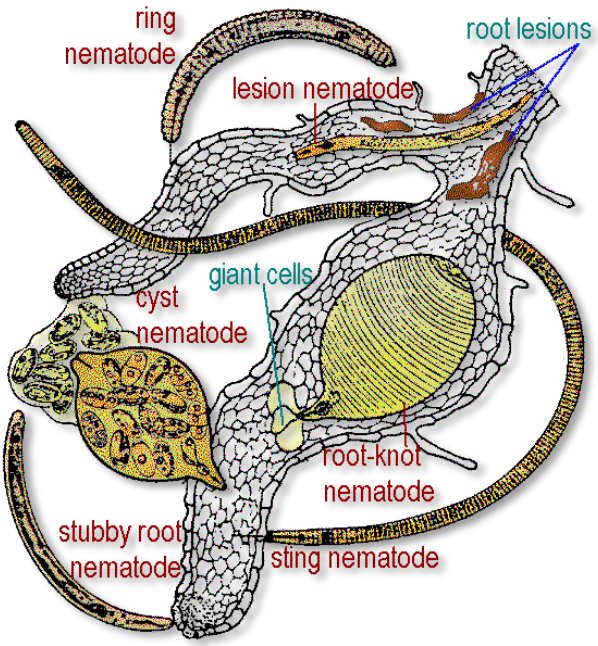
(Hamamouch and adil , 2019).

Role of flavonoids in formation of feeding site:

Feeding sites are important for nematode survival. The endoparasitic nematodes like root knot nematode, cyst nematodes and some semi-endoparasitic nematodes. Feeding sites are giant cells, syncytium and nurse cells.

Flavonoids involved in the regulation of polar auxin transport to enhance auxin accumulation in nematode feeding sites. Some flavonoids inhibit cell-to-cell polar auxin transport and/or the inhibiting auxin efflux transporters, PIN (Pin-formed) and PGP (P-Glycoprotein). Flavonoids may also be involved in the cell cycle regulation of nematode feeding sites. Nematode feeding sites commonly contain enlarged nuclei with higher DNA content compared with other cells, a process achieved through endo-reduplication in the S-phase of mitosis during cell proliferation. It is presumed that endo-reduplication is a strategy used to increase DNA content and gene dosage, thereby increasing cell metabolism and growth in feeding sites.

Flavonoids such as quercetin, genistein, persicogenin, artemetin, luteolin, penduletin, and vitexicarpin inhibit cell cycle progression from G2 to mitosis and induce apoptosis . In addition, some flavonoids can control auxin content by regulating IAA (indole Acetic Acid) oxidase.



Chin *et al*., (2018).

Conclusion:

Several metabolic compounds were varied from resistant and susceptible hosts. Those compounds will give the resistance to the host from nematode attack and also enhances the establishment of nematode feeding site

References:

Chin, S., Behm, C. A., & Mathesius, U. 2018. Functions of flavonoids in plant–nematode interactions. *Plants*, 7: 85.

Hamamouch, N., & Adil, E. (2019). The Role of the Shikimate and the Phenylpropanoid Pathways in Root-Knot Nematode Infection. *Springer nature* (1-15).

AMFI-SI-43

SEWAGE TREATMENT IN INDIA: PROCESS AND PRESENT STATUS

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1. Introduction

Water is one of the most vital natural resources for all life on Earth. The availability and quality of water always have played an important part in determining not only where people can live, but also their quality of life. The wastewater contains many pathogenic bacteria, microorganisms, suspended solids, nutrients, minerals, toxicmetals etc. For several years the primary goal of wastewater treatment was to reduce the number of suspended solids, oxygen-demanding materials, harmful bacteria, and dissolvedinorganic compounds. However, in recent years more stresshas been placed on improving the municipal treatment processes for the disposal of solid waste. The traditional wastewater treatment aims at producing an effluent meeting the recommended microbiological and chemical quality guidelines both at low cost and with minimal operational and maintenance requirements. In traditional wastewater treatment physical, chemical and biological processes are employed to remove organic matter, nutrients and solids from wastewater. Preliminary, primary and secondary treatments are the different treatment stages. Preliminary treatment includes the removal of coarsesolids and other large materials from wastewater. The physical processes of sedimentation and flotation are used inprimary treatment to remove organic and inorganic solids. In secondary treatment, the effluent is treated to remove theresidual organics and suspended solids. Even though more than 75% of the earth is covered by water the availability of pure water is short. There are places in India where people are having difficulty in finding pure water for their daily needs. The conventional method of treating wastewater helps in reducing the adverse environmental and health problem created by them with minimum cost, but the quality of treated water is not up to the standards of pure water. Also, various human activities have created new contaminants in wastewater called emerging pollutants and their presence is challenging for the conventional wastewater treatment methods.

2. Preliminary treatment

The objective of preliminary treatment is to separate floating materials like dead animals, free branches, papers, pieces ofrags, and also heavy settleable inorganic solids. This stagealso helps in removing oils, grease, etc., from the sewage. This treatment reduces the BOD of wastewater by 15-30%. Screening, detritus tank, comminutors, floatation unit andskimming tanks are the various units involved in preliminarytreatment. Screening is used for the removal of floatingmatter. Detritus tank is also known as grit chamber, is usedfor removal of sand and grit. Comminutors are used

forgrinding and chopping large size suspended solids. Floatation units and skimming tanks are used to remove oils and greases.

3. Primary treatment

The main objective of the primary treatment process is to remove settleable organic pollutants and inorganic solids particulate matters by sedimentation process, and the removal of floating materials by scum by skimming. Approximately 30 to 50% of the incoming (BOD_5) biochemical oxygen demand and 50 to 70% of (TSS) total suspended solids and 65%-70% of the oil and grease are removed during primary treatment. Some organic nitrogen, organic phosphorus, and heavy metals associated with solids are also removed during primary sedimentation but colloidal and dissolved constituents are not affected. After the removal of the maximum amount of gross solids, grease, oil, gritty materials. This step reduces the pollution of the wastewater and also improves secondary treatment efficiency.

Primary treatment involves following process:

3.1 Sedimentation

Sedimentation process can remove suspended solids efficiently and economically. This process is particularly suitable for treatment of wastewater passing high amounts of settleable solids. Sedimentation chambers designed specifically to enhance suspended particles to get settled under earth gravity. The common methods for settling sediments are centre-feed-circular clarifiers tank and horizontal flow sedimentation chambers. A highly efficient sedimentation chamber can settle about 80-85% of the suspended solids present in wastewater and approximately 40-50% of organic matter.

3.2 Chemical Coagulation

Wastewater is treated with some chemicals such as Alum, $Al_2(SO_4)_3.18H_2O$, Hydrated lime, Chlorinated copperas, $FeSO_4.Cl$ which induces processes of settling of suspended and colloidal particles to develop flocculent precipitate. Some other common coagulants are mixtures of ferric sulphate and chloride, Copper as $FeSO_4.7H_2O$, Ferric chloride etc. are most common coagulants used for development of coagulation process. The most common economical and effective means to remove finely divided suspended solid impurities is Coagulation.

3.3 Mechanical flocculation process

Wastewater is passed through specially designed chambers, the detention time of water is 30-40 minutes with gentle stirring, the finely divided suspended solids coalesce into larger particles.

3.4 Equalization

Most industries produce different quality of wastewater, with different characteristics at different hours of time. Hence, to apply a uniform treatment method is not possible. Unit volume of wastewater is mixed with other unit volumes of different wastewater to produce a homogeneous mixture. Mechanically with paddles and with aeration usually enhance mixing of effluents.

3.5 Neutralization

Wastewater with highly acidity, highly alkaline should be neutralized before discharge. Alkaline wastewater can be neutralized by sulphuric acid, CO2, waste boiler flue gas. Acidic wastewater can be neutralized by limestone, lime-slurry, caustic soda, depending upon the type and quantity of the wastewater.

4. Secondary treatment:

Secondary wastewater treatment processes use microorganisms to biologically remove contaminants from wastewater. It is also known as biological treatment. Secondary biological processes can be aerobic or anaerobic, each process utilizing a different type of bacterial community. Coupled anaerobic–aerobic processes may also be employed under certain circumstances. Secondary treatment involves following process:

4.1. Activated sludge:

Activated sludge process is used for treating sewage and waste water commonly referred as effluent using bacteria (to degrade the biodegradable organics) and air (Oxygen for respiration). Activated sludge refers to a mixture of microorganisms and suspended solids. The bacterial culture is cultivated in the treatment process to break down organic matter into carbon dioxide, water, and other inorganic compounds. The typical activated sludge process has following basic components:

- Primary Clarifier to separate the solids carried along with Sewage/Effluent
- A reactor in which the microorganisms are kept in suspension, aerated, and in contact with the waste they are treating
- Liquid-solid separation; and
- A sludge recycling system for returning activated sludge back to the beginning of the process.

4.2 Trickling filter

Trickling filter process is one of the types of aerobic wastewater treatment. It is a fixed-bed bioreactor that is the part of secondary wastewater treatment, which eliminates the coarse particles, suspended organic and inorganic waste, small colloids etc. out of the primary effluent. A trickling filter is also called biological filter, as it makes the use of active microbial mass as a bioweapon to degrade the waste out of primary sewage.Unlike activated sludge treatment, the trickling filter follows an attached

growth system inspite of suspended growth system.The filter bed is placed below the pebble filled media, which aids the separation of secondary effluent out of waste activated sludge. The final effluent is released from the outlet pipe and further treated with disinfectants like chlorine, UV, ozone etc. to make it safe for disposal.

5. Tertiary Treatment

Tertiary treatment includes final filtration of treated water through disinfection. This process includes removal of phosphorous and nitrogen from water through application of alum. Disinfection is done through addition of chlorine which kills bacteria, viruses and parasites. Tertiary treatment includes advanced treatment technologies membrane filtration, advanced oxidation, ozonation and enzyme treatment.

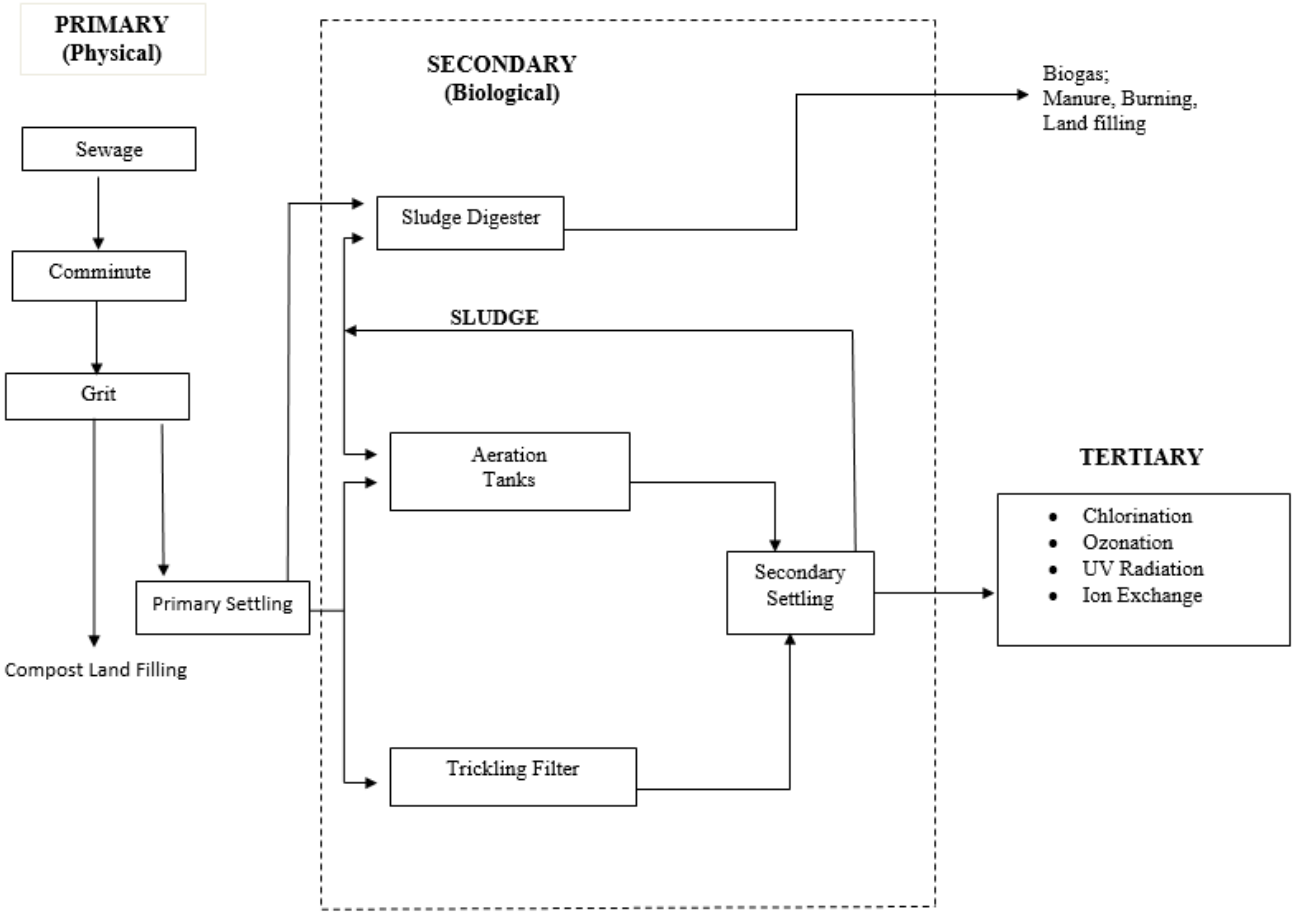

Fig. 1: Sewage Treatment Plant

with a total capacity of 36,668 MLD covering 35 States/UTs. Out of 1,631 STPs, 1,093 STPs are operational, 102 are non-operational, 274 are under construction and 162 STPs are proposed for construction. In comparison to 2014 data, treatment capacity has increased by 50 % in 2020-21. Highest number of STPs are located in Maharashtra (154) with capacity of 6890 MLD. Among the various technologies adopted, Sequential Batch Reactor (SBR) (490 STPs) and Activated Sludge Process (ASP) (321 STPs) are most prevalent in treating the sewage water. Although the number of STPs are increasing

considerably, however, there is a wide gap between the amount of sewage generation from domestic and industrial waste and present treatment capacity. At present sewage generation is estimated as 72,368 MLD and treatment capacity is only 20,235 MLD signifying that 52,133 MLD sewage is released directly into aquatic system without treatment. In some states like Arunachal Pradesh, Andaman & Nicobar Islands, Lakshadweep, Manipur and Nagaland, there are no STPs developed yet. Maharashtra, Gujarat, Uttar Pradesh, NCT of Delhi and Karnataka contributes to about 60 % of the total installed capacity.

7. Conclusion

It is the need of the hour to narrow down the gap between the amount of sewage generated and treatment capacity. Further, considering the increase in population and urbanization, it is necessary to project the future need of treatment capacity in next 10 years. There is a scope for strengthening the sewerage conveyance system through connection of sewer line to domestic outlets in different housing societies of tier I and tier II cities. Treated sewage can be further utilised for horticulture, irrigation, firefighting, industrial cooling , toilet flushing and washing.

AMFI-SI-44

SIGNIFICANCE OF CHELATION REACTION IN SOILS

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Introduction

Micronutrient deficiencies are major constraints in crop production in the present day agricultural programmes. Micronutrient fertilizers are gaining importance day by day and would play a major role in bringing stability and sustainability in the production of food grains, pulses and oilseeds in the coming decade. The three main classes of micronutrient sources are inorganic, synthetic chelates and organic complexes.

Inorganic sources such as sulphates of Cu, Mn, Fe and Zn are the most common metallic salts used in the fertilizer industry because of their ready plant availability and water solubility. In the past 35-40 years, it has been recognised that compounds containing chelated metals could supply many of the micronutrient requirements of plants. These chelates find use in a wide variety of agricultural crops. Applications for chelates vary from fertilizer additives, seed dressing to foliar sprays and hydroponics.

Definition of Chelates

The word chelate is derived from the Greek word for “claw”. In fertilizer technology, it refers to inorganic nutrients that are enclosed by an organic molecule.

Characteristics of chelates

- This compound are true chelating agent, it must have certain chemical characteristics.
- Chelating compound must consist of at least two sites capable of donating electrons (coordinate covalent bond) to the metal it chelates.
- For true chelation to occur the donating atoms must also be in a position within the chelating molecule so that a formation of a ring with the metal ion can occur.
- Typical structure of chelates with known organic acids like citric acid, tartaric acid, gluconic acid and glycine.

Chelates and Chelating Agents

A chelate describes a kind of organic chemical complex in which the metal part of the molecule is held so tightly that it cannot be 'stolen' by contact with other substances, which could convert it to an insoluble form. This is especially true for many soil types in India. Chelating agents are organic molecules that can trap or encapsulate certain metal ions like Ca, Mg, Fe, Co, Cu, Zn and Mn and then release these metal ions slowly so that they become available for plants to take them up. A chelate refers to a ring system that results when a metal ion combines with two or more electron donor groups of a single molecule. Actually unidentate water molecules, which are coordinated with a metal ion, are replaced by the most stable bi-, tri or poly dentate groups of the chelating agent (Rachhpal Singh and . Sinha 1999).

This results in the ring formation. Metals bound in chelate rings have essentially lost their cationic characteristics. In this form they are less prone to precipitation in some chemical reactions. This is the characteristic feature that makes these compounds useful in agriculture. The plant availability of certain micronutrient fertilizers reduces by transformation of the added micronutrient into forms that plants are unable to absorb. For example, if the inorganic iron salt (iron sulphate) is supplied to some soils, much of the iron is transformed into forms that are not readily assimilated.
They are converted to 'plant unavailable' forms. This problem can be overcome by using chelates. There are many naturally occurring chelating agents that are products of organic matter decomposition such as organic acids, amino acids, ligninosulfonates, ligninipolycarboxylates, sugar acids and derivatives, phenols, poly flavonoids, siderophores and phyto siderophores.

Many chelating agents have been developed synthetically. Both classes of chelating/complexing agents increase micronutrient solubility. One of the most important characteristics of chelating agents used is the relative stability of various metal chelates, especially if one is considering synthetically developed chelates. In other words, it is the degree of affinity of a given agent for a metal.

Types of chelate

Natural (Produced from plant itself)

- Plant roots can release exudates that contain natural chelates.
- The nonprotein amino acid, mugineic acid, is one such natural chelate called phytosiderophore (phyto: plant; siderophore: iron carrier)
- Produced by graminaceous (grassy) plants grown in low-iron stress conditions.
- The exuded chelate works as a vehicle, helping plants absorb nutrients in the root-solution-soil system.

Table 1: Natural Chelating Agents

Name	Formula	Abbreviation
Citric acid	$C_6H_8O_7$	CIT
Oxalic acid	$C_2H_2O_4$	OX
Malonic acid	$C_3H_4O_4$	MAL
Malic acid	$C_4H_6O_4$	MA
Tartaric acid	$C_4H_6O_6$	TAR
Humic acid	-	-
Fulvic acid	-	-
Phenols	-	-
Poly flavonoids	-	-
Ligno sulphonates	-	-

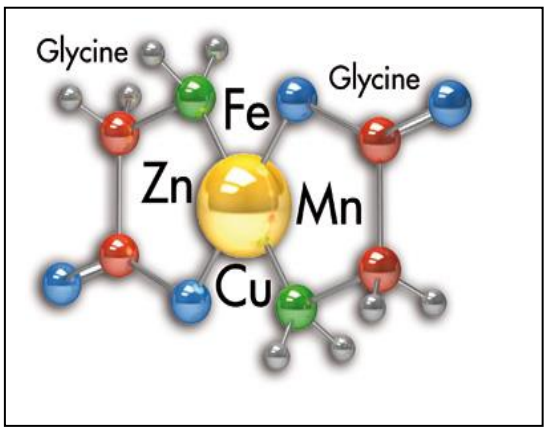

Table 2 : Synthetic Chelating Agents

Name	Formula	Abbreviation
Cyclohexane diamine pentaacetic acid	$C1_4H_{22}O_8N_2$	CDTA
Diethylene triamine pentaacetic acid	$C_{14}H_{23}O_{10}N_3$	DTPA
Ethylene diamine diaminedi-o-hydroxyphenyl acetic acid	$C_{18}H_{20}O_6N_2$	EDDHA
Ethylene glycol bis (2-aminoethyl ether) tetraacetic acid	$C_{14}H_{24}O_{10}N_2$	EGTA
Hydroxy ethylene diamine triacetic acid	$C_{10}H_{18}O_7N_2$	HEDTA
Nitrilo-triacetic acid	$C_6H_9O_6N$	NTA
Pyrophosphoric acid	$H_4P_2O_7$	PPA
Triphosphoric acid	$H_5P_3O_{10}$	TPA
(***Source***: **Tewari *et al*. 2018)**		

Biological Chelating Agents

Apart from the synthetic chelating agents, there are compounds that occur naturally like fulvic acid that function as "natural" chelating agents. Plants growing naturally depend on fulvic acid and other chelating agents found in nature to enable absorption of trace elements. Fulvic acid results from the decomposition of organic matter into humus. The humus is acted upon by microbes to produce humic acids.

The humic acids are further processed by micro-organisms into fulvic acids. Like some synthetic chelating agents, Fulvic acid forms four-point bonds with the elements it chelates, but unlike the synthetic agents it can be absorbed into the plant. This adds to the mobility of the nutrients within the plant. The nutrients chelated by fulvic acid can move more freely which prevents a number conditions like localized calcium deficiency which happen due to low mobility of nutrients.

The Significance of chelation process in soil

Plants require certain minerals and nutrients in order to convert water and carbon dioxide into glucose and oxygen.

1.**Increase the availability of nutrients**

In high pH soils, metal ions, such as zinc, magnesium and iron, are positively charged and react with negatively charged hydroxide ions, which are abundant in these soils. This makes the metals unavailable to plants. chelating agents help plants growing in these soils by protecting the chelated ions from reacting with chemicals like hydroxide to ensure that the ions are available to be taken up by plants. Within the structure of the chelate, the mineral is suspended between two or organic and amino acids (Tewari *et al*. 2018).

2. **Prevent mineral nutrients from forming insoluble precipitates.**

The chelating agents of the metal ions will protect the chelated ions from unfavorable chemical reactions and hence increase the availability of these ions to plants.

One example is iron in high pH soil In high pH soil, iron will react with hydroxyl group (OH^-) to form insoluble ferric hydroxide ($Fe(OH)_3$) which is not available to plants.

$$Fe^{+3} + 3\ OH \text{-------} \rightarrow Fe(OH)_3$$

Soluble Insoluble

Chelation will prevent this reaction from happening and hence render iron available to plants.

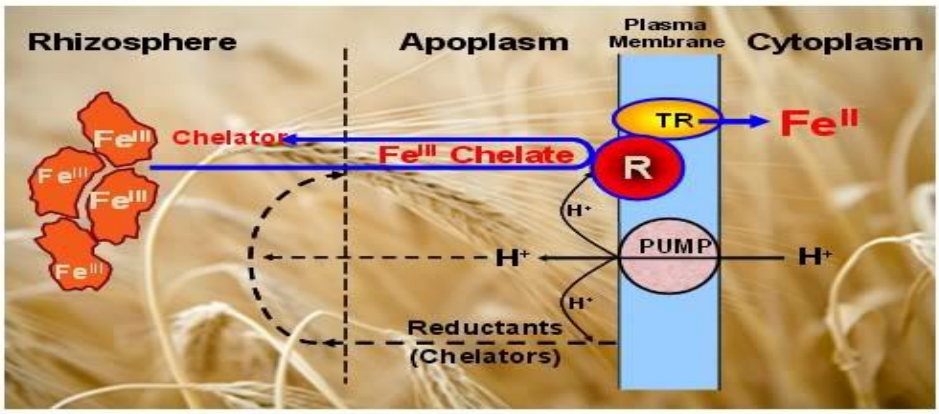

Fig 1. Cycling of chelating Iron in soil

3.**Reduce toxicity of some metal ions to plants**

Chelation in the soil may reduce the concentration of some metal ions to a non-toxic level. This process is usually accomplished by humic acid and high-molecular-weight components of organic matter. Brian Campbell in 2010 found that the organic matter application reduces the copper toxicity in tomato plants through chletaion

4. **Prevent nutrients from leaching**

Metal ions forming chelates are more stable than the free ions. Chelation process reduces the loss of nutrients through leaching

5.**Increase the mobility of plant nutrient**

Chelation increases the mobility of nutrients in soil. This increased mobility enhances the uptake of these nutrients by plants.

6. **Suppress the growth of plant pathogens.**

Some chelating agents may suppress the growth of plant pathogens by depriving iron and hence favor plant growth.

Table 3: Nutrient content of different chelating agents

Name	Nutrient content (%)	pH stability range
Iron EDTA	13	Acidic - neutral(1.5-6.5)
Iron EDTA	6	Slightly acidic- alkaline (1.5-6.5)
Iron DTPA	10	Neutral
Zinc EDTA	14	Acidic alkaline(2-10)
Copper EDTA	14	Acidic alkaline91.5-10)

Advantages of Chelates over Tradition Forms

The chelated forms of micro nutrients have a number of advantages over more traditional forms of trace elements such as oxides and sulphates.

1. Much lower quantities are necessary compared to inorganic compounds because they are completely assimilatable by crops. Chelates are thus cost effective even though they are a little more expensive.
2. Chelates are much more easily absorbed by plant roots or leaves because chelates are of organic nature. The chelation process removes the positive charge from the micro nutrients following the neutral or slightly negatively charged chelates to slide through the pores on the leaf and root surface more rapidly. Since these pores are negatively charged, positively charged micro nutrients would normally be 'fixed' at the pore entrance would be difficult to be assimilated by plants. When neutral chelated micronutrients are used there would be no such restriction barriers.
3. Chelates are more easily translocated within the plant as their action is partly systemic. Chelates are easily assimilated within the plant system.
5. The chances of 'scorching' of crops while using chelates is less because they are organic substances.
6. Under alkaline conditions, chelated iron, zinc, manganese and copper is a better way to provide micronutrients to a crop.
7. Chelates are compatible with a wide variety of pesticides and liquid fertilizers, as chelates do not react with their components. Most chelates can be mixed with dry mixes and liquid fertilizers.
8. Chelates are not readily leached from the soil as they adsorb on to the surface of soil particles.

Conclusion

Addition of chelating agents to the soil can bring metals into solution through desorption of sorbed species, dissolution of Fe and Mn oxides, and dissolution of precipitated compounds. Important consideration in the application of chelating agents for soil remediation, include complexing power, selectivity, and recoverability of the chelators with respect to heavy metal contaminants. EDTA has been the best chelating agents for removing heavy metals from soil. Use of chelated fertilizers is a new approach towards increasing the nutrient availability in soil. Chelated fertilizers are less reactive to soil conditions and can significantly enhance nutrient uptake and utilization efficiencies.

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AMFI-SI-45

SOIL HEALTH AND SUSTAINABILITY

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Abstract

A balanced soil functions as a complex living environment that provides a variety of environmental resources, including maintaining water quality and plant fertility, regulating soil nutrient recycling decomposition, and eliminating greenhouse gases from the atmosphere. Soil health is described as an integrative property that expresses a soil's ability to react to agricultural activity in order to continue to sustain both agricultural production and the provision of other ecosystem services. The most difficult aspect of sustainable land conservation is preserving environmental service delivery while increasing agricultural yields. It is suggested that soil quality is based on the preservation of four major functions: carbon transitions, nutrient cycles, soil structure conservation, and pest and disease regulation. Each of these functions is made up of a set of biological processes carried out by a diverse group of interacting soil organisms under the influence of the abiotic environment.

Sustainable agriculture is primarily concerned with the land fertility and reducing the negative impacts of farming activities on the atmosphere, soil, water, ecosystem, and human health. Reduces the use of non-renewable energy and inputs from petroleum-based goods in favour of renewable resources.

Introduction

Soil health is characterised as "the capacity of soil, within ecological and land-use boundaries, to act as a vital living system to preserve plant and animal production, retain or improve water and air quality, and promote plant and animal health." A soil's health is one of its most important characteristics. It is known as a set of characteristics that characterise and classify its fitness. Soil content, on the other hand, is an extrinsic property of soils that varies according to the intended use of that soil by humans. It may be related to farm production and wildlife support, watershed protection, or recreational outputs. Sustainable agriculture has been described as an alternative integrated approach for addressing both fundamental and applied issues in food production in an environmentally friendly manner. It combines biological, physical, chemical, and ecological concepts to create modern environmentally friendly activities. Furthermore, sustainability has the potential to assist in meeting global food agriculture

needs. Soil microorganisms (mostly bacteria and fungi) can convert nitrogen (N) from organic to inorganic forms, affecting plant mineral absorption, composition, and productivity. Microbial communities play an important role in fundamental processes that ensure the stability and productivity of agro-ecosystems.

Soil Biodiversity and Sustainability

The term "soil biodiversity" refers to all species that live in the soil. Soil biodiversity is characterised by the Convention on Biological Diversity as "variation in soil life, from genes to ecosystems, and the ecological complexes of which they are a member, ranging from soil microhabitats to landscapes." Soil microorganisms bind roots to soil, recycle nutrients, decompose organic matter, and react rapidly to changes in the soil biome, serving as reliable markers for particular soil functions. Microbial population functions and their interactions with soil and plant may provide a long-term soil ecological environment that supports crop growth, production, and yields. As a result, studying the functions, behaviour, and communication mechanisms of microbial communities in soil and plants is important for preventing unintended management activities until they do irreversible harm to the agro-ecosystem. Understanding microbial activities, in particular, can provide consistent diagnostics of long-term soil health and crop quality. Dense population use, climate change, and depletion of aboveground habitats, as well as overgrazing, soil organic matter depletion, deforestation, crop erosion, and land destruction, were all stressors on soil biodiversity. As a result, recognising threats to soil biodiversity and intervening to protect it is crucial for global agricultural sustainability. Decomposition, nitrogen cycling, and population control are examples of collective soil characteristics and processes. Overall, microbial communities' functional capacities in the soil for nutrient acquisition, mobilisation, fixation, recycling, decomposition, depletion, and remediation are linked to soil quality and agricultural sustainability.

Soil Health Components for Sustainable Agriculture

The concepts "soil health" and "soil quality" were used as indicators of soil condition, and their evaluation aimed to track the impact of current, historical, and future land use on agricultural sustainability. Soil salinization, acidification, compaction, crusting, fertiliser depletion, loss in soil biota biodiversity and biomass, water mismatch, and disturbance of elemental cycling are all examples of unsuitable farming activities that degrade soil quality. The most common biological indicator candidates were: Soil microbial taxa and community structure, Soil microbial community structure and biomass, Soil respiration, Multi-enzyme profiling, Nematodes, Micro arthropod, Soil fauna and flora, Soil invertebrates, Microbial biomass. Overall, defining soil health components is critical for the effective implementation of national and global agricultural monitoring systems, as well as the long-term viability of our agricultural systems. Pathogens are suppressed, biological activities are sustained, organic matter is decomposed, radioactive materials are inactivated, and nutrients, resources, and water are recycled in healthy soil. Soil quality is a term that refers to the biological characteristics and functions of soil, as well as their interactions with chemical and physical properties. Organic farming is becoming increasingly popular as the most productive agricultural method because it increases

not only physical, biological, and environmental services such as soil nutrient mineralization, microbial activity, abundance and diversity, and groundwater quality, but also yield and product quality.

Conclusion

Soil health assessment is based on soil quality variables that guarantee sustainability of crop production in agricultural lands. Improved soil health indicators are needed to better understand how production strategies and environmental factors affect the physical, biological, and chemical stability and dynamics of soil-rhizosphere-plant systems, as well as their impact on short- and long-term sustainability.

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AMFI-SI-46

SPIDER MITES A DEEP MENACE IN CARNATION UNDER PROTECTED CULTIVATION

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Introduction:

Carnation/ clove pink (*Dianthus caryophyllus*, Family: Caryophyllaceae) is one of the most beautiful and commercially important flower crops. Originated from Mediterranean region represent one of the leading cut flowers in both domestic and international trade market. Carnations have a sweet fragrance, with varying colours, like red, salmon, pink, purple, yellow, orange, white and in varied combinations. Due to its excellent keeping quality, a wide range of varieties being available for selection, and quality to withstand long-distance during transport attract farmers towards Carnation cultivation. Jammu and Kashmir leads the country in area and production of carnation with 2350 Ha and 110 MT, respectively (2015-16) (Ministry of Agriculture and farmers welfare, GOI).

Mites are among the most important arthropods in greenhouses, both as pests causing economic injury to greenhouse crops, and as natural enemies used in the biological control of pest insects and other mites. Because of their minute size, mites are much less well known than insects. Spider mites (Tetranychidae) are among the most important pests on many greenhouse plants. False spider mites (Tenuipalpidae), which are related to spider mites, sometimes also become pests on greenhouse plants. Several species of tarsonemid mites and eriophyoid mites injure both vegetable crops and ornamental plants. Acarid mites of the genus *Rhizoglyphus* damages the bulbs of flowers and stored roots of many crops.

Varieties:

Standard Types: Killer, Malaga, Delphi, Madame Colette, Varna, Solar, Lady Green

Spray Types: Estimade, Indira, Vera, Durago, Amore, Kiss Siga

Soil and Climate: Well drained and Red loamy soil with the pH of 6 is most suitable. Temperature should be within the range of 25° C - 27° C.

Season: Throughout the year as it is cultivated under controlled conditions.

Propagation and Planting: Plantlets/suckers – 5-10 cm terminal cuttings treated with NAA at 500 ppm for 5 minutes. Cuttings are dipped in Carbendazim 2g/lit. solution. Raised beds at 3 feet width and 45 cm height are formed at 45 cm interval and planting is done on top of the bed at 15 x 15 cm spacing.

Growing condition - Day temperature - 20-25° C Night temperature - 10-15° C Critical photoperiod - 13 hours RH - 50-60%

Irrigation: Irrigation @ 4-5 lit/m2 /day is provided with drip system once in 2-3 days according to soil moisture to maintain water holding capacity at 60% to 65%.

Manuring:
Basal: Neem cake 2.5 ton/ha. Phosphorus 400 g/100 sq.feet, Magnesium sulphate 0.5 kg/100 sq.feet.
Top dressing: Calcium Ammonium Nitrate + MOP at 5:3 ratio is mixed and applied @ 2.5 g/ plant/month.

Season of Flowering development and Harvest: Starts after 4 months of planting and continued up to one and half years. Daily harvest is made leaving bottom 5 nodes of stalk to facilitate side shoot development. To keep the stalk, erect, 4 – 5 stage stocking is provided.

Post-harvest Treatment: Citric acid is added to water to make the pH 4.5 to 5 and 5 mg of Sodium hypochloride is added to 1 litre of water. Cut flower stalk is soaked in this solution for 4 - 5 hours to improve vase life.
Grading: Based on stem thickness, stem length and quality of flower grading is done as A, B, C and D

Red spider mite- *Tetranychus urticae* Koch
Ubiquitous species that is common in greenhouses throughout the world. It is the most polyphagous species of spider mites and has been reported from over 150 host plant species. It attacks over 300 plant species in greenhouses. A recent checklist includes some 1,200 host plant species in 70 genera (Jeppson *et al.* (1975); Bolland *et al.* (1998)).
Appearance and damage symptoms: The eggs are laid singly on the under surface of leaves. They are spherical in shape and amber in colour, often with a distinct pale brownish spot or traces of red. Newly hatched six-legged larvae are yellow to orange in colour and become greenish after feeding. Eight-legged nymphs are yellowish green with dark spots, their bodies rounded in shape with short legs. Adult females are about 400-500 µm and males are smaller with a tapered hysterosoma. The females (summer form) are dark red in colour with two black spots on the dorsolateral idiosoma, with carmine colour extending to the eyes and the rest of the propodosoma is yellowish. Males are straw-coloured. Overwintering females are pale red or purple.

***Tetranychus urticae* Koch**

Damage symptom:

Two-spotted spider mites often feed on cell chloroplasts on the under surface of the leaf. The upper surface of the leaf develops characteristic whitish or yellowish stippling, which may join and become brownish as mite feeding continues. As mites move around, their webbing can span leaves and stems. Heavy damage may cause leaves to dry and drop, and the plant may be covered with webbing and may die prematurely. Heavily infested plant may be discoloured stunted.

Development occurs between 12 and 40°C. Developmental time from egg to adult decreases with increasing temperature and is less than a week at optimal temperatures for development (30-32°C). Under a diurnal temperature cycle of 15 to 28°C, developmental time is about 16 days. Males develop slightly faster than females.

Carnation under protected cultivation

Infested bud

Inflorescence showing damage symptoms

Control

- Chemical control of spider mites is becoming more and more difficult due to the rapid development of resistance in mites and the decrease of the number of registered acaricides for use. Abamectin is one of the most widely used chemicals in greenhouses.
- Plant varieties having straight and flat leaves Spray dicofol 18.5 EC @ 2 ml/lit or wettable sulphur 50 WP 3 g/lit.
- Apply Abamectin (Vermitec) 1.9EC @ 0.5ml/litre
- Spray Azadiractin 50,000ppm 3ml/litre
- Discard the plant and leaf debris.
- Biological control of *T. urticae* by phytoseiid mites is now widely used by the greenhouse industry in Europe, some parts of Asia and Africa, Australasia and North America. The most commonly used species are: *P. persimilis*, *P. micropilis*, *Neoseiulus californicus*, *N. fallacis*, *N. longispinosus* and *Galemdromus occidentalis*.

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AMFI-SI-47

SUCKING PESTS OF MULBERRY AND THEIR MANAGEMENT STRATEGIES

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Mulberry is prone to attack by numerous pests which cause abrupt reduction in leaf yield quality. The insect pests infesting mulberry are divided into four types such as sucking pests, defoliators, stem borers and subterranean pests. Among these types, the damage caused by sucking pests cause significant loss to the mulberry leaves. They suck the plant sap and cause mainly the reduction in leaf quality. While sucking sap, some of them inject toxic material into the plant, which causes abnormality on the growing part like tukra, drying up of leaf margin, etc. The important sucking pests are mealy bugs, leaf hopper, scales, spiraling white fly and thrips.

1. Papaya mealybug - *Paracoccus marginatus*

Papaya mealybug is a new record, exotic in origin and seems to have been introduced into India. It is an invasive pest on wide variety of commercial crops causing serious economical damage characteristics and biology. In the year 2008, it was recorded on papaya from Coimbatore in Tamil Nadu for the first time.

Biology

Small to medium sized, yellow coloured insects with mealy or waxy coating having oval to elongate insects with terminal or waxy filaments. Eggs are yellow in colour and laid in sac (400 - 500 egg) which is three to four times more than the length of the body and covered with white wax. Egg period is 7-14 days. Nymphs are yellow with 4-5 instars and live for a month. First instar nymph is referred to as "Crawler". Upon hatching it moves out and selects tender portions and starts feeding. Female has four developmental stages, whereas, the male has six developmental stages. Females are wingless and adult male has a pair of membranous wings; but short lived; die after mating.

Damage symptoms

- Malformation of affected portion due to toxin injected during feeding.
- Apical portions are affected initially. Thereafter it spreads all over the plant affecting even woody regions.
- Yellowing of leaves
- Stunted growth of leaf and plant
- Sooty mould on leaves and plants due to honey dew secretions of the pest.
- Movement of ants in the vicinity which help in spread of the mealy bugs.

Management

- Inoculative release of the exotic parasitoid, *Acerophagus papaya* in the pest infested hotspot areas; releases may be repeated if necessary
- Removal of weeds in and around the garden.

- Removal of affected portions and burn them to avoid further spread.
- A lycaenid predator, *Spalgis epius* larva voraciously feeds on different stages of mealybug. This may be conserved or collected and released in place of need.

2. Pink mealybug - *Maconellicoccus hirsutus*

Biology

Males have a pair of wings and two long waxy tails. Females are pink in color with a white waxy covering and have no wings. Each female lays approximately 350-600 eggs in an ovisac covered with cotton like mealy substance. The eggs period is 6-9 days. Males have four nymphal instars while females have only three. Nymphal period lasts for 23-27 days. Lifecycle is completed in 30 days and has 10-12 generations in a year.

Damage symptoms

Malformation of the apical shoots, retarded growth, wrinkling and curling of the affected leaves, become dark green in colour. Leaves become pale yellow on severe infestation. Affected portions become brittle. Symptoms are collectively called as Tukra (Bushy top) disease. Nymphs and adults suck the cell sap from tender leaves and buds. Nutritive value of leaves, leaf yield and plant height are drastically reduced.

Management

- Spraying Fish Oil Rosin Soap (FORS) @ 40 g/l
- Cutting the affected shoots and burning
- Releasing *Cryptolaemus montrouzieri* @ 750 beetles/ha

3. Thrips - *Pseudodendrothrips mori*

Biology

The eggs are bean shaped and whitish in colour. Each female lays about 30-50 eggs on ventral surface of tender leaves which hatch in 6-8 days. The newly hatched nymph is initially colourless and transparent with a pair of dark red compound eyes and gradually changes to light creamy yellow. The pupa is yellow coloured, characterized by two pairs of short wing pads and pupation takes place in soil. Female is yellow in colour, while male is darker. Life cycle is completed in 20-22 days and has 15 generations in a year.

Damage symptoms

In early stage of infestation streaks are observed on leaves. In advanced stages, the leaves become yellowish brown on maturity. Injure the epidermal tissues of leaves and desap. Early maturity, depletion of moisture, reduction in crude protein and total sugars. Leaves become unfit to rear silkworm.

Management

- Release of *S. coccivora* @ 500 adults or *Chrysoperla* @ 1000 eggs / acre, a week after the insecticide spray.
- Mulberry field should be thoroughly cleaned after harvest by removing small side branches, dead leaves and weeds in order to eliminate any developmental stages of thrips on them.

- Providing frequent irrigation helps in increasing the pupal mortality in soil thereby reducing the thrips emergence.
- Water jetting or sprinkler irrigation is effective in reducing thrips population.

4. Leaf hopper - *Empoasca flavescens*

Biology

Adults are pale green or greenish yellow in color. Body is wedge-shaped with whitish markings on the head and thorax. The head is prolonged forward as a smooth, flat, triangular structure with a pair of antennae possessing sensoria. The thorax is simple and abdomen is tapering at the posterior end. The hind legs have two parallel rows of spines which extend all along the hind tibiae.

Damage symptoms

Hopper burn, triangular dark brown spot at the tip and margin of leaves. Drying starts from periphery to midrib of leaf. Finally leaves become cup shaped and wither. Adults and nymphs attack the mulberry leaves from lower side of the margin of the veins and deplete nutritive value of leaves. Also suck the sap from the tender stems of the twigs.

Management

- Spray neem oil (2%) or fish oil rosin soap (2%) with a safe period is 15 days.
- Set up light traps and yellow sticky traps to destroy adult population.
- Spray of a strong jet of water in the affected mulberry garden help to reduce the pest population.

5. Spiralling whitefly - *Aleurodicus disperses*

Biology

Each female lays about 40-70 pale yellow coloured eggs with a short pedicel on the underside of leaf. The eggs are laid along with deposit of waxy secretion in a characteristic spiraling pattern, hence the name 'spiralling whitefly'. Incubation period is 4-6 days. There are four nymphal stages. The first instar nymphs are mobile (crawlers) and suck the sap from the tender leaves. Subsequent instars are immobile which are found on the underside of older leaves. They produce whitish waxy filaments and copious quantities of honey dew. The final instar is the pupa from which adults emerge. The nymphal period exist for 14-20 days. The adult flies are 2 mm in length with white powdery wax material over the wings and whole body. Life cycle is completed in a month and has 10-12 generations per year.

Damage symptoms

Adults and nymphs congregate on the lower surface of leaves. Desap the leaves, resulting in yellowish speckling on leaves. Leaves crinkle and curl and sooty mould appears. Infestation spreads from the bottom leaves to the top. Eggs are laid on lower leaves with irregularly spiralling deposits of waxy white flocculence. Desapping of the leaves. Depletes nutritive value of leaves. Nymphs and adults cause damage

Management

- Removal of weeds

- Spraying Fish Oil Rosin Soap @ 40 g/l or Neem oil @ 20 ml/lit.
- Collection and destruction of leaves with egg masses, nymphs and adults.
- Setting up light traps and yellow sticky traps

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WATER SAVING TECHNOLOGIES IN RICE

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Introduction

Rice is the major food for more than half population of the world. Water resources, both surface and underground are shrinking and water has become a limiting factor in rice production (Farooq *et al*., 2009). Irrigated low land rice not only consumes more water but also causes wastage of water resulting in degradation of land. Although the intensive water and labor requirements in transplanting rice in puddled fields are well known, technologies such as Aerobic rice, Semidry rice and alternate wetting and drying (AWD) could be an option to produce rice in both irrigated and rainfed rice ecosystems. Aerobic rice cultivation under direct seeding, and AWD in transplanted rice with suitable drought-tolerant varieties, will not only save water but also bring more areas under cultivation and increase rice productivity. Some of the water saving technologies are as follows.

Aerobic Rice- An eco-friendly rice farming

- Growing the rice like any other ID crop
- Land should be leveled properly
- Seeds are sown on dry soil with onset of monsoon.
- Seed rate 25 to 30 kg/acre.
- Inter row spacing 20-25 cm.
- Sown with seed drill /country plough or broadcasted.
- Depth of sowing 3-5 cm
- Pre emergence herbicide–Pendimethalin 1 L/acre or Pretilachlor + safener (Sofit) 0.6 L/acre
- Post emergence herbicide (15-20 DAS)-Bispyribac sodium @ 10 ml/acre.
- Field is maintained near saturation.
- Fe deficiency – Spray 3 to 5 g ferrous sulphate + 0.5 g citric acid per litre at weekly intervals.
- No methane emission.
- Reduced cost of cultivation (30%)
- Yield 1.6 to 1.8 t/acre.
- Water saving 40-50%.

Aerobic Rice

Alternate Wetting and Drying (AWD)

- Rice crop is subjected to alternate wetting and drying cycles
- Perforated PVC pipe of 15 cm radius, 40 cm length is installed in the field.
- AWD is initiated 2 – 3 weeks after transplanting
- Whenever water level drops 5 cm below the ground surface, crop is re flooded to 5 cm above the soil surface.
- One week before and after flowering, maintain water level up to 5 cm above the soil surface.
- Water Saving is 15-30%.

Alternate Wetting and Drying (AWD)- in Rice

Semidry Rice

- Any variety is suitable.
- Seeds are sown on dry soil with onset of monsoon.
- Seed rate 25 to 30 kg/acre.
- Inter row spacing 20-25 cm.
- Sown with seed drill /country plough
- Depth of sowing 3-5 cm

- Pre emergence herbicide–Pendimethalin 1 L/acre or Pretilachlor + safener (Sofit) 0.6 L/acre
- Followed by one hand weeding at 30 to 35 DAS.
- Grown under semidry condition up to 45 days.
- Converted to wet on release of water
- Pre-monsoon sowing with medium duration variety is an advantage for higher grain yield and as well to manage the heavy rainy season.

System of Rice Intensification (SRI)

- Transplanting of young seedlings with soil (8-10 days old).
- Line Planting with wider spacing 25 x 25 cm.
- No standing water during entire crop growth.
- Application of organic manure.
- Early and frequent weeding with cono weeder.
- Fields are kept un-flooded and the soil well aerated throughout the entire vegetative growth, while only a little water is kept on the field during the reproductive growth phase.
- Cost reduction (can reduce water, seed, labour and other inputs) and increased profitability.
- Resistance to pests and diseases.

SRI Cultivation

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AMFI-SI-49

INTEGRATED MANAGEMENT OF YELLOW MOSAIC DISEASE IN BLACK GRAM

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Black gram (*Vigna mungo* L.) is an important short duration pulse crop provides 24% protein, 60% carbohydrate, 1.3% fat, richest source of minerals, amino acids and vitamins. They play a vital role in improving the soil fertility by fixing atmospheric nitrogen. The main reason for low productivity is the susceptibility of crop to pests and diseases. A foliar disease known as yellow mosaic caused by the virus Mungbean Yellow Mosaic Virus (**MYMV**) is the most common, wide spread, destructive and economically important disease of black gram. They showed considerable yield loss ranging from 35 to 100 per cent.

Symptoms

Initially small yellow patches or spots appear on green lamina of young leaves. Soon it develops into a characteristics bright yellow mosaic or golden yellow mosaic symptom. Yellow discoloration slowly increases and leaves turn completely yellow. Infected plants mature later and bear few flowers and pods. The pods are also become yellow, small and distorted. Early infection causes death of the plant before seed set (Fig. 1 & 2).

Transmission by Vectors

Transmission is mainly by the tiny insect whitefly, *Bemisia tabaci* (Gennadius). Not transmitted through seed or sap or soil. Warm temperature, high humidity favours the whitefly population. A single viruliferous insect can transmit the virus but for 100 % transmission 10 viruliferous whiteflies per plant are required. They transmit the virus in a circulative persistent manner. Acquisition and inoculation by white flies can each be effected in a minimum time of 15 min. The latent period is less than four hours. They deliver the virus into the phloem cells of the plant. A viruliferous female and male adult in a population can retain infectivity for 10 days and 3 days respectively. Neither female whitefly nor male whitefly adults can retain infectivity throughout the life span. Female whitefly adults are over three times more efficient as vectors than male adults. The virus does not pass through eggs of whitefly. Nymphs of *Bemisia tabaci* can acquire the virus from diseased leaves. Pre-adult stages of whitefly could also acquire and transmit the virus into the plant cells.

Figure 1. Yellow mosaic disease infected blackgram plants under field conditions
Yellow plants are infected plants; Green plants are disease free plants

Figure 2. Yellow pods in the yellow mosaic infected blackgram plant under field conditions

Management

- Avoid sowing susceptible varieties during summer months instead cultivate the same crops during rabi season.
- Treat the susceptible seeds with imidacloprid 600FS @ 5 ml/kg of seeds.
- Selection of resistant varieties such as VBN 6, VBN 8, VBN 10, VBN 11 and moderately resistant varieties including VBN 9, MDU 1, CO 6 , ADT 6.

- Increase the seed rate (25 kg/ha) of susceptible varieties and rogue out the diseased plants up to 40 days after sowing. Finally optimum plant population with free of yellow mosaic disease can be maintained.
- Follow mixed cropping by growing two rows of maize (60 x 30 cm) or sorghum (45 x 15 cm) or cumbu (45 x 15 cm) as barrier crops for every 15 rows of susceptible black gram
- Maintain proper field sanitation by removing the weed hosts or alternate hosts periodically in the field.
- Removal and destruction of infected plant portions in early stage.
- Avoid heavy application of nitrogenous fertilizers during growth phase of susceptible varieties.
- Placing of yellow sticky traps at 5 per acre or light traps at one per acre to attract and kill the vector whiteflies.
- Spraying of 10% Nochi (*Vitex negundo*) Leaf Extract (or) 1% Tobacco Leaf Extract at 30 days after sowing.
- Spraying of 5% Neem Seed Kernel Extract (NSKE) or 3% Neem oil.
- Spray methyl demeton 25 EC 500 ml/ha or dimethoate 30 EC 500 ml/ha or thiamethoxam 75WG @ 100 g/ha or imidacloprid 17.8 SL @ 250 ml/ha or thiamethoxam 75 WS 1 g /3 lit and repeat after 15 days, if necessary.

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ZINC DEFICIENCY AND ITS CORRECTIVE MEASURE OF INDIAN RICE SOILS

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Introduction

Among the micronutrients, zinc (Zn) deficiency is considered as a major threat to the global and regional food security as it is the most deficient micronutrient in soils worldwide and more than 30% of soils have low Zn availability. Around the globe, it is estimated that 50% of agricultural soils devoted to cereal cultivation are potentially zinc deficient. Over two-thirds of the rice grown worldwide is produced on flooded paddy soils, which generally contain very low amounts of plant-available zinc. In high rice consuming areas, zinc deficiency caused yield reduction and Zn malnutrition in humans. Zn act as an essential component of many enzymes and controls several biochemical processes in the plants required for growth (IRRI, 2000). Compared with legumes, cereals are generally more prone to Zn deficiency leading to a substantial reduction in grain yield and nutritional quality Nonetheless, frequency of Zn deficiency is greater in rice than other crops. Total Zn contents in Indian soils ranged between 2 and 1,205 mg kg−1 compared to 10–300 mg kg−1 reported in soils of World. A significant correlation was reported between $CaCO_3$ and the Zn content of soils. Zinc availability is also dependent upon environmental conditions, plant species and their cultivars. Its deficiency is widely reported in flooded rice and in maize and wheat due to the slow release of Zn from soil organic matter complexes, as well as restricted root growth in the winter season leading to lower uptake of Zn by plants.

Role of zinc in plants

- Enzyme activation (carbonic anhydrase, alcohol dehydrogenase, Cu/Zn-superoxide dismutase and RNA polymerase)
- Auxin synthesis in plants is also controlled by Zn (its deficiency leads to leaf distortion and a shortening of Internodes)
- Photosynthesis, Protein synthesis, metabolism of carbohydrates, lipids, Auxins and nucleic acids, gene expression and regulation and reproductive development (pollen formation)

Reasons for zinc deficiency

High pH (close to seven or alkaline under anaerobic conditions). Solubility of Zn decreases by two orders of magnitude for each unit increase in pH. Zn is precipitated as sparingly soluble $Zn(OH)_2$ when pH increases in acid soil following flooding.

High calcareous soil: Adsorption or co-precipitation of zinc onto calcium carbonate particles in the presence of a large amount of free $CaCO_3$. HCO_3^- concentration because of reducing conditions in calcareous soils with high organic matter content or because of large concentrations of HCO_3^- in irrigation water.

Other Elements: Depressed Zn uptake because of an increase in Iron (Fe) , Calcium (Ca), Magnesium (Mg), Copper (Cu), Manganese (Mn), and Phosphorus(P) after flooding.
Formation of Zn-phosphates following large applications of P fertilizer. High P content in irrigation water (only in areas with polluted water).
Formation of complexes between Zn and organic matter in soils with high pH and high organic matter content or because of large applications of organic manures and crop residues.
The poor availability of zinc caused by water logging can be due to a relatively high pH, zinc being present as the insoluble sulphide (ZnS) and elevated concentrations of ferrous, bicarbonate, and phosphate ions Excessive liming.

Zinc deficiency in paddy

- Symptoms appear between 2 to 4 weeks after transplanting in case of paddy
- Dusty brown spots on upper leaves of stunted plants
- Uneven plant growth and patches of poorly established hills in the field, but the crop may recover without intervention
- Burning appearance of plants
- Reduction in yields
- Tillering in paddy decreases and can stop completely and time to crop maturity increases under severe Zn deficiency
- Increase spikelet sterility in rice
- Chlorotic midribs, particularly near the leaf base of younger leaves
- Leaves lose turgidity and turn brown as brown blotches and streaks appear on lower leaves, enlarge, and coalesce
- White line sometimes appears along the leaf midrib

Zinc Deficiency in india

In India, zinc is now considered the fourth most important yield-limiting nutrient after, nitrogen, phosphorus and potassium, respectively. In all over India showed that 48.5% of the soils and 44% of the plant samples were potentially zinc-deficient and that this was the most
common micronutrient problem affecting crop yields in India. Deficiency of zinc has increased in Southern States due to extensive use of NPK without micronutrients.

Periodic assessment of soil test data also suggests that zinc deficiency in soils of India is likely to increase from 49 to 63% by the year 2025 as most of the marginal soils brought under cultivation are showing zinc deficiency (Singh, 2006). Farming families consuming their zinc deficient crop produce leads to low zinc in their blood plasma compared to those which were fed on produce received from farms fertilized with zinc regularly. Zinc supplementation is therefore essential for maintaining high zinc content in soil, seed and blood plasma of human and animals (Singh *et al*., 2009).

State	1968-83	1983-89	1988-97	1997-2008
Punjab	53* (13341)	37 (6641)	27 (3142)	23 (3790)
Haryana	77 (14472)	52 (13350)	28 (7376)	19 (1702)
Uttar Pradesh	69 (6093)	62 (5570)	39 (20033)	36 (1259)
North India	66 (33906)	50 (25561	35 (30551)	24 (6751)
Bihar	54 (10779)	49 (6746)	66 (8435)	57 (721)
Madhya pradesh	63 (7643)	66 (8069)	38 (25224)	64 (1804)
Gujarat	26 (21994)	22 (18944)	18 (8158)	37 (943)
Central india	41 (40416)	38 (33759)	55 (41817)	55 (3468)
Andhra Pradesh	51 (4405)	52 (3304)	47 (3753)	45 (685)
Tamil Nadu	36 (7540)	48 (19433)	67 (25470)	74 (4581)
Sothern India	42 (11945)	49 (22737)	55 (6300)	70 (5266)

Singh *et al.* (2009)

Is Zinc fertilization really give profits?

Occurrence of Zn deficiency has been confirmed through the biological responses achieved in a large number of experiments on cultivator's fields conducted throughout India. A soil is classified as being 'responsive to Zn' only when it gave more than a 200 kg ha^{-1} increase in grain yield (Singh *et al.*, 2003). Further increases in economic yield of <200, 200–500, 500–1,000 and >1,000 kg ha−1 representing <6%, 6–15%, 15–30% and >30% responses with a basal application of 5 kg Zn ha1 were considered as indicative of 'high', 'marginal', 'low' and 'very low' fertility status of the soils (Singh, 2001). Based on the above criteria, 37%, 37%, 19% and 7% of the 5,807 trials conducted on farmers fields showed high, marginal, low, very low fertility status of Indian soils, respectively. Therefore, Zn fertilisation proved a highly profitable option in 63% of cultivated soils in India .

Zinc sources:

Highly soluble,

Zinc sulphate heptahydrate ($ZnSO_4.7H_2O$) (21–22% Zn),

Zn sulphate monohydrate ($ZnSO_4.H_2O$) (33% Zn),

Sparingly soluble,

Zn oxide (ZnO) (67–80% Zn),

Zn carbonate ($ZnCO_3$) (56% Zn),

Zn phosphate (Zn $(PO_4)2$ (50% Zn),

Zn frits (4–16%Zn),

Zn chelates,

Zn-EDTA (12–14% Zn)

Teprosyn-Zn slurry (55% Zn) are the important sources for ameliorating Zn deficiency.

Zinc sulphate is the most common source of Zn in India due to its high water solubility, easy availability and relatively low price compared with other sources and it is being widely used to correct Zn deficiency in different crops and soils.

Application of Zn-EDTA was found comparable to ZnSO4 in the calcareous soils of Pusa and Inceptisols of Hisar. It proved better than ZnSO4 in combating Zn deficiency in rice on loamy sand soils of Punjab, but the higher cost of chelates made them less popular than ZnSO4.

Blended sources of micro and macronutrients, like zincated urea, when added on a Zn equivalent basis to rice in calcareous soils produced comparable yields to those with $ZnSO_4$ and left significant residual effects to succeeding wheat crops compared with controls.

Zinc deficiency correction

- Generally, broadcast- plow down is the most effective method of application. Banding may be preferred in situations of shallow or minimum tillage.
- In season, zinc deficiency may be corrected by spraying the crop with a 0.5 percent zinc sulphate solution (1 percent for potatoes).
- Include a surfactant (wetting agent). Foliar applications are effective in greening foliage but are not as effective in producing yield response. Consider them as a salvage measure.
- Manure applications are quite effective in eliminating zinc deficiency problems when applied at the rate of 15 to 20 tons per acre.

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