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Recombination Breeding in Crop Plants

NEW RELEASE

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What is Plagiarism?

Many people think of plagiarism as copying another's work or borrowing someone else's original ideas. But terms like "copying" and "borrowing" can disguise the seriousness of the offense:

According to the Merriam-Webster online dictionary, to "plagiarize" means:

- to steal and pass off (the ideas or words of another) as one's own
- to use (another's production) without crediting the source
- to commit literary theft
- to present as new and original an idea or product derived from an existing source

In other words, plagiarism is an act of fraud. It involves both stealing someone else's work and lying about it afterward.

But can words and ideas really be stolen?

According to U.S. law, the answer is yes. The expression of original ideas is considered intellectual property and is protected by copyright laws, just like original inventions. Almost all forms of expression fall under copyright protection as long as they are recorded in some way (such as a book or a computer file).

All of the following are considered plagiarism:

- turning in someone else's work as your own
- copying words or ideas from someone else without giving credit
- failing to put a quotation in quotation marks
- giving incorrect information about the source of a quotation
- changing words but copying the sentence structure of a source without giving credit
- copying so many words or ideas from a source that it makes up the majority of your work, whether you give credit or not (see our section on "fair use" rules)

Most cases of plagiarism can be avoided, however, by citing sources. Simply acknowledging that certain material has been borrowed and providing your audience with the information necessary to find that source is usually enough to prevent plagiarism.

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1. BIOTECHNOLOGY 17266

Virus Induced Gene Silencing: Tools for Functional Characterization of Gene

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In this genomic era characterization of genes for knowing their function is obligatory. Reverse genetics is one of the approach used for this purpose. Virus–induced gene silencing (VIGS) is an important tool for gene function investigation by use of viral vectors having a target gene segment which generates dsRNA which elicit RNA-mediated gene silencing. Many plant viruses have been adapted for effective silencing of gene of interest in a sequence specific manner. Based upon the infection, plant species and purpose of silencing different types of approaches have been adapted and amended for the VIGS. Entry of gene of interest through viral vectors are accomplished on host plants by means of agro-infiltration and *in vitro* transcriptions. VIGS approach possess various benefits in comparison to other loss-of-gene function approaches. Some of them are speedy generation of phenotype, avoiding the necessity for plant transformation, relatively low cost and large scale studies in less amount of time. Moreover, this approach have restrictions to be overcome. Recently, virus-derived vectors are improved in such a way that they can silence more than one host plant such as TRV-derived viral vectors are utilized to silence Arabidopsis as well as *Nicothiana benthamiana*. Monocot plants can also be targeted as silencing host by the modified viral vectors for example, Barley stripe mosaic virus (BSMV) enabled VIGS silencing of monocot plants barley and wheat genes.

Origin and Types of Viral Vectors

Various virus species based upon their infection to dicot and monocot species were modified as viral vectors for silencing of gene of interest. Tobacco mosaic virus is one of the well explored vector system used to silence PDS (Phytoene Desaturase) gene in *Nicotiana benthamiana* plants. The entry of virus downregulate the target gene transcript through homology dependent degradation and thus can potentially use for the gene function analysis. Tobacco rattle virus (TRV) system was also used as a silencing tool in *N. benthamiana* and in tomato plants. This TRV based system is highly amenable and successful for the Solanaceous species. In this system gene of interest is cloned in TRV vector mobilized into agrobacterium and infiltrated into the plants. TRV vector is more vigorous and spread all over the plant through the vasculature while generating mild symptoms. Examples of TRV vectors are pYL156, pYL279 etc. TRV based vector system is also used for different crop plants. Very recently a viral vector derived from Turnip yellow mosaic virus (TYMV) was shown to have the ability to induce VIGS in Arabidopsis thaliana. Potato virus X (PVX) mediated gene silencing was also developed and used in N. benthamiana plant. PVX based vectors has more limited host range (only three families of plants are susceptible to PVX) than TMV based vectors (nine plant families show susceptibility for TMV) but PVX based vectors are more stable compared to TMV

Geminivirus derived vectors for example Tomato golden mosaic virus (TGMV) was used in *N. benthamiana* for studying meristematic genes. Satellite virus based vectors along with their helper virus were also used for VIGS and known as Satellite-virus induced silencing system, SVISS. For example Tomato yellow leaf curl China virus being helper and a modified satellite DNA was used to silence gene in *N. benthamiana*. For monocot species barley stripe mosaic virus (BSMV) was developed for efficient silencing of pds gene in barley. This system was then explored for silencing of wheat genes.

Methods used in VIGS

1. **PVX (Potato Virus X) - derived VIGS for potato silencing:** PVX is RNA virus and infects broad range of solanaceous plants. A PVX derivative vector, an agroinfection vector, pGR106, has been previously constructed for gene silencing. The vector was also used for the PVX mediated VIGS in leaves and tubers of potato plants
2. **TRV-derived VIGS for Solanaceous and other crop species:** The most widely used viral delivery vectors are Tobacco rattle viruses (TRV) because introduction of virus into plant including is easy in meristematic tissue. TRV mediated gene silencing was applied to many plant from diverse genus such as *Nicotiana benthamiana*, tomato, pepper (*Capsicum annuum*), potato (*Solanum tuberosum*), and petunia (*Petunia hybrida*) from Solanaceae family, opium poppy (*Papaver somniferum*), from Papaveraceae, and Arabidopsis thaliana a model organism. The TRV silencing in plants is usually mediated by *Agrobacterium tumefaciens*. TRV vectors pTRV1 and pTRV2 are placed between LB and RB sites separately. One of these vectors pTRV1/2 is constructed with GOI for targeted gene silencing.
3. **3-'One-step' TYMV-derived vector:** Turnip yellow mosaic virus is a positive strand of RNA virus from the genus Tymovirus, and infects

many Brassicaseae including Arabidopsis. Recently, a TYMV-derived vector used to induce VIGS in Arabidopsis. The TYMV-derived vector for efficient silencing includes inverted repeats of target gene fragments. The system has ability to silence the gene even expressed in meristem, and contains only a single vector. The other advantage of the TYMV mediated VIGS system that allows direct delivery of plasmid DNA to plant cells using rub-inoculation is the precluding of *in vitro* transcription, biolistic and agro-infiltration steps.

4. **Barley Stripe Mosaic Virus (BSMV) mediated silencing:** The BSMV contains positive strand tripartite RNA virus (α, ß and γ). Where γ genome can be used to make construct for silencing.

2. BIOTECHNOLOGY 17572

Spray Induced Gene Silencing (SIGS)

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Plant pathogens cause serious crop losses worldwide. Plant diseases caused by eukaryotic pathogens, such as fungi and oomycetes, have a devastating worldwide economic and agronomic effect on crop production. For example, *Fusarium graminearum* causes Fusarium head blight and Fusarium seedling blight in important cereal crops such as rice, maize, and wheat, as well as other crops such as soybean. Mycotoxins produced during the progression of these diseases are harmful to animals and humans and compromise food safety, putting a strain on the world grain industry. We should adopt new strategies to control these pathogens. As the spraying of chemical pesticide are increasing health complication in humans we should adopt new technologies and molecules for controlling the diseases. Current disease control methods are still mainly dependent on chemical sprays, which potentially have harmful environmental and health side effects, and induce fungicide-resistant pathogen strains. With the increasing world population, reduced farmland, and need for heightened global food security come the need for new sustainable, effective, and environmentally-friendly solutions to control plant diseases.

One of the such molecular strategies are the spraying of double-stranded RNAs (dsRNAs) and small RNAs (sRNAs) molecules targeting essential pathogen genes on plant surfaces which enable effectual crop protection. Spraying of these molecules termed as spray-induced gene silencing (SIGS). This strategy of disease control is possibly more sustainable and environmentally friendly.

A recent study demonstrated an effective RNA spraying method for controlling *F. graminearum* infections on barley. Arabidopsis and barley plants ectopically expressing a double-stranded RNA (dsRNA) targeting three important fungal genes which encode cytochrome P450 lanosterolC14/-demethylase significantly enhanced plant resistance to *F. graminearum* species by disrupting fungal membrane integrity.

In the consequent study spraying detached barley leaves with a 791-nt long-dsRNAs that complementary to fungal sequences prior to fungal infection reduces the disease. Further, spraying the RNA fragments of jelly fish green fluorescent protein (GFP) on barley leaves effectively silenced the expression of GFP in a GFP-expressing *F. graminearum* strain. This suggest SIGS is not sequence selective, and allows for targeting of any essential genes in various interacting pathogens. Thus, SIGS is a new innovative strategy for protecting crops from pathogen infection.

Such RNA-based disease control strategy is effective on both monocots and dicots. SIGS is powerful, fast, and environmentally friendly, which also circumvents the problems in creating GMOs. Strikingly, SIGS also conferred resistance against *F. graminearum* in unsprayed distal leaf parts. These dsRNAs were translocated into plant cells and tissues and the silencing signals were effectively spread to distal parts. RNA uptake has been only observed in a few organisms, and most mechanistic studies were performed in nematodes.

Thus, the RNAs sprayed on the plant surfaces have at least two possible pathways to get into fungal cells: the RNAs are taken up by the plant cells first and then transferred into the fungal cells, and/or the RNAs are taken up by the fungal cells directly. Fungal cells are likely to take up RNAs via both pathways spontaneously. To serve as an efficient disease control agent, a reasonable duration of efficacy is desired. The Northern blot analysis showed that the expression of CYP3-dsRNAs was not reduced even at 168 hours post spray of the local sprayed site, suggesting either these external RNAs were stable for seven days on the surface of the leaves and/or they were efficiently taken up and remained stable in the plant cells.

Reference

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3. BIOTECHNOLOGY 17688

India's 1st Edible GM Crop: Molecular Characterization of Mustard Hybrid DMH-11 and its Parental Lines

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Between 1995 and 2003, the *barnase – barstar* based system for hybrid seed production has been approved for use in *Brassica napus* (rapeseed, commercially known as Canola) in Canada, USA and Australia. Rapeseed is a crop that is closely related to Indian mustard (*Brassica napus*). Canada was the first country in 1996 to allow environmental release of lines containing the *barnase- barstar* and bar genes for commercial hybrid seed production. After that Canada has emerged as the biggest exporter of rapeseed oil, seed, and meal to Japan, China, Hong Kong and many countries around the world including India. Other countries are using the GM (Genetic modified) techniques and we are consuming it by exporting tonnes of oils every year. Scientists feel that there is no reason why India should be spending Rs 60,000 crore on importing edible oils that can be produced within the country. It's time for India to stand on GM crop.

DMH -11 is transgenic mustard had been developed by a team of scientists Centre for Genetic Manipulation of Crop Plants at Delhi University led by for former Vice-Chancellor Deepak Pental under Government sponsored project. It is a genetically modified variety of Herbicide Tolerant (HT) mustard. It was created by using "barnase/barstar" technology for genetic modification by adding genes from a soil bacterium that makes the mustard self-pollinating plant. DMH -11 (Dhara Mustard Hybrid) contains three genes *viz.* Bar gene, Barnase, and Barstar sourced from a soil bacterium. The bar gene had made the plant resistant to herbicide named Basta. This research program undergoes through a step by step process from research to technology development to generate data on food and environmental safety.

On the generation of data in laboratory and confined field trials under an authorized condition of RCGM and GEAC as per guidelines and protocol, the applicant submits the detailed dossier to GEAC for environmental release.

1. Molecular Characterization of GE (Genetic Engineered) Mustard DMH-11

It is necessary to undertake detailed molecular characterization of the entire introduced genetic elements and the GE plant produced thereof, for ensuring the safety of human, environment, and animals.

The Male Sterility: Fertility Restorer Technology

GE technology based hybrid seed production system has utilized genetic diversity available in *B. Juncea* to produce a hybrid that shows heterosis for yield. The hybrid breeding system developed in *B. Juncea* (Indian mustard) which consists of a *barnase* gene containing line the confers male sterility (MS) and a *barstar* gene containing the line that restorer fertility (RF). A pollination control mechanism is required to disallow self-pollination because *Brassica juncea* is predominantly self-pollinating crop.

Initially, two *B. juncea* varieties, mainly, RLM 198 for *barnase* gene and varuna for the *barstar* gene were used for genetic transformation experiments, along with bar gene as a selectable marker in both the construct. Punjab Agriculture University developed mustard variety RLM198 through a combination of mutation and recombination breeding. Later, the *barnase* elite event (bn 3.6) was transferred to Varuna genotype of *B. juncea* by backcrossing while the *barstar* gene construct event (modbs 2.99) was used to transfer the barstar gene to EH -2 (European gene pool lines) via backcross breeding. EH-2 is developed from east European material by the University of Nagpur. This combination of male sterile (*barnase*) and restorer (*barstar*) lines in *B. juncea* has been used to develop hybrid DMH-11.'

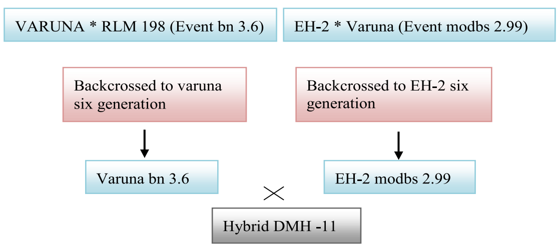

FIG 1: GE events to productive lines for developing hybrid DMH-11

Gene Construct: The Sources of Introduced Genes and their Product

- The *barnase* and *barstar* genes are derived a commonly occurring soil bacterium from *Bacillus amyloliquefaciens*, which colonizes plant roots.
- The *bar* star gene introduced into both the MS and RF lines is derived from *Streptomyces hygroscopicus*, a saprophytic soil-borne

microbes and are not reported to be pathogens of human or animals.

- Promoter *TA29* is derived from *Nicotiana tabacum* which regulate expression of *barnase* and *barstar* genes in tapetum layer cells.
- Promoters *CaMV 35S* (Cauliflower mosaic virus) and AMV leaders sequence (Alfalfa mosaic virus) are used to derive bar gene expression in the *barnase* gene construct.
- Terminator poly –A signal sequences *35S poly (A)* signal (35SpA) derived from Cauliflower mosaic virus is used for transcription termination sequence for *barnase* gene and *barstar* gene.
- Terminator poly –A signal sequences *osc poly (A)* signal derived from *Agrobacterium tumefaciens* is used for transcription termination sequence for *bar* gene in both gene construct.

GE Brassica lines *i.e.*, Varuna bn 3.6 (MS) and EH-2 modbs 2.99 (RF) were developed by Agrobacterium mediated genetic transformation through T-DNA transfer. Insertion of any vector sequence other than T-DNA into plant genome would have been eliminated after six backcrossing.

2. Characteristics of Inserted Genetic Material and Stability of Genetic Modification

Expression at protein level: Quantitative enzyme-linked immunosorbent assay (ELISA) was performed to detect presence and level of expression of the three proteins (*barnase*, *barstar*, bar) in GE events.

Barnase protein expression was detectable only in the bud of DMH-11 *i.e.*, 0.190 ng/gm of total protein. *Barstar* protein expression was detectable at a very low level in buds of EH-2 modbs 2.99 and hybrid DMH-11 *i.e.*, 0.150 ng/ gm. Negligible level of *barstar* protein was detected in other parts of EH-2 modbs 2.99 and DMH-11. *Bar* protein was found to be expressed in all the three lines, with low levels in leaves and barely detectable in the seeds.

It is scientifically proved that proteins/genes present in GE mustard are not present in leaves and seeds. The edible plant parts of Indian mustard are mainly seeds and leaves. Seeds of GE hybrid DMH-11 to be used for oil extraction and meal, contain only traces of the Bar protein. Seeds do not have any detectable levels of either *barstar* or *barnase* protein.

It only contains fat, so there are no threats to human and animals due to the absence of protein in mustard hybrid DMH-11.

To the standing crop but also to the succeeding crop. The improvement of soil physical properties due to organic farming has spatio-temporal dimension also.

Impact of Organic Inputs on Chemical Properties of Soil

Organic farming has potential to maintain soil fertility and increase organic carbon in soil. Application of different organic inputs like FYM, vermicompost, green manuring etc. ensures both the sustainability of soil organic carbon and supply of nutrients to the plants. Application of good quality FYM improves the total nitrogen and organic matter in the soil, which is "an important substrate of cationic exchange and the warehouse of most of the available nitrogen, phosphorus, and sulphur the main energy source for microorganisms; and is a key determinant of soil structure". Significant differences and higher values of soil organic carbon, carbon stocks, and carbon sequestration rate were observed in organically managed plots compared to non-organic plots. It is undoubtedly an important controlling factor for C:N ratio, total and available N, N mineralization, soil moisture, microbial activity, and soil texture. Strikingly, several studies have reported that organically amended soil holds more available N than the soil receiving inorganic fertilization, mainly due to relatively slower and constant mineralization rates, ultimately decreasing nitrogen leaching. Organic acids and humus fraction of decomposing matter are more efficient in releasing phosphorus and reducing its fixation in soil. Nutrient supply through organic sources also ensures micronutrient availability to the plant.

Impact of Organic Inputs on Biological Properties of Soil

Soil micro-organisms are the living part of soil organic matter present in the soil. The microbial biomass and microbial activities in soil are crucial to sustain the productivity of soil. For ensuring consistent release of nutrients to the plants, there is a need to have balanced ratio of microbial biomass and activity in soil. Organic farming is reported to have enhanced both microbial biomass and microbial activity by 20-30% and 30-100%, respectively. The soil having high organic matter content ensures greater microbial activity and greater soil N supplying power than the soil having less organic matter (which is managed inorganically). In addition to this, soil organic matter has a capacity to sink the atmospheric CO_2 and thereby increasing the carbon content in the soil, which further enhances the microbial biomass and respiration. It has also been well documented that the organically managed soil enriched with several beneficial microorganisms like arbuscular mycorrizal fungi for ensuring improved crop nutrition and decreasing soilborne diseases. Arbuscular mycorrizal fungi is a special fungal group, which makes symbiotic association with the plant's root system enhancing plant nutrient uptake and water absorption.

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4. MICROBIOLOGY 17155

Plant-Microbe Interactions in Remediation of Contaminated Soil

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INTRODUCTION: The soil is an important habitat to thousands of organisms associate, among the microscopic ones, wide variety of fungi, actinobacteria, algae, protozoa and bacteria. The microorganisms can occur in association to clay particles or organic matter, in the rhizosphere of plants and in small colonies in the pores among the particles. Microbial–plant interactions were largely investigated; however, about the plant– pathogen interactions. Only ten years ago, the ecology of microbes in the rhizosphere was focused to many kinds of decontamination processes.

Plant–Microbes Interactions

The rhizosphere defined by Hiltner as the volume of soil is influenced by the roots of plants can be defined as the three units interacting: the plant, the soil and the microorganisms. The composition of rhizosphere structure is highly orientated by the type of plant, quantity and composition of root exudates and different root zones. The root-associated microorganisms establish a synergism with plant roots and can help the plant to absorb nutrients improving plant performance and consequently the quality of soils. Soil bacteria: beneficial microorganisms for plants Bacteria may interact with and affect the growth of plants in a variety of ways. Some bacteria are phytopathogenic and actively inhibit plant growth; others (plant growth-promoting bacteria) can facilitate the growth of plants using a wide range of different mechanisms; and there are a large number of soil bacteria that do not appear to affect the growth of plants one way or the other, although this may vary as a function of a range of different soil conditions. With the discovery of a number of soil microorganisms that are capable of degrading xenobiotic chemicals including herbicides, pesticides, solvents, and other organic compounds; microbial degradation might provide a reasonable and effective means of disposing of toxic chemical wastes. Due to the sensitivity and the sequestration ability of the microbial communities to heavy metals, microbes have been used for bioremediation; although microbial communities in metal-polluted bulk soils have been studied, there is little information on the composition of microbial community in the plant rhizosphere growing in soils highly polluted with heavy metals.

Rhizoremediation of Organic Contaminants by PGPR's

Plant growth promoting microbes as rhizosphere inoculums are receiving attention in profitability of phytoremediation process; this partly depends on the plant's ability to withstand metal toxicity and to yield adequate biomass. The PGPR (plant growth promoting rhizobacteria) are defined by three intrinsic characteristics: the organisms are capable of colonizing the root; the organisms have capability for survival, proliferation and competition in microhabitats associated with the root surface; and the organisms are able to promote plant growth. The PGPR have been divided into two groups: those that are found to be involved in nutrient cycling and phytostimulation, including fixing atmospheric nitrogen and supply it to plants, synthesizing siderophores which can sequester iron from the soil and provide it to plant cells, synthesizing phytohormones such as auxins, cytokinins and gibberelins, solubilizing minerals such as phosphorous, making them more readily available for plant growth and synthesizing the enzyme ACC-deaminase, which can lower ethylene levels; and those that are found to be involved in the biocontrol of plant pathogens resulting from any one of a variety of mechanisms including antibiotic production, depletion of Fe from the rhizosphere, induced systemic resistance, production of fungal cell wall lysing enzymes, and competition for binding sites on the root. Although PGPR was first used for prompting the plant growth and for the biocontrol of plant diseases, much attention has recently been paid on bioremediation of contaminated soil with PGPR. In contrast with inorganic compounds, microorganisms can degrade and even mineralize organic compounds in association with plants. Bacteria is capable of degrading certain kind of organic pollutant, such as polychlorinated biphenyls (PCBs) have been isolated from a range of sites and the pathways and encoding genes have been known. But most of these bacteria cannot survive in the near-starvation conditions found in soils, including in the rhizosphere region.

Rhizoremediation of Metals Facilitated by PGPR's

A large number of plants have been tested for their ability to take up high levels of metals and then translocate those metals from roots to leaves and shoots, however, many so-called hyperaccumulating plants do not produce sufficient biomass to make this process efficient. The use of soil bacteria (often plant growth-promoting bacteria) as adjuncts in metal phytoremediation can significantly facilitate the growth of plants in the presence of high (and otherwise inhibitory) levels of heavy metals.

Conclusion: The root exudates provide an abundance of energy for the microbial transformation of organic compounds in the resolver zone. Soil microorganisms are also known to produce biosurfactants for facilitating removal of organic pollutants. Direct detoxification of metals by utilization of root exudates (through forming chelates with metal ions) can be carried out in such soils contaminated with heavy metals. The PGPR has important roles in facilitating plant growth on soils contaminated with both heavy metals and organic compounds and detoxification of soils and is exploited for phytoremediation purposes.

5. MICROBIOLOGY 17412

Quorum Sensing

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INTRODUCTION: Quorum sensing is the capability to detect and response to cell population density by gene regulation. This process enables the bacteria to restrict the expression of specific genes to the high cell densities at which the resulting phenotypes will be most beneficial. It is a cell to cell communication process that capable the bacteria to collectively modify behaviour in response to change in the cell density and species composition of the surrounding community.

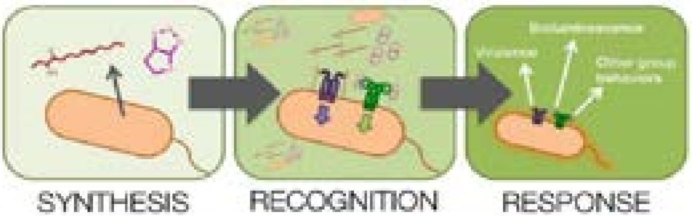
Quorum sensing was discovered and described over 25 years ago in two luminous marine bacterial species, *Vibrio fischeri* and *Vibrio harveyi* by Nealson in 1960 [1]. In both species the enzymes responsible for light production are encoded by the luciferase structural operon lux CDABE and light emission was determined to occur only at high cell-population density in response to the accumulation of secreted auto inducer signalling molecules [1]. Auto inducers which are involves in the quorum sensing are the extracellular signalling molecule. When the bacterial density increases the auto inducer molecules accumulated in the environment. Quorum sensing controlled many processes such as bioluminescence, the secretion of virulence factors, the production of public goods and the formation of biofilms, are unproductive and costly when undertaken by a single bacterial cell, but become effective when undertaken by the group [2].

Quorum Sensing Interaction between Plant and Bacteria

Bacteria community communicate with plant by quorum sensing process. Plants produced and secretes some auto inducer type's molecules that disturbed and manipulate quorum sensing regulated behaviour in bacteria, secreted auto inducers mimic the AHL compound (circle /square, triangle/square.).

Steps in Quorum Sensing

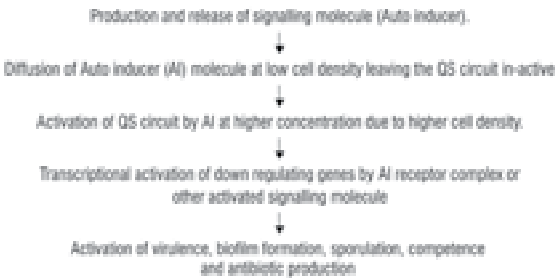
In bacterial cell quorum sensing basically competed in three steps.



These steps are:

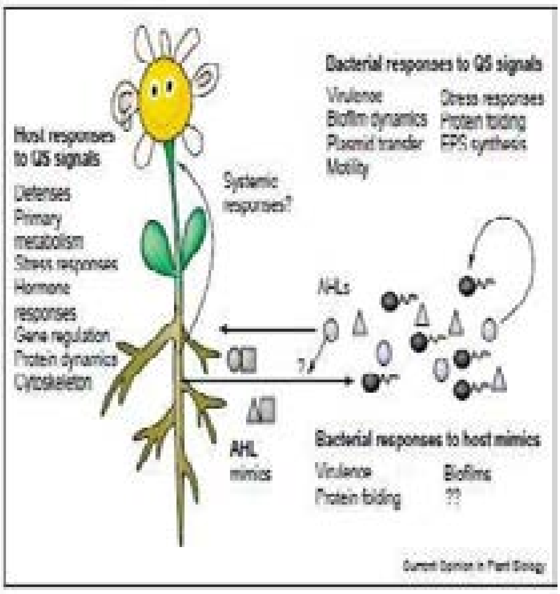
1. **Synthesis:** in this step bacterial cell synthesize some auto inducer which help them to Communicate with other cells.
2. **Recognition:** In this step the cell surface receptors recognize the auto inducers.
3. **Response:** In the last step bacterial cell give the response according to the types of secreted auto inducers.

Quorum Sensing in a Nut Shell

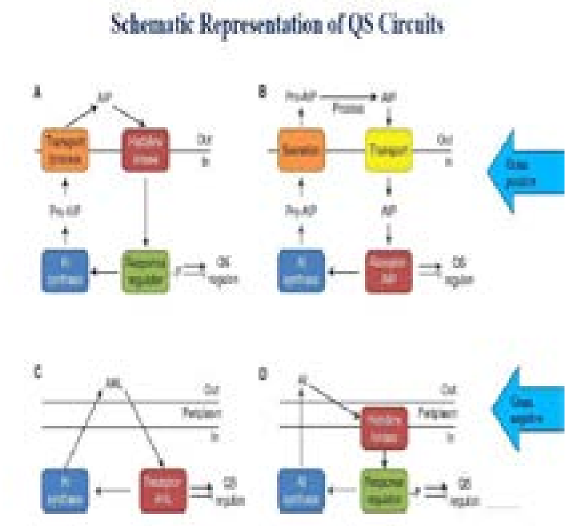


Quorum Sensing in Bacteria

Both Gram-positive and Gram-negative bacteria use quorum sensing. Gram-positive bacteria generally use secreted oligopeptides typically 8- 10 amino acid long and two-component systems, which consist of membrane-bound sensor kinase receptors and cytoplasmic transcription factors that direct alterations in gene expression. These Oligopeptides excretes in extracellular environment via active transport. While Gram –negative bacteria use acyl homoserine lactones (AHLs). AHLs diffuses extracellular and intracellular via passive transport.



Schematic model of QS-related interactions between plants and bacteria



Conical bacterial quorum sensing (QS) circuits. Auto inducing peptide (AIP) QS in Gram positive bacteria by (A) two componenent signalling or (B) an AIP – binding transcriptional factor. Small molecule QS in Gram –negative bacteria by (C) a LuxR –type system, or (D) two –component signaling.

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6. MICROBIOLOGY 17452

Earthworms and Microoganisms

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Earthworms, annelids of the class Oligochaeta, are ubiquitous and amongst the most ancient of terrestrial animal groups. They play a crucial role in sustainable agriculture, by formation and maintenance of fertile soils as they recycle organic matter and also as indicator species for environmental health. Charles Darwin was one of the first scientists to give information about the importance of earthworms to soil fertility, and thus human survival. Earthworms are a major component of the soil macrofauna and as ecosystem engineers have significance in all these processes and roles, either directly by working within the soil or indirectly by influencing macro, meso-, and micro- organisms. The digestive system of earthworms consists of a pharynx, oesophagus and gizzard followed by an anterior intestine that secretes enzymes and a posterior intestine that absorbs nutrients. Through the digestive system the earthworms mechanically mix mineral particles and organic matter which results in increasing or decreasing the activity and number of beneficial or pathogenic microorganisms. Symbiotic interactions between earthworms and microorganisms are of great importance as they are involved in the breakdown of the organic matter, finally incorporating it into water-stable aggregates. The bacterial species reported within the intestines of the earthworms belong to the genuses Bacillus, Aeromonas, Pseudomonas, Flavobacterium, Nocardia, Gordonia, Vibrio, Clostridium, Proteus, Serratia, Mycobacterium, Klebsiella, Azotobacter and Enterobacter. These bacteria inhabit the soil and develop considerably when there are easily degradable organic soil nutrients. The bacterial community inside the digestive tract of earthworms pertains to at least four physiological groups: plant growth promoters, free-living nitrogen fixers, biocides and phosphate solubilizers. The diversity of bacterial communities within the digestive tracts of earthworms depends on climate, soil type and organic matter. Earthworm castings are rich in nutrients and support a diverse microbial community. Castings are also rich in calcium humate, a binding agent that reduces desiccation of individual castings and favors the incubation and proliferation of beneficial organisms, such as *Trichoderma* species, *Pseudomonas* species, and mycorrhizal spores. They are key in important soil processes such as denitrification, nitrification, nitrogen fixation, methane oxidation and growth hormone production. The mineral nutrients in earthworm casts and lining earthworm burrows are in a form readily available to plants. There is evidence that interactions between earthworms and microorganisms not only provide these available nutrients, but stimulate plant growth indirectly in other ways. Earthworms have complex interactions with microorganisms that can lessen or increase plant disease attack. Earthworms increase communities of gram negative bacteria and concluded that any disease suppression was mediated by enhancing beneficial microbes. Although other microbial communities have been associated with disease suppression, such as filamentous actinomycetes and Mn-reducing microbes. Earthworms are known as soil-engineers that modify soil properties that may favor or suppress different microbial populations. The gut of the earthworm constitutes a unique microenvironment in soils. The selective digestion of microbes in the gut influences the type of nutrients that are available for subsequent assimilation by both the earthworm and members of the gut microflora. The variation in the microbial populations in the earthworm gut may be because of their nutritional needs and digesting ability of the earthworms.

7. MICROBIOLOGY 17507

Roles of Plant-Microbe Interaction for Improving Abiotic Stress Tolerance in Plants

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Agriculture is considered to be one of the most vulnerable sectors to climate change. Abiotic stresses comprise drought, low/high temperature, salinity, acidic conditions, light intensity, submergence and nutrient starvation are becoming a serious threat to crop production. Economic losses due to increasing temperature and drought are being witnessed as a result of global warming and climate change. Extensive research is going on for mitigation through the development of tolerant varieties, shifting crop calendars, resource management practices etc. while most of the technologies are cost intensive and long term processes, resent studies indicate that microorganisms can also help crops to cope up with abiotic stresses. It involves the utilization of multi-faceted traits of several microorganisms with an established role in plant growth promotion, nutrient management and disease control. The last two decades have witnessed many reports on the utilization of such microbes for induction of tolerance against abiotic stresses.

Microbes are ubiquitous in nature and almost present in all extreme environmental conditions. Presence of microbes-*Rhizobium*, *Bradyrhizobium*, *Azotobacter*, *Azospirillum*, *Pseudomonas* and *Bacillus* has been reported from extreme environmental conditions in India. Adaptation mechanisms of microorganisms to combat extreme conditions includes the ability of forming biofilm and exopolysaccharide production for enhanced water retention, production of osmoprotectants like proline, glycine betaine, trehalose etc., to modulate their cytoplasmic osmolarity, synthesis of heat shock and cryoprotective proteins and hormonal regulations.

Being important living component of the soils, microorganisms naturally become integral part of the plant system as soon as seed comes into the soil to start its life cycle. Microorganisms are important inhabitants of plants and form symbiotic associations at the surface, rhizosphere or endophytic interactions inside the roots, stems or leaves. Plant microbiome provides fundamental support to the plants in acquiring nutrients and resisting against diseases by various direct and indirect mechanisms. Microbial associations direct plant responses against abiotic stress. In the last decade, bacteria belonging to different genera including *Rhizobium*, *Bacillus*, *Pseudomonas*, *Pantoea*, *Paenibacillus*, *Burkholderia*, *Achromobacter*, *Azospirillum*, *Microbacterium*, *Methylobacterium*, *variovorax*, *Enterobacter* etc. have been reported to provide tolerance to host plants under different abiotic stress environments. Some of the mechanisms to alleviate abiotic stresses in plants by microbes are modulation of physiological status of the plant, production and regulation of phytohormones, ACC deaminase activity, protective metabolites production and accumulation, maintaining ion homeostasis, exopolysaccharide production, nutrient uptake enhancement, antioxidant mechanisms, regulation of stress responsive gene expression etc.

Auxins, ABA and Gibberelic acid production and regulation were reported by many microorganisms such as *Azospirillum*, *Acetobacter*, *Bradyrhizobium*, *Enterobacter*, *Pseudomonas*, *Rhizobium* etc. Microorganisms improve root biomass, surface area and volume of plants under water stress condition by regulating auxins production. ABA regulates transpiration rate by stomatal closure and stress signal transduction pathways. Reduced water loss and controlled transpiration rate by regulating ABA levels to cope up with salinity and drought stress was observed in microorganism inoculated plants. Under stress conditions, the plant hormone ethylene endogenously regulates plant homeostasis which leads to inhibition of growth and harmful effects on plants including senescence, chlorosis, and abscission. Degradation of the ethylene precursor ACC into 2-oxobutanoate and ammonia by bacterial ACC-deaminase lowers the ethylene concentration in plant roots, relieves the ethylene repression of auxin response factors synthesis, and indirectly increases plant growth.

Salinity causes an imbalance in the ratio of ion homoeostasis in the plant system. Rhizospheric bacteria were found to produce EPS which significantly decreased Na+ uptake in plants under saline conditions. EPS producing bacterial strains also enhances K+/Na+ which maintain photosynthesis machinery in plants under salt stress. Protective metabolites like Proline, glycine betaine are protecting membranes and proteins against the adverse effects of high concentration of inorganic ions and temperature extremes. Increased production of proline along with decreased electrolyte leakage, maintenance of relative water content of leaves and selective uptake of K+ ions under salt stress was observed in PGPR inoculated plants.

Plants inoculated with PGPR has enhanced nutrient uptake by fixation, solubilization and mobilization of nutrients, thus shown to have greater tolerance by improving plant health. The concentration of toxic reactive oxygen species (ROS) increases during various abiotic stresses. Studies on wheat showed that in susceptible varieties, both superoxide dismutase (SOD) and catalase (CAT) declined from the onset of drought; application of either *Bacillus safensis* or *Ochrobactrum pseudogregnonense* helped to maintain higher levels of the two enzymes and thus helped alleviate drought. Some other mechanisms of stress alleviation by plant microbe interaction include production of heat shock proteins, cryoproteins and induction and regulation of novel genes.

Plant associated microorganisms can play an important role in conferring resistance to abiotic stresses. The development of stress tolerant crop varieties through genetic engineering and plant breeding is essential but a long drawn process, whereas microbial inoculation to alleviate stresses in plants could be a more cost effective environmental friendly option which could be available in a shorter time frame. It can thus be hoped that, in coming years, such microorganisms could be routinely used in the field for sustainable agriculture and these will be available to farmers as low-input technologies.

8. MICROBIOLOGY 17514

Can we use Halophilic Archaea in Alleviating Salinity Stress in Agriculture?

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INTRODUCTION: Maintaining proper supply of food to ever increasing global population has come up like challenge in this 21 century which is predisposed to the vagaries of nature, some of which are of immense concern and should find solution in immediate future. Some of the critical problems are global scarcity of water resources, environmental pollution and increased salinization of soil and water, various environmental stresses *viz*. high winds, extreme temperatures, soil salinity, drought and flood which have adversely affected the production and cultivation of agricultural crops throught the world. The global population is estimated to increase to 10 billion in next 50 years. The cultivable soils are decreasing every year by 1-2 % due to salinity and drought in arid and semiarid zone globally. 50% increase in global production of food materials is needed to ensure food security to all the people on earth in near future. In the country like India which is second most populated after china and 6.72 Mha agricultural land out of 143 Mha total cultivable area is affected by salinity stress, the problem of food security is more serious.

Effect of Salinity on Agriculture

Salinity is one of the most brutal environmental factors because most of the crop plants are sensitive to salinity caused by high concentrations of salts in the soil, and the area of land affected by it is increasing day by day. For all important crops, average yield is 60-70% of the record yields, these losses are mostly due to drought and high soil salinity. Efficient resource management and crop/ livestock improvement for evolving better breeds can help to overcome salinity stress. However, such strategies being long drawn and cost intensive, there is a need to develop simple and low cost biological methods for salinity stress management, which can be used on short term basis. Microorganisms could play a significant role in this respect, if we exploit their unique properties such as tolerance to saline conditions, production of plant growth promoting hormones and their interaction with crop plants.

Halophilic Archaea in Agriculture

Out of various natural salinity tolerant organisms the Extreme Halophilic Archaea growing in the natural saltern areas of marine and coastal habitats are of special interest. Haloarchaea are members of phylum Euryarchaeaota (habitants of extreme environments like, high level of temperature, acidity, alkalinity and salinity). Archaea are an important component of biogeochemical cycles in different ecological habitats. Until late last decade it was believed that this primitive group of organisms occupy only extreme environmental niches. However, with advancement in the field of Metagenomics coupled with high throughput sequencing technologies, the perception of scientific community changed and large number of archaea from different habitats with normal environmental conditions were isolated including rhizosphere of various crops. Rhizospheric archaea assist the plants in sustaining the effects of drought and salinity by altering the level of osmoprotectants (carbohydrates, amino acids, proline), which helps in maintaining their membrane integrity under water deficient conditions as well as salinity stress. These rhizospheric archaea were also found to posses plant growth promoting attributes that assist in nutrient management such as solubilization of P, K and Zn. The role of microorganisms in plant growth promotion, nutrient management and disease control is well known. These beneficial microorganisms colonize the rhizosphere/ endorhizosphere of plants and promote growth of the plants through various direct and indirect mechanisms. The process of Conversion of atmospheric nitrogen to ammonia *i.e.* Biological nitrogen fixation (BNF) is performed in diazotrophic microorganisms, particularly bacteria and archaea. Leigh in 2000 reported the biological nitrogen fixation potential of Methanogenic archaea which brought broadened perspective to the field of nitrogen fixation. Biochemical and genetic studies show that nitrogen fixation in Archaea is evolutionarily related to nitrogen fixation in Bacteria and operates by the same fundamental mechanism. Phylogenetic analysis suggests that nitrogen fixation may have originated in a common ancestor of the Bacteria and the Archaea. Phosphorus (P) is an essential nutrient for plants, participating as a structural component of nucleic acids, phospholipids and adenosine triphosphate (ATP), as a key element of metabolic and biochemical pathways, important particularly for BNF and photosynthesis. Yadav and colleague in 2015 reported seven species of phosphate solubilizing halophilic archaea belonging eleven genera secreting seven different kinds of organic acids, namely: gluconic acid, citric acid, formic acid, fumaric acid succinic acid, propionic acid and tartaric acid from the cultures of these isolates which contributes to increased ability for phosphorus solubilization. Besides role in biogeochemical cycles of nutrients these haloarchaea have been found to produce various phytohormones like IAA (Indole-3-acetic acid) in much higher amount as compared to plant growth promoting rhizobacteria. Siderophores chelates the iron and makes it available to the producing microorganism and are also assimilated by plants through similar kind of transporters besides controlling the pathogen invasion through competition for iron and other nutrients also. A similar kind of functions were identified for nine halophilic archaea found to produce Siderophores. In addition to role as growth regulator ethylene also act as a stress phytohormone under abiotic and biotic stresses including drought, flood, salt, pathogen attack and contaminants like organic and inorganic compounds, inducing senescence and hampers growth of the roots and thus the growth of the plant as a whole. ACC deaminase activity which helps plant to overcome stress condition by degrading ethylene has also been observed in in-vitro studies.

Conclusion: Halophilic archaea have been long regarded as ideally suited for the investigation of salt dependent gene regulation because they can tolerate a wide range of salt concentration ranging from 1.2 M NaCl to saturation, it can be speculated that, the genes responsible for salinity stress tolerance are present in their genome and are being expressed constitutively. Thus the genomes of these Haloarchaea can be analyzed using bioinformatics tools which include both cross genome comparisons as well as integration of genomic data with experimental results. The system biology approach can be used to construct predictive models for genes expression in salinity stress conditions and metabolism. The various genomic approaches including structural and functional genomics can be used for comparing the genomes, their annotation, gene prediction and assigning the functions to them. Thus the studies shows that halophilic archaea can be exploited as potential tool for alleviating salinity stress in agriculture by using it either as Archaeal bio-inoculants directly in the field or in combination with the bacterial culture as consortium or the genes obtained after analysis of their genomes using various omics approaches.

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9. MICROBIOLOGY 17523

Met Genomics: An Emerging Science of Microbiology to Decipher Microbial Community Structure and Functioning

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INTRODUCTION: The microbiology field has undergone a paradigm shift in the last 30 years, changing both our view of microorganisms and the techniques used to study them. In the early 20th century, it was believed that a microorganism could not exist if it could not be cultured. This belief was overturned in the 1980s with the revolutionary work of Pace *et al.* in 1985, demonstrating that the unseen uncultured microbial diversity far outweighed the small range of microbes that had been cultured so far. Following this revelation a whole nascent field, metagenomics, was developed. Unprecedented insights of microbes that resisted cultivation analysis can be done using metagenomics. Intense effort was given to characterising the diversity of a huge variety of environments, from human intestines to deep sea vents, discovering many new phyla, genera and species.

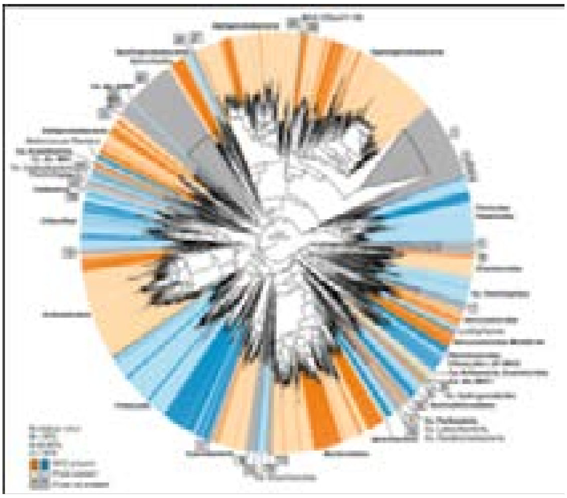
Metagenomics

The term metagenome was introduced by "Jo Handelsmann" in Wisconin University. Metagenomic data provides the opportunity to simultaneously explore two aspects of a microbial community: who is there and what are they capable of doing? High-throughput DNA sequencing technology with the ability to cheaply sequence DNA directly from environments and to discover not only what species they are but also what effects they have on their environments, has revolutionised microbiology. Metagenomics sequence reads can be taxonomically classified to identify the microbes, or functionally classified (gene functions, metabolic pathways, etc.) to identify the functional potential of the community. There exist two general approaches for characterizing the taxonomic content of environmental samples:

1. Shotgun sequencing whereby DNA extracted is sheared into tiny fragments using sonicator/ other instruments and sequenced independently. The billions of reads are made to align to various genomic locations for the myriads of genomes present in the sample, including non-microbes genomic DNA in the community sequenced.
2. "Amplicon analysis": sequencing of PCR amplicons corresponding to phylogenetic marker genes.

Deciphering Microbial Community Structure and Function

The sequence reads generated are assembled using assembler like, Meta-IDBA, MetaVelvet, MetaSpade and Ray-Meta etc. Annotation of the metagenomic assemblies predicts genes present therein. Taxonomic assignments involve use of the marker genes like, 16S rRNA, a universal phylogenetic marker gene and other single copy genes like GroEL, -subunit of DNA Gyrase and other housekeeping genes. Functional assignments of metagenomic reads may be made by comparing sequences against reference databases such as COG or KEGG, and tabulating the abundance by category and evaluating any differences for statistical significance. Comparative analyses of metagenomes can provide additional insight into the composition and function of complex microbial communities and their role in host health.



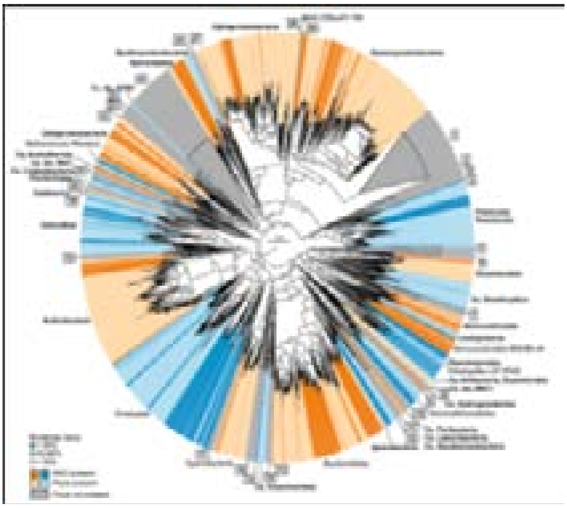


Fig: (A) Maximum likelihood phylogeny of Bacteria, (B) Maximum likelihood phylogeny of CPR and Archaea based on 16S ribosomal proteins.

Reconstruction of metabolic pathways can lead to discovery of new metabolic pathways or presence of previously known pathway in new genera or species *e.g.* Wood-Ljungdahl pathway in many more taxonomic groups than those encompassing known homo-acetogens, sulfate-reducers, and methanogens in hypersaline soda lake sediments of Siberian with a pH 10 and salt content between 70 and 400 g L–1. Metagenomic studies of this lake resulted into reconstruction of 871 metagenomes assembled genomes (MAG) and discovery of first extremophilic member of Candidate Phyla Radiation (CPR) along with many more novel uncultured members.

Limitations

These technologies however are not without their limitations: the short length of the reads requires the production of vast amounts of data to ensure all information is captured. This "data deluge" has been a major bottleneck and has necessitated the development of new algorithms for analysis and is the foundation on which the nascent field of metagenomics has been built. It has democratised sequencing and allowed researchers to gain unprecedented insights into diverse microbial communities.

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10. MICROBIOLOGY 17588

Pseudomonas fluorescens: A Potential Role in Biocontrol of Pests of Crops

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Environmental and consumer concerns have focused interest on the development of biological control agents as an alternative, environmentally-friendly strategy for the protection of agricultural and horticultural crops against phytopathogens. *Pseudomonas fluorescens* is one such proven biological control agent.

Pseudomonas fluorescens

Pseudomonas fluorescens, a non pathogenic saprophytes that colonize soil, water and plant surface environments. It is a common gram negative, rod-shaped bacterium. As its name implies, it secretes a pyoverdin - a water soluble yellow greenish fluorescent pigment known as fluorescein which is a type of siderophore, particularly under conditions of low iron availability. It has commensal nature with plants as they are nonpathogenic and lack virulence factors of plant pathogens. As because they are well adapted in soil, it has a simple nutritional requirements and grows well in mineral salts media supplemented with any of a large number of carbon sources. It grows at an optimum temperature of 25°C but can also survive in temperatures as low as 0°C. Therefore, it is rarely pathogenic in humans making it an effective microbe for treating crops since it is not able to survive in the human body.

Pseudomonas fluorescens strains are being investigated extensively for use in applications mainly for biocontrol of pathogens in agriculture and bioremediation of various organic compounds. They have been shown to be potential agents for the biocontrol which suppress plant diseases by protecting the seeds and roots from fungal infection. They are known to enhance plant growth promotion and reduce severity of many fungal diseases. *P. fluorescens*, protecting the roots of some plant species against parasitic fungi such as *Fusarium* or the oomycete *Pythium*, as well as some phytophagous nematodes. *Pseudomonas* species are effective against mold causing disease in produce such as apples and pears system.

Mechanism of Action

This bacterium enhances induced systemic resistance in the host plant, so it can better resist attack by a true pathogen. Plant treatment with *Pseudomonas fluorescens* can prevent pathogenic organisms from growing and spreading through spore production. Production of secondary metabolites including antibiotics, siderophores and hydrogen cyanide play an important role in plant disease suppression. It produces antibiotics such as pyrrolnitrin, pyoluteorin, and 2,4-diacetylphloroglucinol that inhibit phytopathogen growth. Among them, the anti-fungal metabolite 2,4-diacetyl phloroglucinol play a major role in the biocontrol capabilities of *P. fluorescens*. The production of siderophores like pyocheline and pyoverdine outcompete with many pathogenic bacteria for iron necessary for growth and suppress pathogens in the rhizosphere. Competitive exclusion of pathogens as the result of rapid colonization of the rhizosphere by *P. fluorescens* may also be an important factor in disease control. *Pseudomonas fluorescens* produces viscosin which is a peptidolipid that enhances antivirality. It also produces exopolysaccharides which are used for protection against bacteriophages or dehydration as well as for defense against the host immune. An another antibiotic compound, pyrollnitrin, which inhibits growth of fungi like *Macrophomina phaseolina*, *Alternaria cajani* and *Curvularia lunata* grow on plant surfaces causing disease and death of the plant. Diseases from *Rhizoctonia solani* and *Pythium ultimum* that affect cotton plants are also inhibited by this organism.

Conclusion: *Pseudomonas fluorescens* will determine its effectiveness as an alternative to chemical fungicides. They are commensal species with plants, allowing plants to attain key nutrients, degrading pollutants, and suppressing pathogens. It acts as a potential bio-pesticide for augmentative biological control of many diseases of agriculture and horticultural importance. Pseudomonas strains able to significantly control a number of fungal, bacterial and nematode diseases in cereals, horticultural crops, oil seeds and others. Besides disease control, treatments also improved seedling health and yields of crops. *P. fluorescens* as a potential bio-pesticide for augmentative biological control of many diseases of agriculture and horticultural importance.

11. MOLECULAR BIOLOGY 17436

Isolation of Genomic DNA From *E. coli*

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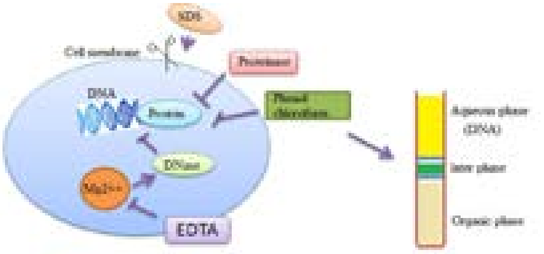
PRINCIPLE: The isolation and purification of DNA from cells is one of the most common procedures in contemporary molecular biology and embodies a transition from cell biology to the molecular biology (from *in vivo* to *in vitro*). The isolation of DNA from bacteria is a relatively simple process. The organism to be used should be grown in a favorable medium at an optimal temperature, and should be harvested in late log to early stationary phase for maximum yield.

The genomic DNA isolation needs to separate total DNA from RNA, protein, lipid, etc. Initially the cell membranes must be disrupted in order to release the DNA in the extraction buffer. SDS (sodium dodecyl sulphate) is used to disrupt the cell membrane. Once cell is disrupted, the endogenous nucleases tend to cause extensive hydrolysis. Nucleases apparently present on human fingertips are notorious for causing spurious degradation of nucleic acids during purification. DNA can be protected from endogenous nucleases by chelating Mg2++ ions using EDTA. Mg2++ ion is considered as a necessary cofactor for action of most of the nucleases. Nucleoprotein interactions are disrupted with SDS, phenol or proteinase K. Proteinase enzyme is used to degrade the proteins in the disrupted cell soup. Phenol and chloroform are used to denature and separate proteins from DNA. Chloroform is also a protein denaturant, which stabilizes the rather unstable boundary between an aqueous phase and pure phenol layer. The denatured proteins form a layer at the interface between the aqueous and the organic phases which are removed by centrifugation. DNA released from disrupted cells is precipitated by cold absolute ethanol or isopropanol.



Schematic Diagram Showing the Principle of Isolation of Genomic DNA from *E. coli*

Materials Required

LB Broth, E. coli DH5 cells, TE buffer (pH 8.0), 10% SDS, Proteinase K, Phenol-chloroform mixture, 5M Sodium Acetate (pH 5.2), Isopropanol, 70% ethanol, Autoclaved Distilled Water, Eppendorf tubes 2 ml, Micropipette, Micro tips, Microfuge.

Preparation of Reagents

1. **TE Buffer (pH 8.0):** 10 mm Tris HCl (pH 8.0), 1 mm EDTA (pH 8.0)
2. **10% SDS:** Dissolve 10 g of SDS in 100 ml autoclaved distilled water.
3. **Proteinase K:** Dissolve 10 mg of Proteinase K in 1 ml autoclaved distilled water.
4. **Phenol – Chloroform Mixture:** The pH is very important. For RNA purification, the pH is kept around pH 4, which retains RNA in the aqueous phase preferentially. For DNA purification, the pH is usually 7 to 8, at which point all nucleic acids are found in the aqueous phase. Mix equal volume of phenol with chloroform. Keep the mixture on ice and add 20 ml TE buffer, extract by shaking for 15 minutes. Remove the dust on the surface layer using a pipette. Repeat 4-5 times. Add 30-40 ml of TE buffer and store it on ice.
5. **5M Sodium Acetate:** Dissolve 41 g of sodium acetate in 100 ml distilled water and adjust pH with dilute acetic acid (pH 5.2).
6. Isopropanol
7. 70% Ethanol

Procedure

1. 2 ml overnight culture is taken and the cells are harvested by centrifugation for 10 minutes.
2. 875 µl of TE buffer is added to the cell pellet and the cells are resuspended in the buffer by gentle mixing.
3. 100 µl of 10% SDS and 5 µl of Proteinase K are added to the cells.
4. The above mixture is mixed well and incubated at 37^o C for an hour in an incubator.
5. 1 ml of phenol-chloroform mixture is added to the contents, mixed well by inverting and incubated at room temperature for 5 minutes.
6. The contents are centrifuged at 10,000 rpm for 10 minutes at 4^o C.
7. The highly viscous jelly like supernatant is collected using cut tips and is transferred to a fresh tube.
8. The process is repeated once again with phenol-chloroform mixture and the supernatant is collected in a fresh tube.
9. 100 µl of 5M sodium acetate is added to the contents and is mixed gently.
10. 2 ml of isopropanol is added and mixed gently by

inversion till white strands of DNA precipitates out.
11. The contents are centrifuged at 5,000 rpm for 10 minutes.
12. The supernatant is removed and 1ml 70% ethanol is added.
13. The above contents are centrifuged at 5,000 rpm for 10 minutes.
14. After air drying for 5 minutes 200 µl of TE buffer or distilled water is added.
15. 10 µl of DNA sample is taken and is diluted to 1 or 2 ml with distilled water.
16. The concentration of DNA is determined using a spectrophotometer at 260/280 nm.
17. The remaining samples are stored for further experiments.

Precautions

1. Cut tips should be used so that the DNA is not subjected to mechanical disruption.
2. Depending on the source of DNA the incubation period of Proteinase K should extended.
3. The phenol chloroform extraction should be repeated depending on the source of DNA to obtain pure DNA.
4. DNase free plastic wares and reagents should be used.

12. MOLECULAR BIOLOGY 17458

Special Types of Chromosomes

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Some tissues of certain organisms contain chromosomes, which differ significantly from normal chromosomes in terms of either morphology or function. Such chromosomes are referred to as special chromosomes.

Lampbrush Chromosome

These are the special type of chromosomes found in primary oocyte nuclei in amphibians. Lampbrush chromosomes are up to 1mm length. Each lampbrush chromosome contains a central axial region where the two chromatids are highly condensed and numerous pairs of lateral loops give them a characteristics lampbrush appearance. The loops are the transcriptionally active region of the single chromatids.

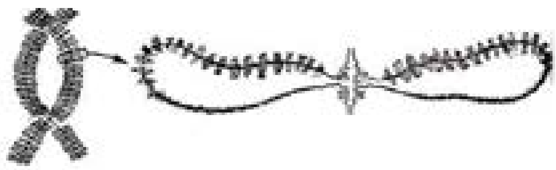

FIG. 1. Lampbrush Chromosome with a pair of loops highly magnified

Salivary Gland Chromosome / Polytene Chromosome / Giant Chromosome

The polytene chromosomes occure in the tissues of salivary glands, guts epithelium and malpighain tubules of many insects of the order Diptera. In salivary gland cells of dipteral species giant chromosomes were observed by E.G. Balblani for first time in 1881. The chromosomes may reach a size of 20 times or more than the normal chromosomes. These salivary gland chromosomes have characterstics of somatic pairing as a result, the number of giant chromosomes in the salivary gland cells always appears to half that in the normal somatic cells. Giant chromosomes have distinct pattern of transverse banding, which consists of alternate chromatic and achromatic regions. The band occasionally forms reversible puffs known as chromosome puffs or Balbiani rings which are associated with differential generation.

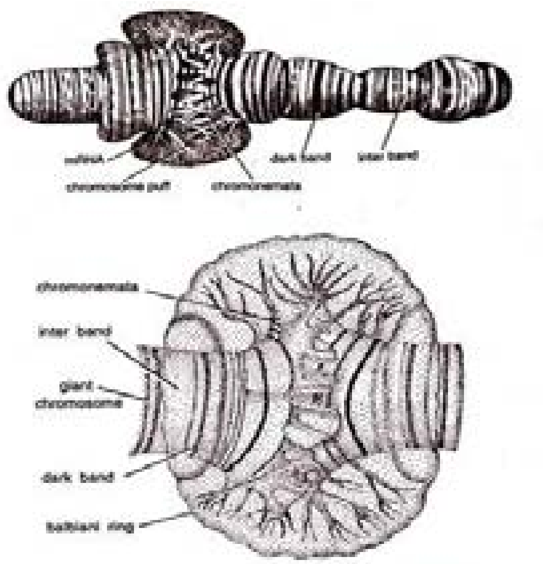

FIG. 2. Polytene chromosome with puff

Giant chromosomes represented by bundle of fibres, which arise by repeated cycle of endo reduplication of single chromatids (Endo – reduplication means chromatids replicates without cell division as a result of which number of chromonemata keep on increasing). That is why these chromosomes are also called as polytene chromosomes and the condition is refered to as polytene. The number of chromonemata per chromosome may be upto 2000 and in some cases it maybe aroung 16,000.

Iso-Chromosome

A chromosome with two identical arms and identical genes is called as isochromosome. The arms are mirror images of each other. It is thought to arise when a centromere divides in the wrong plane yielding two daughter chromosomes, each of which carries the information of one arm only but present twice. At meiosis isochromosomes pair in three different ways. (i) Internal pairing (ii) Fraternal pairing (iii) Normal pairing

In internal pairing, the two arms of the isochromosomes pair with each other. In fraternal pairing, one or both of the arms of the isochromosomes pair with a homologous arm of another chromosome. In normal pairing, the isochromosome pairs with another one just like it.

'B' Chromosome

It is a particular kind of supernumery chromosome that may or may not be found in organisms as extra chromosomes over and above the standard diploid or polyploidy chromosome complements. The standard complements are called 'A' chromosome.

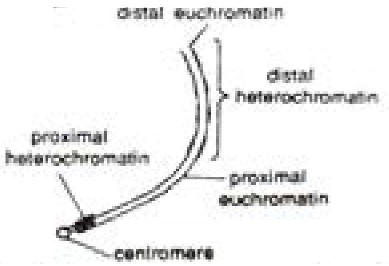

FIG. 3. Morphology of B-chromosome in Maize

Tahe 'B' chromosomes found in natural population are recognized on the basis of following characteristics.

i) They are dispensable (not found is all the individuals of the species or organisms)
ii) They are not homologous with any of the basic 'A' chromosomes.
iii) Their inheritance is non Mendalian.
iv) They are usually smaller than the 'A' chromosomes.
v) Generally they are genetically inert rarely organize nucleoli.
vi) When it present in higher number they suppress the vigour and fertility.

The most significant effect of 'B' chromosome is on seed and pollen fertility. Flowering time is generally delayed by 'B' chromosomes and has negative consequences for the organism as they have deleterious effect because of abnormal crossing over during meiosis.

Ring Chromosome

The chromosomes of higher organisms usually have two ends and do not form a continuous ring. However, the chromosomes of lower organisms such as prokaryotes. (*E. coli*) normally have ring shaped chromosomes. Often such chromosomes are referred to as genophores, which are more than 1 mm in length and consists of a single DNA molecule. Chromosomes in higher organisms are not naturally ring shaped. However ring chromosomes have been detected in humans, *Drosphila* and certain plant species. Ring chromosomes were most thoroughly studied in maize by Mc Clintock. Normal chromosomes do not form rings because they are believed to have telomeres on each end. Telomeres prevent the union of chromosome arms into ring formation. A chromosome can form a ring chromosome by fusion of the raw ends only if it has two terminal deletions producing centric segment with two raw ends and two acentric fragements. A ring chromosome lacks the genetic information that was carried by the terminally deleted fragments. Ring chromosomes are meiotically unstable and they are associated with several syndromes.

13. NANOTECHNOLOGY 17411

Nan Formulations: A New Approach for Smart Delivery of Pesticides

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The advent of agrochemicals has increased the food production substantially. However, the non-judicious use of these indispensable chemicals has led to serious ecological problems. Most of us are well aware that about 90% of applied agrochemicals never reach to their target in a definite time in the precise quantities due to leaching, surface migration, volatilization, fast degradation, etc. In modern agricultural crop management, increasing attention is being given to the production of new controlled release nanoformulations to overcome the above mentioned problems. The controlled release pesticide formulations are superior to conventional formulations in extending activity, reducing leaching, volatilization and degradation, minimizing residues on food stuffs and decreasing dermal toxicity. A broad variety of natural or synthesized materials are used in construction of nanoformulations of pesticides, such as metal, metal oxides, non-metal oxides, carbon, silicates, ceramics, clays, layered double hydroxides, polymers, lipids, dendrimers, proteins, quantum dots, and so on.

Types of Nanoformulations

The nanoformulations can be classified into the following categories:

1. **Nanoemulsion:** The term 'nanoemulsion' also refers to a miniemulsion which is fine oil/water or water/oil dispersion stabilized by an interfacial film of surfactant molecule having droplet size range 20–600 nm. The main components of nanoemulsion are oil, emulsifying agents, and aqueous phases. Because of small size, nanoemulsions are transparent. There are three types of nanoemulsion which can be formed: (a) oil in water nanoemulsion in which oil is dispersed in the continuous aqueous phase, (b) water in oil nanoemulsion in which water droplets are dispersed in continuous oil phase, and (c) bi-continuous nanoemulsions. The advantages of nanoemulsions are greater spreadability, wettability, and superior mechanical stability in comparison to normal emulsion. These characteristics of NEs are also found to be helpful in less degradation and volatilization of active ingredient (AI) and improve their bioavailability for longer period.
2. **Nanosuspension:** It is useful for molecules with poor solubility, poor permeability or both, which poses a significant challenge for the formulators. It is submicron colloidal dispersion of pure particles of pesticide stabilized by surfactants. Preparing nanosuspensions is preferred for the compounds that are insoluble in water (but are soluble in oil) with high log P value. By formulating nanosuspensions, problems associated with delivery of less water soluble pesticide and lipid-soluble pesticides can be solved. Conventionally, the pesticides that are insoluble in water but soluble in oil phase system are formulated in liposome, emulsion systems but these lipidic formulation approaches are not applicable to all pesticides. In case of pesticides that are insoluble in both water and in organic media instead of using lipidic systems nanosuspensions are used as a formulation approach.
3. **Nanoencapsulation:** Nanoencapsulation is the coating of various substances within another material at various sizes in the nano-range. The encapsulated material is commonly referred to as the internal phase, the core material, the filler or the fill, for instance pesticides. Various nanomaterials have already been used to encapsulate pesticides such as polymer based nanomaterials, solid lipid nanoparticles, inorganic porous nanomaterials, nano-clays and layered double hydroxides (LDHs), etc. The polymeric shell is usually composed of biodegradable polymeric, including poly-- caprolactone (PCL), polylactic acid (PLA), polyglycolic acid (PGA), poly (lactic-co-glycolic) acid (PLGA), polyethylene glycol (PEG), chitosan, etc. The polymeric shell degrades slowly in the environment, thus improves chemical stability for environment-sensitive compounds (*i.e.*, UV degradation and soil degradation). In addition, nanocapsules can increase the target delivery efficiency with membranel polymeric leaf-affinity modification, improving the behaviors of wetting, spreading and absorbing of droplets on leaves.
4. **Nanospheres:** Nanospheres are solid sphere vesicular systems where the pesticides are uniformly distributed through adsorption or entrapment inside the nano-matrix. Nanospheres are composed of organic polymer materials or inorganic mesoporous materials, such as activated carbon, non-metal oxides and porous hollow silica. While nanospheres can be synthesized by implementing the methods of nanocapsules synthesis, the polymerization technique plays the key role, for example emulsion or interfacial polymerization. Nanospheres possess high drug-loading capacity, good biocompatibility and slow/ controlled release pattern, showing great potential in soil borne pests.
5. **Nanomicelles:** Nanomicelles are ideal bioactive smart nano delivery systems for encapsulating pesticides. The amphiphilic block copolymers, polymers, surfactants, etc. play a vital role in the formation of micelles. Because of their amphiphilic properties, the materials are able to self-assemble to form spherical micelles in an aqueous solution by keeping hydrophilic ends as the outer shell and the hydrophobic ends as the core. Nanomicelles can be induced by the external environment, and thus making the corresponding changes in physical and chemical properties. For example, hydrogen bonding based cross-linked nanomicelle forms environment-responsive controlled release system. Under high temperature and high humidity conditions, the hydrogen bonding breaks, the nanomicelle swells and releases the pesticides.
6. **Nanogels:** Employing nanogels as a media to deliver pesticide is a very recent phenomenon and only a few studies have been published on it. Nanogels may be defined as nano-sized hydrogel systems which are highly cross linked systems in nature involving polymer systems, which are either co-polymerized or monomeric. In the cross linking approach, polymerization occurs between several polymers leaving a bio-active cross linked chain where the active compounds are entrapped easily. Wide variety of polymer systems and the easy alteration of their physicochemical characteristics

have given advantage for versatile form of nanogel formulations. Nanogels are typical formulations mainly of the size range of 100nm, by varying solvent quality and branching the volume fraction, one can alter variables to maintain a three dimensional structure. Nanogel formulations may have good future in seed dressing/coating because of its lower particle size, large surface area and greater adhesive properties. Nanogels may be superior to nanospheres because they are insoluble in water, and the active compounds have an easy loading and release profile.

In conclusion, nano-based pesticide formulations bring beneficial improvements in properties and behaviour of traditional pesticides such as solubility, dispersion, stability, and targeted delivery, controlled release of active ingredients, etc. Additionally, it is not only significantly improving the bioavailability and the duration of drug efficacy, but also reducing the toxicity to non-target organisms and ensures lower residues of pesticides in food and environmental compartments.

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14. CROP PHYSIOLOGY 17466

Spad Chlorophyll Meter

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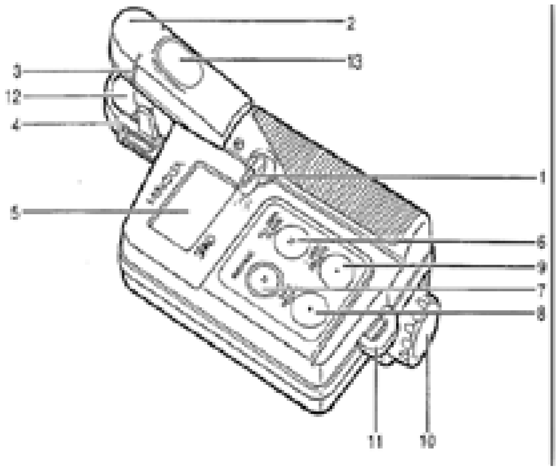
Chlorophyll Meter SPAD-502 Plus (Soil-Plant Analysis Development) Released in 1984 (Minolta Co. Ltd, Japan) is a compact, lightweight meter which can be used to determine the amount of chlorophyll present in plant leaves. The amount of chlorophyll present in plant leaves can serve as an indicator of the overall condition of the plant itself. In general, healthier plants will contain more chlorophyll than less healthy ones. The SPAD value determined by the SPAD·502 Plus provides an indication of the relative amount of chlorophyll present in plant leaves. This SPAD Value can be used to determine if and when supplementary fertilizer is necessary. Through proper use of measured SPAD values. It is possible to produce healthier plants, resulting in a larger and higher quality crop yield.'

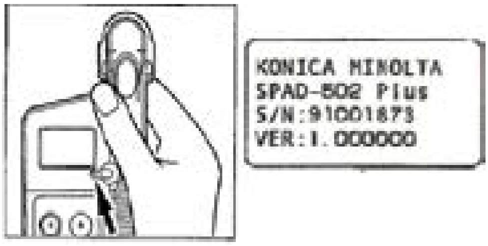


Names of Parts

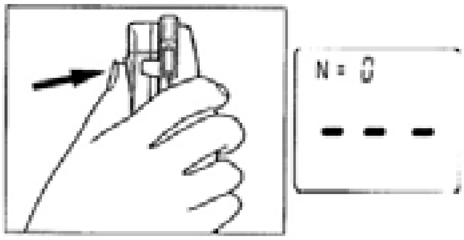
1. **Power switch**: Switches power on and off.
2. **Measuring head:** When closed, measurement is performed.
3. **Center line:** Indicates the center of the measuring area.
4. **Sliding depth stop:** Can be set to ensure that measurements of all samples are taken at the same distance from the sample edge. Can be removed if desired.
5. **LCD panel:** Displays data and other information.
6. **Average:** Calculates the average value of all data in memory.
7. **All Data Clear:** Deletes all data in memory.
8. **Data Recall:** Recalls data stored in the previous data number to tile display.
9. **Data Delete:** Deletes the displayed data.
10. **Battery chamber cover**
11. **Strap eyelet**
12. **Sample slot:** Samples are inserted here for measurement.
13. **Finger rest:** Press here to close measuring head.

Calibration: Calibration is necessary whenever the meter is switched on after having been switched off. The meter can be calibrated by following the steps below:

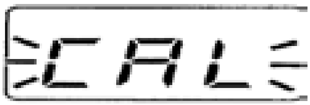
Turn power switch to on. The display shown will appear.



With no sample in the sample slot, press on the finger rest to close the measuring head. Hold it closed until a beep sounds and the display shown appears. Calibration is now complete.

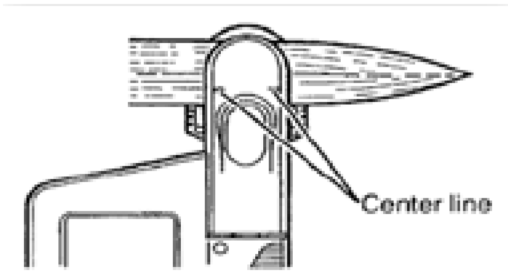


If a series of beeps sounds and CAL blinks in the display. calibration was not performed correctly (measuring head was not completely closed during calibration or was opened before Calibration was completed). Repeat step 2, keeping the measuring head completely closed until calibration is finished.



If the series of beeps sounds and CAL blinks and “EU” appear in the display, the emitting and/or receiving windows of the measuring head may be dirty. Clean the windows and repeat step 2.

Taking Measurements: The SPAD-502Plus can be easily used 10 take measurements in the field. The measuring area is only 2mm X 3mm, allowing small leaves to be measured, and samples may be up to 1.2mm thick.



Position of emitting and receiving window

The center line indicates the center of the measuring area. The position of the emitting and receiving windows is indicated in the figure below. The depth stop may be used to keep the measurement depth constant.

Steps in Measurement: The SPAD-502Plus is water-resistant and can be used in the rain. After use, wipe it dry with a clean, soft cloth. Do not immerse it in water or wash it with water.

- Perform calibration.
- Insert the sample to be measured into the sample slot of the measuring head.
  a) Be sure the sample completely covers the receiving window.
  b) Do not attempt to measure extremely thick parts, such as the veins of a leaf. If measuring a leaf that has many fine veins, take several measurements and average them for best results.
  c) If the emitting and/or receiving windows of the measuring head are dirty or have some water on them, precise measurement cannot be performed. Clean them before measurement.
  d) When using the meter in direct sunlight, shade the meter with your body to prevent the sunlight from affecting measurements.
- Press on the finger rest to close the measuring head. Hold it closed until a beep sounds and the measured value appears in the display. The measurement will automatically be stored in memory. If a series of beeps sounds and “ERROR” appears in the display, measurement was not performed correctly (measuring head was not closed completely, measuring head was opened before measurement was completed, or sample Is 100 thick or thin). Repeat steps 2 and 3, keeping the measuring head completely closed until measurement is finished.

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15. CROP PHYSIOLOGY 17511

Physiology and Biochemistry of Seed Inducing by Magnetic, Electric and Chemical Approaches

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INTRODUCTION: Quality seed plays pivotal role in increasing the agriculture production as well as productivity. Careful farming envisages and enforces first and foremost attention on the seed. "Care with seed joy with harvest" is the popular adage which en-lights about the importance of seed quality. National economy progress depends on growth of its agriculture, which intern depends on the seed. Seed act as bases for enhancing yield or productivity and about 25-30 per cent increase in yield is possible by use of high quality seeds alone. Green revolution was possible through the use of high quality seed of improved varieties. Higher yield and profits are assured and produce will fetch high price in the market. Use of the quality seed prolongs life span of the variety and prevents the genetic deterioration. Hence seed act as an insurance against crop failure and seeds of hope may turn in to seeds of frustration if high quality seeds are not used for planting.

Types of Seed Treatment

Seed quality can be improved by different seed invigoration techniques such as

1. Seed hardening
2. Seed priming
3. Seed pelleting
4. Seed coating with film.
5. Chemical treatment.

Physical methods for seed treatment such as:

- Electric and magnetic field
- Low ionizing radiation
- Laser irradiation
- Ultraviolet
- Microwave
- Ultrasound treatment

Magnetic Treatment

Pre-sowing seed treatment including chemical and physical treatments like electrical, microwave and irradiation are known to improve seed performance. Alexander and Doijode (1995) noted that aged onion (*Allium cepa*) and rice (*Oryza sativa*) seeds exposed to a weak electromagnetic field for 12 h increased the germination shoot and root length of seedlings. Celestino *et al.* (2000) reported enhanced germination and growth of Cork oak (*Quercus suber*) seedlings when exposed to chronic magnetic field.

Effect of Magnetic Seed Treatment

- Magnetic treatment improve seed germination and seedling growth.
- It enhances the conc. of ions, free radicals and electrical charges, physically without any degradation in the chemical profile of seed.
- Free movement of ions activate the metabolic pathways by enhancing the physiological and biochemical feedback. Magnetic treatment influence the structure of cell membranes.
- It increase the permeability and ion transport in the ion channels.
- The enzymes which are necessary for seed germination were found higher in magnetically treated seeds during germination.

Electric Treatment

Electric fields modify the rate of ion transport across the plasma membrane. Plants have important role in earth and studying about the environmental factors which affect plant growth is essential. Electric fields are a part of environmental factors which affect plant so these effects have attracted considerable attention. The term "electric fields" covers all the fields emitted by natural and man-made sources.

They influence the physiological and biochemical process in the seeds. There by contribute to greater vigor and improved crop stand. Therefore, physical pre-sowing seed treatment for enhancing the seed performance.

Effect of Electric Treatment

1. It may cause the alteration in the permeability of the plasma membrane of plant roots.
2. Electric field in the ionic currents across the cellular membrane with leads to change in the osmotic pressure.
3. Plants are able to recognize and respond to their surrounding environmental stresses.
4. The balance between the productions of reactive oxygen species.
5. It increase the activity, conc. of lifetime of free radicals.

6. It increase enzyme activity.
7. Oxygen stress occurs when there is a serious imbalance between the productions of ROS.

Chemical Treatment

- Seed hardening is a process or treatment by which plants growing from the hardened seeds are capable of withstanding soil moisture stress.
- Different chemicals are used for seed hardening such as zinc sulphate, Mgso4, sodium chloride, calcium chloride and potassium dihydrogen phosphate etc.
- Hardened seeds will have the ability to withstand drought during germination and plant growth.
- Therefore there is a need to identify suitable ameliorative measures to overcome the moisture stress effect. The pre-sowing seed hardening with chemicals is one of the simple technique being employed to modify the morpho- physio -biochemical nature of seed, so as to induce the characters that are favorable for drought resistance.

Effect of Chemical Treatment

- It increases the speed of germination and germination percentage
- It increases the seeding vigour.
- The uniformity of seedling emergence.
- Increases the root growth.
- Flowering occurs 2-3 days earlier.
- Uniform seed set and maturity.

16. CROP PHYSIOLOGY 17540

Roles of Plant Growth Regulators in Fruit Crops

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Plant growth regulator are the chemical compounds which modify or regulate physiological processes in an appreciable measure in the plants when used in small concentrations. They are readily absorbed and they move rapidly through the tissue when applied to different parts of the plant. The plant hormone are also regulators but produced by the plants in very low concentration. The use of plant growth regulator in horticulture are discussed below:

1. **Propagation of plants:** The most common use of plant regulators in horticulture is to induce rooting of cutting in many horticulture plants. The most common compound is indole butyric acid (IBA) which is most effective one and other compound are Naphthalene acetic acid (NAA), Indole acetic acid (IAA) and 2, 4-Dichloro phenoxy acetic acid (2,4-D).
2. **Control of flowering:** The plant regulators are used for the regulation of flowering in certain crops. In pineapple, flowering is irregular and harvesting becomes a problems and hence to regulate the flower production, plant regulator are used. The treatment generally consists of pouring of required quantity of 50 ml of the solution containing 0.50 mg of alpha naphthalene acetic acid (NAA) in the central core of the plants.
3. **Fruit setting:** Synthetic growth regulators induce greater fruit set in various plants. NAA and 2, 4-Dichloro phenoxy acetic acid and para chloro phenoxy acetic acid are the growth regulators which are successful in increasing fruit set.
4. **Induction of parthenocarpy:** The other important effect of synthetic growth regulators is the production of seedless fruits. Chemicals used for this type of action are 2, 4-Dichloro phenoxy acetic acid, 2, 4, 5-Trichloro phenoxy acetic acid and gibberellic acid. Application of gibberellic acid (GA) at 100 ppm induces complete seedlessness in the grape varieties *viz.* Anab-e-Shahi etc.
5. **Control of pre-harvest fruit drop:** In apple and pears, pre harvest fruit drops can be checked by the application of 2, 4-D and 2, 4, 5-Trichloro phenoxy acetic acid. Timing of spray is important, in that the effectiveness of the spray should last until the expected fruit drop occurs.
6. **Blossom thining:** Blossom thining is practiced to reduce the heavy setting of fruits in one particular season. NAA is an effective chemical in thinning the crop in grapes when applied two to four weeks after petal fall stage.
7. **Fruit ripening:** The plant growth regulators can be employed to hasten or delay fruit ripening. Plant regulators like 2, 4, 5-Trichloro phenoxy acetic acid (2, 4, 5-T) at concentrations of 25-100 ppm has been found hasten the ripening of some varieties of plum and peach. In banana, ethrel treatment at 2500 ppm induces ripening in 24 hours.
8. **Weed control:** Chemical weed killers are now extensively used as hand weeding is very laborious and expensive. 2,4-D is used as a spray solution at 0.1% to kill the broad leaves plant.
9. **Modification of sex expression:** Plant regulators can be employed to modify the sex expression in certain crops. In cucurbitaceous vegetable the production of male flower will always more in number than the female flower and this sex ratio can be narrowed by application

of ethrel at 100 to 250 ppm after 10-15 days after sowing.

10. **Control of dormancy:** plant regulators can be employed to break dormancy or prolong the dormancy. Sprouting of potato tubers and onion bulbs is a common phenomenon in storage. Pre harvest spray of Maleic hydrazide (MH) at 2000 ppm given just before 15 days of actual date of harvest prolong dormancy in the above storage organ by inhibiting the sprouting. In fruit trees of apple, plum and figs early flowering is induced by spraying Dinitro orthocresol at 0.1% in oil emulsion.
11. **Production of latex flow of rubber plants:** Application of NAA, 2,4-D, 2,4, 5-T and ethrel at the tapping panel increase the flow of latex in rubber. These stimulants are useful especially in older trees before they are felled to completely exhaust the flow of latex.
12. **Arrest the plant growth:** Periodical pruning of hedge plants and centering in tea (removal of terminal shoots to enourge shoots) are laborious and costly process. Growth regulators like Maleic hydrazide, CCC (2-chloro ethyl trimethyl ammonium chloride) and ethrel at appropriate concentration normally retard the growth rate in plants.
13. **Increasing the fruit size and quality:** Dipping the inflorescence in a beaker containing 50 ppm of gibberellic acid especially during calyptra falling increase the fruit size in grape and the quality of the treated fruits are always superior than the normal fruits.

17. CROP PHYSIOLOGY 17578

Heat Stress in Wheat during Reproductive and Grain-Filling Phases

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Worldwide climate models predict an increase in mean ambient temperatures between 1.8 and 5.8°C by the end of this century (IPCC, 2007). Future climates will also be affected by greater variability in temperature and increased frequency of hot days. To adapt new crop varieties to the future climate, we need to understand how crops respond to elevated temperatures and how tolerance to heat can be improved. Plants detect changes in ambient temperature through alarms in metabolism, membrane fluidity, protein conformation and assembly of the cytoskeleton. Such reactions activate adaptive processes like expression of heat shock proteins, until new cellular equilibriums are reached. However, temperatures above the optimum for growth can be deleterious, causing injury or irreversible damage, which is generally called 'heat stress. Heat stress is a function of the magnitude and rate of temperature increase, as well as the duration of exposure to the raised temperature. Wheat (Triticum aestivum L.) is very sensitive to high temperature and trends in increasing growing season temperatures have already been reported for the major wheat-producing regions. Wheat experiences heat stress to varying degrees at different phenological stages, but heat stress during the reproductive phase is more harmful than during the vegetative phase due to the direct effect on grain number and dry weight.

Impact of terminal heat stress. The optimum temperature for wheat anthesis and grain filling ranges from 12 to 22 C. Exposure to temperatures above this can significantly reduce grain yield Heat stress during anthesis increases floret abortion. Heat stress during the reproductive phase can cause pollen sterility, tissue dehydration, lower CO_2 assimilation and increased photorespiration. Although high temperatures accelerate growth they also reduce the phenology, which is not compensated for by the increased growth rate. However, temperatures >30°C, during floret formation, may cause complete sterility. Therefore, when temperatures are elevated between anthesis to grain maturity, grain yield is reduced because of the reduced time to capture resources.

A. Photosynthesis

Photosynthesis is the most sensitive physiological process to elevated temperature and any reduction in photosynthesis affects growth and grain yield of wheat. Heat stress reduces photosynthesis through disruptions in the structure and function of chloroplasts, and reductions in chlorophyll content. The inactivation of chloroplast enzymes, mainly induced by oxidative stress, may also reduce the rate of leaf photosynthesis. Oxidative stress may induce lipid peroxidation leading to protein degradation, membrane rupture and enzyme inactivation.

B. Leaf Senescence

Leaf senescence is the progressive loss of green leaf area that occurs during reproductive development of a crop. As plants use the resources to cope with the stress, limited assimilates remain available for reproductive development. Heat stress further triggers the senescence-related metabolic changes in wheat. In addition, chlorophyll biosynthesis is inhibited under exposure to heat stress which hastens diurnal temperature differences are also important in this regard for instance, larger diurnal fluctuations promoted senescence of flag leaves under high-temperature conditions.

C. Water Relations

Leaf relative water contents (LRWC), leaf water potential, stomatal conductance and rate of transpiration are influenced by leaf and canopy temperature. In dry environments, higher temperatures lead to higher vapour pressure deficits, which drive higher evapotranspiration. As soil water is depleted, LRWC and leaf water potential decrease. However, evaporation from the leaf surface enhances leaf and canopy cooling, so overheating may be ameliorated by higher rates of transpiration. Although trade-offs exist between heat balance, stomatal regulation and depletion rate of limited soil water, there is a tendency for most species to conserve water over temperature regulation, particularly when ambient temperatures exceed 30°C.

D. Grain Growth and Development

Grain development is impacted by heat stress because assimilate translocation, grain-filling duration and rate are influenced directly by changes in ambient temperature. The extent of heat-driven damage is dependent on the level of heat stress. Both grain number and weight is sensitive to elevated temperature. Influence of temperature on each of these components of grain yield depends on the developmental phase at which the elevated temperature occurs. For instance, between spike initiation and anthesis, temperatures above 20°C may substantially reduce grain number per spike. Several events during this phenostage that influence grain number include spikelet initiation, floral organ differentiation, male and female sporogenesis, pollination and fertilization. Heat stress speeds up development of the spike reducing spikelet number and thus, the number of grains per spike. However, the period between spike initiation and anthesis is not the most sensitive period to heat stress. The most sensitive period is between the appearance of double ridges on the shoot apex and flag leaf.

E. Grain Quality

Grain protein content and grain size are the most important characteristics determining grain quality in wheat. Heat stress during grain-filling phase affects the grain protein contents through reductions in starch deposition, which influences protein concentration by allowing more nitrogen per unit of starch. Although the daily flow of carbon and nitrogen into grain increases with increasing temperature, carbon flow decreases per degree-day. As a result, grain size is more affected by temperature than quantity of grain nitrogen.

Management Strategies

Agronomic strategies for mediating future increases in ambient temperature include practices that conserve water (*e.g.*, no tillage and stubble retention), fertilization during critical growth stages and timing of sowing. For example, continuous water supply to heat-stressed wheat helped sustain grain-filling rate, duration and size. Of course, this is not possible in rainfed wheat growing regions if it doesn't rain. Application of nitrogen, phosphorus and potassium improve plant growth under moderate heat stress. When nitrogen, phosphorous and potassium are applied post anthesis, more protein accumulates in the grain at day/night temperatures of 24/17°C, but not at 37/28°C. Application of some micronutrients such as zinc, can also improve heat tolerance in wheat. The timing of nutrient application to coincide with key developmental stages is already regularly practiced, such as nitrogen application when the spike is 1 cm in length. Time of sowing is another important management strategy in some regions. Although periods of elevated temperature may occur during the growing season, grain filling usually occurs when seasonal temperatures are increasing. Early planting may avoid terminal heat stress so that grain filling occurs during cooler temperatures. Other management strategies for improving heat tolerance, such as application of exogenous signalling compounds, osmolytes and certain inorganic salts.

18. CROP PHYSIOLOGY 17585

Mycorrhiza and Stress Management

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INTRODUCTION: Plants are continuously exposed to variety of environmental stresses, being sessile in nature, have a greater chance to interact with biotic and abiotic stresses hence, resulting in perturbed growth and metabolism. The abiotic stresses like salinity, drought, cold, heat, nutrient imbalances etc. and biotic stresses especially soil borne pathogens can severely hamper the growth and development of plants and ultimately reduce the productivity. Plants may adopt several stress tolerance strategies through modulating their physiology and biochemistry to limit stress-accrued damages or to facilitate the repair of damaged systems in order to achieve improved plant productivity/yield by externally applying chemicals and biotic agents. The soil microbiota especially arbuscular mycorrhizae fingi (AMF) association with plant roots is considered as one of the fascinating alternatives to be used as either biofertilizers, biostimulants or biocontrol agents in order to improve plant growth and productivity and eventually bring higher crop/plant productivity under normal and stressful conditions.

AMF and Stress Tolerance Mechanisms: The mycorrhizal plants have an improved ability for nutrient uptake tolerate stress environments. Mechanisms underlying the protective roles of AMF are credited to AMF-assisted alleviation of oxidative stress in plants, rapid water uptake and nutrient absorption and change of transcript levels of genes involved in signaling pathway or stress response. Mycorrhizal plants could adapt to drought stress in morphology, especially leaf epicuticular wax and root morphology and possess direct pathway of water uptake by extraradical hyphae. In addition, AMF enhance drought tolerance of the host plant either through physiological mechanisms like nutrient uptake and biochemical mechanisms including hormones, osmotic adjustment, and antioxidant systems. AMF also release glomalin into soil, defined as glomalin-related soil protein, to improve soil structure, thereby regulating water relations of plant/soil. The expression of an insoluble glycoprotein, known as glomalin is released by some AM fungi and heavy metals binding genes which are also known to allocate the heavy metals to different parts of mycorrhizal plant under the stress of heavy metals.

Mycorrhizal fungal colonization also enables salinity-exposed host plants to absorb more water through their hyphal network and improve gas exchange capacity. In plants thriving under saline conditions, mycorrhizal fungal colonization can also: (a) enhance hydraulic conductivity of the root at low water potential (b) stimulate and alter root system morphology and (c) increase stomatal conductance. Mycorrhiza-inoculated plants were reported to exhibit increased chlorophyll content, higher uptake of N and Mg but inhibited Na-transport and also improved cytokinin concentration and a higher translocation of photosynthetase in even under saline conditions. Recently, AM inoculation was reported to boost the performance of PS I and PSII, and enhance the chlorophyll and carbonic anhydrase content.

The mycorrhizal symbioses have a protective effect against biotic factors especially plant pathogens. Disease reduction within host plants colonized by AMF is the result and output of the complex interactions among pathogens, AMF and plant. AMF show no indirect interaction with soil borne pathogen through antagonism, mycoparasitism and or antibiosis. Different mechanisms have been reported to explain bio-control by AMF including biochemical changes in plant tissues, microbial changes in rhizosphere, nutrient status, anatomical changes in cells, root system morphology and stress alleviation. Therefore, potent native AM fungi, can be used as bioinoculants to alleviate the adverse environmental effects of biotic and abiotic stresses on plant growth.

Conclusion: Notably, among the sustainable efforts, the association of soil microbiota especially AMF with plant roots can also be exploited through adoption of above mentioned stress management strategies. Hence, utilization of these arbuscular mycorrhizae to increase the productivity is a viable alternative to organic fertilizers which also help in reducing the pollution and preserved the environment in the spirit of an ecological agriculture.

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19. AGRONOMY 15702

Physiological Factors of Dry Land Crop Production

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INTRODUCTION: Soil moisture is the most limiting factor in dry land farming. Understanding the physiological processes that occur during moisture stress is necessary to ameliorate the stress effects either by management practices or by plant improvement. The major physiological principles that affects dry land crops are as follows:

Soil moisture stress, Effect on photosynthesis, Assimilate saturation, Respiration, Metabolic reaction, Hormonal relationships, Growth and Leaf area development and Reproduction and Yield

Major problems of crop production in dry land farming: Inadequate or uneven distribution of rainfall, Late onset and early cessation of rainfall, Prolonged dry spells during the crop period, Low moisture retention capacity of the soil, Drought and Phenological changes in crops. Moisture Loss Spectrum: Evaporation loss from soil surface, Transpiration loss from plant surface and Combined effect of evapotranspiration loss. Major ways to overcome moisture loss: Suitable selection of drought resistant crops, Using different types of mulches, Using different types of antitranspirants, Wind breaks and shelter belts, Adopting efficient weed control methods, Selective tillage practices for dry land areas like zero tillage, minimum tillage, summer ploughing, Water harvesting and supplemental irrigation and Water shed management. Effect of moisture stress on physiological aspects: Moisture stress does not affect all aspects of plant growth and development equally. Some processes are highly susceptible while others are less affected. But finally, the yield of the crop is reduced by the integrated result of these effects of stress on photosynthesis, respiration, nutrition, growth and development.

Effect on Photosynthesis: Photosynthesis is reduced by moisture stress due to reduction in photosynthetic rate, chlorophyll content, leaf area and increase in assimilate saturation in leaves. Similarly the translocation of assimilates is affected due to water stress in plants. The Photosynthetic process: The photosynthetic process *i.e.* entry of carbon dioxide into the leaf and photochemical reactions are affected by moisture stress. At moisture stress, stomata closure is a mechanism to reduce the transpiration losses. Due to this, CO2 entry is also reduced by mesophyll cells. Ultimately reduced photosynthetic rate mainly due to stomatal resistance and closure. Assimilates Saturation: Translocation of assimilates is affected by water stress. Due to assimilate saturation, photosynthesis is reduced. Effect on Respiration: During the mild water stress the respiration rate in plants increases, whereas during severe water stress the rate of respiration is decreases in plants. More severe drought lowers water content and respiration. In wheat CO2 output is more in early stages of drought before there is any measurable change in water content. C4, CAM plants have less respiration loss than C3 plants in dry land farming. Effect on Metabolic reactions: Almost all metabolic reactions are affected by water deficits. Severe water deficits cause decrease in enzymatic activity. Eg. Nitrogenase enzyme activity in legume crops. Accumulation of amino acids and sugars takes place under moisture stress. Proline, an amino acid, accumulates whenever moisture stress occurs. Its accumulation is more in later stages of plants and it is considered as a good indicator of moisture stress. Effect on Hormonal Relationships: As a consequence of water deficits, hormonal balance is altered. The activity of growth promoting hormones like cytokines, gibberellic acid and indole acetic acid decreases and growth regulating hormones like abscisic acid, ethylene and betain increases. Abscisic acid acts as water deficit sensor, it controls stomata and thus minimise the water loss. Ethylene production induced by moisture stress causes leaf and fruit drop. Betain hormone also produced in moisture stressed plants used as an indicator of moisture stress. Effect of Protoplasmic dehydration: When dehydration is severe tissues become desiccated, protoplasm viscosity increases and leads to rigid and brittle nature of plants. Effect on anatomical changes: Periodical water stress develops decrease in size of plant cells and decrease in size of intercellular spaces, thicker in size of cell wall and greater development of mechanical tissues and increase in number of stomata per unit leaf area.

Effect on Nutrient Uptake: Moisture stress affects nutrient fixation, NPK uptake and assimilation of nitrogen. Nitrogen fixation by leguminous plants is reduced by moisture stress due to reduction in activity of nitrogenise enzyme in leghaemoglobin in root nodules. Nutrient uptake is the product of nutrient content and dry matter production. Moisture stress may or may not reduce nutrient content, but reduces dry matter production and nutrient uptake of plants. Severe moisture stress affects N fixation, N uptake and assimilation of N and reduction of N fixation by legumes, there is an inverse relationship between specific nodule activity and stomatal resistance and the nitrogenase enzyme activity is also reduced. Ultimately the moisture stress reduces the dry matter production and nutrient uptake. NPK uptake is reduced and N, P deficiency increases due to increase in stomatal resistance and stomatal closure.

Effect on Growth: Due to moisture stress the rapidly growing plant organs gets affected. The expansion of cells and cell division is reduced. The decrease in growth of leaves, stems and fruits were noticed. The germination, leaf area development, leaf expansion and root development were affected. The assimilates accumulation in leaves leads to leaf turgor and leaf activities. Effects on Development: Moisture stress delays maturity, moisture stress before flowering increases the duration of the crop, similarly moisture stress after flowering reduces the duration of the crop, the stress degree days approach is used for predicting the crop production, which considers light, temperature and water levels in calculating maturity date of the crop. Effect on Leaf area: In moisture stressed plants, the reduction in leaf area may be due to breakdown of chlorophyll, reduction of leaf expansion which leads to lesser tillering or branching and increase in leaf senescence of plants. The elongation rates of leaves are more reduced due to moisture stress than net photosynthesis. Effect on Reproduction and Grain

Growth: Moisture regime during flowering and grain development determines the number of fruits and weight. For many crop plants especially cereals, the moisture stress at panicle initiation is critical. Anthesis is another important moisture sensitive stage in crops. However, vegetative and grain filling stages are less sensitive to moisture stress. Effect on Yield: The effect of water stress on yield depends largely on what proportion of the total dry matter is converted into useful material to be harvested. Stress during grain development reduces the yield and the moderate stress on crop growth does not have adverse effect on yield. Moisture stress influences the pod abortion in legumes and decreases the leaf sucrose and starch concentration, in case of forage crops and leaf tobacco the leaf growth were affected. The crops like sugar beet, potato are highly sensitive to moisture stress and the yield is affected drastically. In case of cereals the moisture stress during flowering is very detrimental. Usually, the moderate moisture stress does not affect the crop yield.

Mechanisms for overcoming moisture stress: Escaping Drought, Drought Resistance, Drought Avoidance and Drought Tolerance.

Plant mechanisms to conserve moisture: Stomatal Machanism: Drought resistant varieties closing stomata when drought prevails and opens the stomata during early morning and produces the photosynthesis rapidly with less amount of water. Increased Photosynthetic Efficiency: In C4 and CAM plants shows increased photosynthetic efficiency when compared to C3 plants. CAM plants are highly drought resistant, C4 plants are drought resistant when compared to C3 plants. Lipid deposits on plant leaf surface will conserve more moisture. Crops like sorghum, soya bean are reducing the water loss by depositing lipids on plant surfaces under moisture stress conditions. In drought, plant shows reduction in leaf area results less transpiration and leaf expansion is limited. Parahelionastic movements: when plant leaves are oriented parallel to sun rays and thus by avoiding the load of solar radiation (legumes/pulses).

Changes in plant morphological characters: Leaves with thick cuticle, leaves with waxy surface, leaves with spine would reduce drought and influence survival of the plants under moisture stress condition. Awned varieties yield more in drought condition, and awns contribute 12% of photosynthates to grain. Drought sometimes increases the water storage in plants (pineapple leaves). The plants with efficient root system, more root-shoot ratio, increase in lipid phase conductance on leaves, osmotic adjustments, drought tolerance of the crop varieties, mitigating drought high degree of tolerance, drought evaluation, plant developmental mechanisms, plant morphological adaptations, plant physiological adaptations, remobilization of reserves and breeding for drought resistance are very important in conserving the soil moisture in drought condition.

Contingency approaches to overcome drought: Contingency cropping plan such as growing of groundnut during June -July and cotton during August utilizes the moisture very effectively. Application of NPK as basal in dry land cropping and usually top dressings and split applications are avoided. By collecting the surface run off collections the rain water is well utilized. In dry land cropping, mono cropping is followed when the rain fall is received less than 500 mm, inter cropping is followed when the rain fall is in between 600-700 mm and double or mixed cropping is followed when the rain fall is more than 850 mm.

Tillage Practices: Zero tillage, minimum tillage, summer ploughing, blade harrowing and tractor drawn cultivators are used in dry land cropping.

The commonly used crops and varieties in dry land areas are sorghum, groundnut, pearl millet, red gram, sun flower, cotton with drought resistant varieties are chosen. The time of sowing usually based on onset of first monsoon rain. Irrigation is followed during the critical stages of the crop, efficient water harvesting methods are followed for water storage and to reuse the stored water through supplemental irrigation by efficient irrigation system.

Ameliorative measures on dry land crops: Application of salicylic acid 0.7 ppm and glycine betaine at 100 ppm at flowering stage is reducing the adverse affects of drought stress in sunflower. Under drought stress condition, 2-aminoethanol per treatment increased the grain yield of barley by 25-30% reported by Brooks *et al.*, 2009. Application of propiconazole increased the enzymatic activities in cowpea (ascorbic acid, polyphenol oxidase, tocopherol etc.,) helps to overcome drought. Application of triadimefon to sun flower increased enzymes like proline, glycine betaine catalase etc., reduces the drought stress. Application of paclobutrazol minimizes the water stress in Groundnut.

Improving soil moisture storage in dry land areas: Soil moisture lost as evaporation from the soil surfaces and as transpiration from the plant surfaces. Both are affecting crop productivity. The evapotranspiration losses can be produced by 1. Suitable selection of cops (drought resistant), 2, Using different types of Mulches, 3. Using different types of antitranspirants, 4. Wind breaks and shelter belts, 5. Effective methods of weed control. Suitable crop selection (drought resistant crops), Plants with increased photosynthetic efficiency, Plants with lipid deposits on leaves and Using of Mulches: About 60-75 % rain fall is lost through evaporation. These can be reduced by applying of mulches. Mulch is any material applied on the soil surface to check evaporation and improve soil water. Application of mulches results in soil conservation, reduction in soil salinity, weed control and improvement of soil structure along with controlling evaporation in moist stress condition. Types of mulches: Soil mulch, Stubble mulch, Plastic mulch, and Vertical mulching.

Using of Antitranspirants: Nearly 90 percent of water absorbed by the plants is lost by transpiration. Antitranspirants are any material applied to transpiring plant surfaces for reducing water loss from the plant. There are four types: stomatal closing type, film forming type, reflectant type and growth retardants type. Stomatal closing type: Most of the transpiration occurs through the stomata on the leaf surface. Some antitranspirants reduce water loss through stomatal closing is called stomatal closing type. Eg. fungicides like phenyl mercuric acetate (PMA), herbicides like Atrazine in low concentrations. Film forming type: Plastic and waxy materials which form a thin film on the leaf surface retard the escape of water due to formation of physical barrier. Eg. Hexadeconol, Silicon. Reflectant type: These are white materials which form a coating on the leaves and increase the leaf reflectance and reduce the transpiration. Eg. Kaolin, Celite. Growth Retardants: These chemicals reduce shoot growth and increase root growth and thus enable the plants to resist drought and they may induce stomatal closure Eg. Cycocel.

Conclusion: Wind breaks are any structures that obstruct wind flow and reduce wind speed. Shelter belts are rows of trees planted for protection of crops against wind. Due to reduction in wind speed, evaporation losses are reduced and more water available to the plants in drought areas. Effective weed control methods: Transpiration rate from weeds is more compared to crops. Effective weed control in dry land agriculture leads to increasing availability of soil moisture to the crops. These are the most useful measures to reduce the transpiration losses in dry land areas. Commonly, watershed is any surface area from which rain fall is collected and drains through a common point. Watershed is synonymous to a drainage basin or catchment area. The size of the watershed varies from a few hactares to several thousands of hactares. Watersheds are classified into micro, mini and macro depends on size. Basically, water shed is as a component of biological, physical, economical and social system and meets the needs of the people and animals in sustained manner.

20. AGRONOMY 17335

Millets

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The rainfed area (85.00 m.ha) in India constitutes approximately 60% of total net sown area. Rain fed agriculture contributing 44.00 per cent of the total food grain production of the country and produces 75.00 per cent of pulses and more than 90.00 per cent of sorghum, millets and groundnut from arid and semiarid regions. The rainfed regions provide livelihood to nearly 50.00 per cent of the total rural workforce and sustain 60.00 per cent of cattle population of the country (Anon., 2011).

Millets are some of the oldest of cultivated crops. The term millet is applied to various grass crops whose seeds are harvested for food or feed. The minor millets includes little millet (*Panicum miliare*), finger millet (*Eleusine coracana*), foxtail millet (*Setaria italica*), barnyard millet (*Echenochloa frumentacea*), proso millet (*Panicum miliarceum*) and kodomillet (*Paspalum serobiculatum*). Presently, minor millets are cultivated in areas where they produce more dependable harvest compared to any other crop.

Importance of Millet

Nutrition: These crops provide good nutrition and comparable very well with rice or wheat. Minor millets are superior in protective nutrient such as vitamins, minerals, dietary fibre, essential amino acids and phyto-chemicals. In recognition of this, these grains are now considered as nutrition grains.

Grow in Adverse Environmental Condition: On global basis minor millets are cultivated on an area of 36.79 m.ha with an annual millet production of 29.20 m.t indicating the productivity of 777 kg/ha, whereas in India, millets are cultivated on an area of 13.30 m.ha producing 10.50 m.t with the productivity of 789 kg/ha (Anon., 2000) Minor millets are grown in diverse soils, varying rainfall regimes and in areas widely differing in thermo and photoperiods. The resilience exhibited by these crops is helpful in adapting themselves to different ecological niches. All these have made quite indispensable to rain fed, tribal and hill agriculture, where crop substitution is difficult. Therefore it is important to enhance production and productivity of these crops to ensure food and nutritional security not only to people living in harsh and difficult terrains, but also in other areas.

Medicinal Use: Common millets and foxtail millets are used in indigenous medicine; foxtail millet is specially used in snake poisoning (FAO, 2000).

Eco-friendly: Being eco-friendly crops, they are suitable for fragile and vulnerable eco-systems and regarded as preferred crops for sustainable and green agriculture. Hence the promotion of these crops can lead to efficient management of natural resources and holistic approach in sustaining precious agro-biodiversity.

Bird Feed: The major uses of proso millet are as a component of grain mixes for parakeets, canaries, finches, lovebirds, cockatiels and wild birds and as feed for cattle, sheep, hogs and poultry. Millet for birdfeed purposes is often grown under contract. Large bright or red seed is preferred, and premiums are sometimes paid for superior quality.

Silage Production: Foxtail millet is usually grown for hay or silage often as a short-season emergency hay crop. Some seed is used for finch and wild bird feeds. It does not necessarily yield more forage than proso but is free of foliage hairs and is finer stemmed. For forage, foxtail millet is harvested at the late boot to late bloom stage.

Limitation

- Inspite of superior nutritive value of grains, their use is limited, largely confined to rural markets and very little finds its way to urban market.
- The problem of pests and diseases in minor millets is negligible.
- Less area under sown.
- Not comes under MSP.
- Lack of awareness among farmer and people regarding these crops.
- Lack of research and hybrid/ resistant variety release in these crops. s

21. AGRONOMY 17352

Agronomic Practices in Tuberose Cultivation - Dharmapuri District

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INTRODUCTION: Mr K. Chennippan and Chitra is the farmer in Nallanahalli, Baisuhalli (post), Dharmapuri (Dist.), doing tube rose cultivation for past 6 years about an area of 1 acre. He is straining a lot to get more yields from his field. He is getting subsidies from horticulture department of about 75% for drip irrigation. They give the better information about the fertigation, various technologies to increase the yield of flower.

Variety: Prajwal.

Land preparation: The land is well ploughed with tractor about two (or) three times to get fine tilth. Fine tilth is very important aspect in tuberose cultivation. There should not be any clods in field. FYM of 10 tonnes is being applied as basal application for 1 acre and superphosphate also applied as basal.

Bulb requirement: About 700 Kg of tubers is required for 1 acre. The well grown tubers is being selected which have many buds on them. The selected tubers must have the duration about 2 years. The tubers should be well matured. The selected tubers is allowed for shade dry for two weeks before transplanting into main field. The main aim of shade dry is to give immediate initiation of buds from tubers. Breadth of the raised bed is about 90 cm, 2 laterals are laid in raised bed, spacing between the plant is about 22.5cm.

Propagation: Tuberose is propagated by bulbs. In general, bulbs having diameter between 1.5 and 2.5 cm are suitable for planting. About 1.25-1.5 lakh bulbs (800-900 kg) are required for planting one hectare.

Bulb treatment: These bulbs are first thoroughly cleaned and treated with Bavistin (0.2%) for 30 minutes. Dipping the bulbs in 4% solution of thiourea can break the resting period. Pre-plant storage of bulbs at 10°C for a period of 30 days to improve the plant growth, increased spike and flower yield.

Planting the tuberose bulbs in main field

Sand mix application of pendimethalin

Season: Planting done in the month of March-April in plains and April-May in hills.

Weed Management

Weed is the major problem in tube rose cultivation. The major weed *Cyperus rotundus*, which affects the tubers growth.

Hand weeding

The weeding should be done once in a month. Manual weeding is more effective. Weeds can be effectively controlled by herbicide application.

Water management: Irrigation before planting provides optimum moisture for sprouting and further irrigation should be avoided until the bulbs are sprouted. During summer, irrigation should be given at weekly interval or even earlier in case soil dries out and during winter at 10 days interval.

Harvesting: Harvesting is done daily according to maturity of the plant. By 3rd month onwards we get less yield and from 6th month we get better yield. Harvesting is done on early morning and marketed daily. After 6 months we get higher yield according to the maturity of the plants.

Conclusion

Tips for Best Crop Cultivation

- The recommended doses of fertilizers must be applied.
- The bulbs of 1.5 -2.5 cm diameter should be planted in for better growth and harvesting.
- No hoeing/weeding should be done till the sprouting takes place.
- Crop is sensitive to water stagnation so ensure proper drainage or otherwise planting be done on bund.

22. AGRONOMY 17530

Conservation Tillage Long Term Effects on Soil

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INTRODUCTION: Soil is one of our most precious natural resources. Proper soil management is a key to sustainable agricultural production. Soil management involves six essential practices: proper amount and type of tillage, maintenance of soil organic matter, maintenance of a proper nutrient supply for plants, avoidance of soil contamination, maintenance of the correct soil acidity, and control of soil loss (erosion). All of these practices depend on soil type, soil texture, and slope as well as on the crops that are grown. Several techniques are available to reduce soil erosion, including residue management, crop rotation, contour tillage, grass waterways, terraces, and conservation structures. The techniques adopted must ensure the long-term productivity of the land, be environmentally sound, and, of course, be profitable. Conservation tillage and crop residue management are recognized as cost-effective ways to reduce soil erosion and maintain productivity.

Conservation Tillage

The objective of conservation tillage is to provide a means of profitable crop production while minimizing soil erosion due to wind and water. The emphasis is on soil conservation, but conserving soil moisture, energy, labor, and even equipment provides additional benefits. Such resistance is achieved either by protecting the soil surface with crop residues or growing plants or by maintaining sufficient surface roughness or soil permeability to increase water filtration and thus reduce soil erosion. Conservation tillage is often defined as any crop production system that provides either a residue cover of at least 30% after planting to reduce soil erosion.

Zero-Till

With no-till, the soil is left undisturbed from harvest to seeding and from seeding to harvest. The only "tillage" is the soil disturbance in a narrow band created by a row cleaner, coulter, seed furrow opener, or other device attached to the planter or drill. Many no-till planters are now equipped with row cleaners to clear row areas of residue. No-till planters and drills must be able to cut residue and penetrate undisturbed soil. In practice, a tillage system that leaves more than 70% of the surface covered by crop residue is considered to be a no-till system.

Strip-Till

A no-till system allows no operations that disturb the soil other than planting or drilling. On some soils, including poorly drained ones, the no-till system is sometimes modified by the use of a strip tillage operation, typically in the fall, to aid soil drying and warming in the spring. Strip-till is sometimes done along with the fall application of anhydrous ammonia, dry fertilizer, or both. This usually involves using a mole knife, which is designed to shatter and lift soil as it places fertilizer. A closing apparatus, usually disk blades run parallel to the row, pulls soil into the row. In some cases a rolling cage is used to firm the strip and break up clods. The width of the strip-till implement is usually matched to the planter width, and the use of RTK-directed autosteer greatly assists the strip-till and planting processes.

Ridge-Till

Ridge-till is also known as ridge-plant or till-plant. With ridge-till, the soil is left undisturbed from harvest to planting except for possible fertilizer application. Crops are planted and grown on ridges formed in the previous growing season. Typically, ridges are built and reformed annually during row cultivation. A planter equipped with sweeps, disk row cleaners, coulters, or horizontal disks is used in most ridges-till systems. These row-cleaning attachments remove 0.5 to 2 inches of soil, surface residue, and weed seeds from the row area. Ideally, this process leaves a residue-free strip of moist soil on top of the ridges into which the seed is planted. Special heavy-duty row cultivators are used to reform the ridges.

Mulch-Till

Mulch-till includes any conservation tillage system other than no-till and ridge-till. Deep tillage might be performed with a subsoiler or chisel plow; tillage before planting might include one or more passes with a disk harrow, field cultivator, or combination tool. Herbicides and row cultivation control weeds. The tillage tools must be equipped, adjusted, and operated to ensure that adequate residue cover remains for erosion control, and the number of operations must also be limited. At least 30% of the soil surface must be covered with plant residue after planting.

Conventional Tillage

Conventional tillage is the sequence of operations traditionally or most commonly used in a given geographic area to produce a given crop. In the past, conventional tillage in Illinois included moldboard plowing, usually in the fall. Spring operation included one or more passes with a disk harrow or field cultivator before planting. More recently, conventional tillage has changed to include the use of a chisel plow instead of a moldboard plow, and newer combination tools are replacing chisel plows. These implements leave more residue than traditional moldboard plows, but often not enough to qualify as conservation tillage. The soil surface following conventional tillage as practiced in the past was essentially free of plant residue. This was helpful with older planting equipment that had limited ability to plant into residue.

Residue Cover

The percentage of the soil surface covered with residue after planting is affected by both the previous crop grown and the tillage system used. In general, the higher the crop yield, the more residues the crop produces. More important, however, is the type of residue a crop produces. Plant characteristics such as composition and sizes of leaves and stems, density of the residues, and relative quantities produced are all factors in the effectiveness of soil protection. Often there is a desire to predict the amount of residue that will remain on the soil surface using a particular tillage system. This estimate is important for compliance with conservation measures. The prediction requires knowing the amount of residue cover remaining after each field operation included in the tillage system.

Conclusion: Tillage has been an important aspect of technological development in the evolution of agriculture, in particular in food production. Tillage has various physical, chemical and biological effects on the soil both beneficial and degrading, depending on the appropriateness or otherwise of the methods used. The physical effects such as aggregate-stability, infiltration rate, soil and water conservation, in particular, have direct influence on soil productivity and sustainability. Soil management and conservation must play a major role in increasing crop yields and soil productivity on a sustainable basis.

23. AGRONOMY 17534

Precision Farming: Technical, Sustainable and Eco-Friendly Farming

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Survival of agriculture in India is not easy, as it has to go through many. Agriculture affects the Indian economy as agriculture sector accounts for 18% of its GDP and is source of employment to nearly 50% of Indian population. But the unpredictable nature of Indian agriculture attributed to monsoon, highly heterogeneous soil across the country, abrupt weather condition and rainfall lead to insufficient production. We have ample farm resources in the country but it has been poorly managed and we need intervention of technology here to overcome the loopholes and maintain a healthy stagnant agricultural production. Precision farming comes as a rescue in this scenario which is a farming management system based on latest technologies. It allows optimum production with minimum use of agricultural resources. Precision here strictly implies to use of resources where required, and in required amount only. Using resources as per requirement only not only save extra inputs which might have gone wasted but also saves environment from being polluted of the overuse of chemicals in form of fertilizer or pesticide or fungicide. So, we can rephrase Precision farming as a farm management approaches which applies modern technology like GIS, VRT, remote sensing etc. for effective use of farm inputs. Precision farming can indirectly prevent soil degradation, reduce cost of reproduction by preventing excessive use of agricultural inputs and promote sustainable agriculture. It is an eco-friendly farming practice.

INTRODUCTION: Precision farming is implication of modern technologies in farming system so that farm resources in form of agricultural chemicals or human labors are used in accordance with requirement only. It can be done by 1) Assessing variability of field where crop will be raised; which can be done by grid soil sampling, and crop scouting 2) Managing variability; which is possible with the help of variable rate technology or monitoring yield 3) evaluating effectiveness of various components used in precision farming. Precision farming has been made feasible with help of latest development in technology like robots, drones and satellite imagery, remote sensors, computer software and hardware.

Components of Precision Farming

There are numerous technologies which contribute in precision in one or other way, like internet, robots, computer, drones, satellite imagery etc. But here in this article few major factors have been dealt in detail-

Variable Rate Technology

Variable rate technology in agriculture applies Variable Rate Application to monitor agricultural chemicals inputs use. It allows variable application of inputs which implies that inputs are being applied according to requirement of a particular area in the given field at the same time. VRT can reduce excess usage of inputs and also benefit farmers in looking after such patches in field which are nutrient deprived. The components of VRT which make technology viable are DGPS receiver, computer, and VRA software and controller. VRT can be implemented in a field in following ways like map-based, sensor-based or manual. If practiced properly, VRT can give good results like it can increase input efficiency, improve crop yield and more important reduce waste of farm inputs. Since it minimizes over use the chemicals in form of pesticide or fungicide or even fertilizers which then would tend to leach if applied in excess hence it saves environment from being polluted too.

Decision Support System

Soil nutrient requirement (micronutrients and macronutrients), soil water content, evapo-transpiration, evaporation, and soil water restoration index affects yield of crop. Therefore, managing these parameters become very necessary. DSS in this situation provide a medium to properly manage these parameters for better crop production. Agricultural DSS encompasses all farm inputs, and manage them in such a way that production can be increased. Simulation based DSS models have been developed in different regions for different crops; like, soil module), weather module and crop module which help in taking decisions regarding when and how much to irrigate, which type of crop will grow well giving good yield and rate of application of fertilizers. DSS minimizes labor as well increase crop productivity and promote sustainable agriculture.

Global Positioning System

GPS is a useful asset to Precision farming. It facilitates in application of agricultural chemicals at precise area of field and at accurate quantity, controlling excessive chemicals uses and at the same time protecting environment too. GPS can be used for farm planning, field mapping, soil sampling, tractor guidance, crop scouting, variable rate applications, and yield mapping. GPS is a network of satellites orbiting around the Earth, forming a radio navigation system. Originally it was developed by US defense Department.

Geographical Information System

GIS can assist framers in crop management by providing them information on soil type, wind velocity and direction, topography, drainage planning etc. It also helps in preventing risk of flood, drought, soil erosion and disease. GIS is an integral part of Precision farming, using data collected with help of GIS, farmers can improve their decision-making capabilities for planning their cultivation to maximize yields.

Concluding Remarks on Precision Farming

It is a management system based on technology which if practiced not only beneficiate farmers but protect environment too. It saves farm chemicals from being wasted due to extra or over use. Its practice save time and make farming more effective and do not leave it in hands of changing weather or at mercy of monsoon. It's very theme that is use of right thing ay right place at right time make farmers save their money and nature from being polluted of extra agricultural chemicals. It is eco-friendly and promotes sustainable agriculture.

Precision farming has a lot of benefits from saving farm resources to increase productivity, and also protecting environment from over used farm chemicals and finally promoting sustainable agriculture; precision farming promises greater role than being just an information and technology based farm management system. Though being so beneficiating its high cost and technology dependence make it less assessable to marginal farmers. Its effectiveness is also questioned under small holdings and if crop heterogeneity is more in the given field.

Looking to the brighter side of precision farming, its wide scale application by farmers should be promoted at large scale. This can be achieved by,

1. Making farmers aware of the fact that precision farming can increase production at minimum required resources utilization
2. Encouraging progressive farmers to follow precision farming
3. Incentives taken by government to ban excessive uses of farm chemicals
4. Providing latest farm technology by government at affordable rate.

24. AGRONOMY 17570

Organic Agriculture Contributes to Sustainable Food Security

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INTRODUCTION: "Food security exists when all people, at all times, have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life." Modern crop production technology has considerably raised output but has created problems of land degradation, pesticide residues in farm produce, gene erosion, atmospheric and water pollution. With exploding population and rapid depletion and degradation of the natural resource base, sustainable agriculture has assumed very great significance. The task of meeting the needs of the present generation without eroding the ecological assets of the future generations is receiving top priority by environmental planners.

Concept of Organic Agriculture

Organic agriculture is one among the broad spectrum of production methods that are supportive of the environment. Organic production systems are based on specific standards precisely formulated for food production and aim at achieving agro ecosystems, which are socially and ecologically sustainable. It is based on minimizing the use of external inputs through use of on farm resources efficiently compared to industrial agriculture. Thus the use of synthetic fertilizers and pesticides is avoided.

Definition of Organic Agriculture

Organic Agriculture is a production system that sustains the health of soils, ecosystems and people. It relies on ecological processes, biodiversity and cycles adapted to local conditions, rather than the use of inputs with adverse effects.

Principles of Organic Agriculture

The Principles of organic agriculture serve to inspire the organic movement in its full diversity. It is based on four basic principles. The principles are to be used as a whole. They are composed as ethical principles to inspire action.

- **Principle of health**: Organic agriculture should sustain and enhance the health of the soil, plant, animal and human as one and indivisible.

- **Principle of ecology**: Organic agriculture should be based on living ecological systems and cycles, work with them, emulate them, and help sustain them.
- **Principle of fairness**: Organic agriculture should build on relationships that ensure fairness with regard to the common environment and life opportunities.
- **Principle of care**: Organic agriculture should manage in a precautionary and responsible manner to protect the health well-being of current and future generations and the environment.

Scope of Organic Agriculture in India

Farmers in these areas often use organic manure as a source of nutrients that are readily available either in their own farm or in their locality. The northeastern region of India provides considerable opportunity for organic farming due to least utilization of chemical inputs. It is estimated that 18 million hectare of such land is available in the north east, which can be exploited for organic production. With the sizable acreage under naturally organic/default organic cultivation, India has tremendous potential to grow crops organically and emerge as a major supplier of organic products in the world's organic market.

Major Components to use in Organic Agriculture

i. Farm Yard Manure and Crop residues	ii. Composting
iii. Green Manure	iv. Bio-fertilizer

Advantages of Organic Agriculture

Organic agriculture is good for biodiversity. Organic farmers use more agro-ecological methods. So that the benefits for using organic agriculture are:

Environmental benefits of organic agriculture.	Promotion of biodiversity and improve ecosystem
Minimize the impact of global warming.	Pollution of ground water is stopped.
Safety and quality of organically produce foods.	Increase the health of top soil

Organic Agriculture and Soil Quality

- Organic farming system is based on the management of soil organic matter, which in turn maintains the physical, chemical, and biological properties of soil.
- Organic fertilizer application improved nodule dry weight, photosynthetic rates, N_2 fixation, and N accumulation as well as N concentration in several crops.

Pathways of Transition to Organic Production

- Intensification of a single component of the farm system - such as home garden intensification with vegetables and trees.
- Addition of new productive elements to a farm system- such as fish or ducks in paddy, fruit or fodder trees planted in fields or products from N fixing crops- that boosts total food production, but does not affect the productivity of staples.
- Better use of natural capital to increase total farm production, by water harvesting or irrigation scheduling enabling growth of additional dry land crops, increased supply of water for irrigated crops or both.
- Improvements in per hectare yields of staples through the introduction of new regenerative elements into farm systems (*e.g.* integrated pest management) or locally appropriate crop varieties and animal breeds.

Multi-Dimensional Challenges and Needs for Research in Organic Agriculture

Eco-functional intensification is knowledge intensive.	Development of agro-ecological methods.
Global collaboration in research and innovation.	Evidence for decision makers.
Value chain development for various markets.	Adoption of agro-ecological methods.

Conclusion: The interest in organic agriculture in developing countries is growing because it requires less financial input and places more reliance on the natural and human resources available. Organic farming is eco-friendly and keeps the soils healthy without polluting environment and it is an alternative renewable source of nutrient supply. Studies to date seem to indicate that organic agriculture offers comparative advantage in areas with less rainfall and relatively low natural and soil fertility levels. In vast areas of the country, where limited amount of chemicals are used and have low; productivity, could be exploited as potential areas for organic agriculture. India has tremendous potential to grow crops organically and emerge as a major supplier of organic products in the world's organic market. Need is for putting up a clear strategy on organic farming and its link with the markets.

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25. AGRONOMY 17581

The Camel of Crops: Sorghum

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Much of the world is turning hotter and dryer these days, and its opening new doors for a water-saving cereal that's been called "**the camel of crops**": sorghum. In an odd twist, this old-fashioned crop even seems to be catching on among consumers who are looking for "ancient grains" that have been relatively untouched by modern agriculture. Sorghum isn't nearly as famous as the big three of global agriculture: corn, rice and wheat. But maybe it should be. It's a plant for tough times, and tough places. Sorghum "originated in the northeastern quadrant of Africa," explains, a plant scientist from Ethiopia and professor at Purdue University. From there, it spread across Africa, India and even into China. "It's got a lot of characteristics that make it a favorite crop for the dry lands of Africa and the semi-arid tropics."

It's an essential source of food in those regions, but it's not typically a big money crop. In Africa, it's grown by subsistence farmers. It's never gotten much attention from seed companies or investors. But it is nutritious. It can grow in soils that other plants won't tolerate. Above all, it doesn't need much water. Compared with corn, for instance, it needs one-third less water, and it doesn't give up and wilt when rains don't come on time. It waits for moisture to arrive.

Change in Rainfall Pattern and Lack of Ground Water

That traditional sorghum looks like an overgrown corn plant, up to 10 feet tall, with a head of seeds on top. Today's climatic condition in America, American farmers grow two kinds of sorghum, Sweet sorghum is tall; you can use it to make a sweet syrup or just feed the whole plant to animals.

But most sorghum in the India is grown for feed grain. Sorghum is used for the same things as corn: high-energy feed for pigs and chickens. It also gets turned into ethanol. But corn is far more popular. Corn produces a bigger harvest, and farmers earn bigger profits with it at least when there's plenty of water. In the India the amount of land in sorghum has been steadily shrinking. There are signs, though, of a sorghum revival on the high plains. The reason is water, or the lack of it. Corn, Sugarcane, Paddy fields have been feed with rivers of water pumped from underground aquifers, and that water is starting to run low.

"Ejeta, who won the World Food Prize in 2009 for his work on sorghum, says that sorghum's renaissance may depend on the price that farmers pay for water." If water is given its real value, and you limit irrigation, or people begin to pay for water, it would be economically smarter to grow sorghum in several areas of the United States," he says. Sorghum "originated in the northeastern quadrant of Africa," explains GebisaEjeta, a plant scientist from Ethiopia and professor at Purdue University. From there, it spread across Africa, India and even into China. "It's got a lot of characteristics that make it a favorite crop for the drylands of Africa and the semi-arid tropics."

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In the latest twist to the sorghum saga, it's actually becoming somewhat trendy among consumers who, are looking for something a little different, and maybe a little more healthful.

26. WEED SCIENCE 17424

Chemical Weed Management in Wheat Crop

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Weeds constitute the single greatest cause of loss in wheat crop. Because their effect on yield tends to be under estimated, their presence is often tolerated. The crop totally fails in the field that is infested with weeds. The quality of produce from weed infested field is inferior due to mixing of weed seeds with wheat grains. Weeds also act as an obstacle in the cultural practices *e.g.* harvesting. Some weeds also help in the spread of diseases and act as multiplication places. Weeds are gifted with more resistance to abiotic stresses and with better nutrient absorption capacity than crops. The productivity of any crop may also be decided by the weeds grown along with the crop.

Controlling of weeds with one or two techniques gives the weeds a chance to adapt to those practices. For example, the use of herbicides with the same mode of action (belonging to the same herbicide group) year after year has resulted in weeds that are resistant to those herbicides. The continuous production of certain types of crops also gives weeds a chance to adapt.

Herbicides usage in wheat crop is an effective option for control of certain weeds in wheat if used properly. However, only using herbicides may not solve all weed problems. Some herbicides are approved for use on wheat crop on different weed species. Weeds seeds emerge out along with emerging crop seedlings. If weeds are not controlled from early stages of crop growth, depending upon the intensity and type of weeds these may cause reduction in yield of the crop up to 40 %.

The major dicot weeds are Chenopodium album, Fumaria purviflora, Cirsium arvense, Anagalis arvensis, Melilotus alba and Melilotus indica, Vicia sativa, lathyrus spp., etc.,

Monocot weeds include: *Phalaris minor*, *Avena fatua*, *Polypogon monspllensis*, *Cyperus rotundus* and *Cynodon dactylon.*

Chemical Control of Weeds

Chemical weed control is preferred because of less labour involvement and no mechanical damage to the crop that happens during manual weeding.

Pre-Emergence Herbicides: Pre-emergence herbicide Pendimethalin @ 8-8.5 ml l^{-1} of water in 160-180 litres of water for one acre of wheat crop at 0-3 days after sowing. Pendimethalin controls both grasses and broad leaved weeds on wheat eco system.

Post Emergence Herbicides: Post emergence herbicides to be sprayed after first irrigation at 30-35 days of sowing or 2-3 leaf stage of weeds

Post Emergent Herbicides for both Grassy and Broad Leaved Weeds

1. Combination of 2, 4-D salt @ 4 gm l^{-1} and isoproturon 1.5 gm l^{-1} 160-180 litres of water for one acre of wheat crop for the control of mixed weed population.
2. Metribuzin 70 % @ 0.5 to 0.75 gm l^{-1} of water in 160-180 litres of water for one acre of wheat crop
3. Sulfosulfuron 75% W.G. @ 13 gm in 160-180 litres of water for one acre of wheat crop.
4. A mixture of Sulfosulfuron 75% W.G. @ at 13 g *Metsulfuron-methyl 20% WP* @ 8 g per acre in 160-180 litres of water for one acre of wheat crop.

Post Emergent Herbicides for Grassy Weeds

1. *Clodinafop*-propargyl @ 0.75-1 gm l^{-1} of water [or 160 gm per acre in160-180 litres of water for one acre of wheat crop.

2. *Fenoxaprop*-p-ethyl 9.3 % @ 100 ml per acre in 160-180 litres of water for one acre of wheat crop.

Post Emergent Herbicides for Broad Leaved Weeds

1. 2, 4-D @ 6 gm l^{-1} of water in 150-180 liters of water per acre.

2. *Metsulfuron-methyl 20% WP* @ 8 g per acre in 160-180 litres of water for one acre of wheat crop.

Do's and Don'ts for Spray of Herbicides in Wheat Eco System

1. Sufficient moisture should be present in the soil to take up for both pre and post emergent herbicides.
2. Post -emergent herbicides should be applied when weeds are at 2-3 leaf stage.
3. Herbicide sprays should be planned on clear and sunny days only when the leaves are dry.
4. Fenoxaprop containing herbicide should be sprayed with flat fan nozzle.
5. Sulfosulfuran containing herbicide should not applied in mixed cropping system of wheat and mustard or other crops.
6. Compulsorily use sticking and spreading agent for herbicide mix for increased efficiency of the herbicides

27. SUSTAINABLE AGRICULTURE 17491

Role of Phyto Remediation in Sustainable Agriculture

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INTRODUCTION: Phytoremediation is a part of bioremediation. It is the process that uses plants to remove, transfer, stabilize, and destroy contaminants from soil or water. It Clean up soil and or groundwater. It can remove organics, metals, leftover pesticides, explosives and radioactive waste.

Types of Phytoremidiation

1. **Enhanced Rhizosphere Biodegradation:** Occurs immediately surrounding plant roots. Plant roots naturally release nutrients to microorganisms in the soil - enhancing their biological activity. The roots also loosen the soil and then die, leaving water & aeration flow paths.
2. **Phyto-Accumulation or Phyto-Extraction:** Contaminant drawn in by plant roots by phyto-extraction, resulting in the translocation/ accumulation of contaminants into plant shoots and leaves.
3. **Phyto-Degradation (Phyto Stimulation):** Plants produce enzymes such as dehalogenase and oxygenase, which help catalyse degradation. This process metabolises the contaminants within plant tissues due to the enzymes.
4. **Phyto-Stabilisation:** Chemical compounds produced by plants immobilise contaminants at the interface of roots and soil.
5. **Phyto-Volatilisation or Evapotranspiration:** Volatile metals (such as mercury and selenium) are taken up, changed in species then transpired through the leaves.

Mechanism

Mechanism	Process	Contaminants	Media
Phyto-stabilisation	Containment	Pb, As, Cd, Cr, Cu, Zn,	Soil, Sediment, Sludges
Rhizo-degradation	Remediation by destruction	Organic compounds, Pesticides, Chlorinated solvents	Soil, Sediment, Sludges, Ground water
Phytoaccumilation	Remediation by extraction and capture	Ag, Au, Cd, Cr, Cu, Co, Hg, Mn, Mo, Ni, Pb, Zn, Radio nuclides	Soil, Sediment, Sludges
Phytodegradation	Remediation by destruction	Organic compounds, Pesticides, Chlorinated solvents, Phenols, Pesticides	Soil, Sediment, Surface water, Groundwater
Phytovolatilisation	Remediation by extraction from media and released to air	Chlorinated solvents, Some inorganic (Se, Hg, As)	Soil, Sediment, Surface water, Groundwater

Best Phytoremedial Plants

Indian mustard (*Brassica juncea* L.) **2**. Indian grass (*Sorghastrum nutans* L.) **3**. Willow (*Salix*species). **4**. Poplar tree (*Populus deltoides* W.) **5**. Sunflower (*Helianthus Annuus* L.).

Uses

- Metals, pesticides, solvents, explosives, crude oil and landfill leached outs. Plants can store all wastes, then would be harvested for the final removal.
- It is environmentally friendly and cost effective. Suited to remediation of large areas of soil.

Limitations

- Limited to shallow soils - limited by depth of roots. And slower method
- Some locations are offer only seasonal treatment - when plant 'in season'.
- The food chain could be adversely affectedby the degradation of chemicals.

Conclution: Water and soil sustainability is important for continuum of living organism. Through this newsletter, you will find a useful guidance on plants with proven qualities to naturally reduce, degrade or remove contaminants from soil and water.

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28. IRRIGATION 17444

Filtration Unit: A Heart of Micro Irrigation System

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Micro irrigation technique is the only solution to boost agriculture production in future or in water scarcity areas. The micro irrigation like drip and sprinkler irrigation are works efficient when selection of pump and filter unit is appropriate. Filter unit is also called as heart of drip irrigation system. Failure of micro irrigation system is only due to wrong selection of filter unit. Selection of a right type, shape and size of filter depends on the type and amount of contaminants or impurities in the irrigation water, size of the irrigation system and the desired management practices. This article encourages the farmer to select the right filtration unit based on the water source.

Water impurities/contamination: Water quality plays a very vital role in micro irrigation system. Water contains physical, chemical and biological contamination but its rate and type is depending upon the source of water. Water quality is the determining factor for selecting a filter in irrigation system. Irrigation water contain organic and inorganic contaminate. Some filters work well on inorganic particulate, such as sand and sediment and some deals with organic contaminants such as algae. Knowing the water quality, coupled with basic understanding on the available filter types, makes the filter selection process easier. Water impurities should be removed by using right filter type, sequence and size called as filtration process. Filtration is a vital process of any irrigation system. Filtration prevents solids from clogging of valves or accumulating in water-distribution piping system.

Plate 1: Disc filter along with fertigation unit drip irrigation system (Source: https://www.way2agribusiness.com)

Type of Filters

Based on the physical contaminants in irrigation water, the filters are basically four types as given below. The selection of one or combination of two filter is depends on the type and amount of contaminants present in the irrigation water.

1. **Screen Filters:** These are most frequently used for due to its simplicity and economical filtration method, available in of various shapes and sizes. These are made of metal, plastic or synthetic cloth enclosed in a special housing. Screen filters are recommended for the removal large- sized inorganic debris and very fine sand. This is not very much effective for the removal of heavy loads of algae or other organic material. When irrigation source is surface water then, screens are often used as secondary filters. Screen filters are normally designed to manage wide range of discharge rates. The selection of mesh size of screen filter is depends upon the ratio of area of openings of screen to the cross sectional area of the pipe and this ratio should be 2 or more (Dorota 2017). It is recommended to flush screen filter, when pressure drops more than 0.5 kg/cm^2
2. **Sand/Media Filters:** Media filters or sand filter has the uniform sized crushed sand filled in filter container. These filtration media is *crushed silica* sand / quartz gravel of particle size in the range of 0.027 to 0.047 inch with the effective filtration is at 75 micron (NCPAH 2011). The water passes through the small spaces between the media grains and impurities/debris/organic material has been trapped. Sand filter is effective for removing heavy organic and inorganic contaminates. The maximum pressure rating is 10 kg/cm^2. The contaminates (debris) present in the water accumulate in media grain and clog the pore space which causes the reduction of efficiency of the filter. The deposited debris in the media filter separates from the media by forcing water by reverse direction and flushed out through the flush valve. The precaution should be taken that media grain should not be washed out with debris. For proper functioning media filters need to be carefully matched with the system flow rate for proper and efficient operation.
3. **Disc Filters:** A disc filter consists of a stack of round discs. The face of each disc is covered with small bumps which create the tiny space between staked discs. Disc filters give the advantages as like as screen and media filter. Disc filters are good at removing both sand and organic matter present in the water. The organic particles present in the water are snagged by the sharp points on the bumps. For automatic cleaning of the filter discs are separated from each other, which removes debris through the

flush outlet.

4. **Hydro Cyclone Filter:** Hydro cyclone filter or Centrifugal filter is used when impurities in water are heavier like sand particle which cannot be clean by disc or screen or media filter. The dirty water when enters the filter where it is swirled around the inner surface of cylinder. The centrifugal force causes the sand particles to move towards the outer edge of the cylinder where gradually slides down to a holding tank placed at the bottom. Hydro cyclone filter is installed inside the well when the diameter of the well is more than 2.5 inches. This filter is used in combination with a sand/ media filter which minimizes clogging in the system preferably in drip irrigation system. It is observed that such filter becomes ineffective once the collection chamber is filled with dirt so flushing should be done at proper time. The hydro cyclone filter gives good results at nominal operating pressure of 2.04 kg/cm^2.

Table 1: Selection of filter as per the water source

Sr. No	Water source	Contaminates/impurities	Filter type
1	River water	Fine sand, organic impurities, mud particle, algae	Disc Filter, Media Filter and Screen Filter, Hydro cyclone and Media Filter.
2	Pond or lake	Mud particle, algae, organic impurities	Screen filter, disc filter, hydro cyclone filter and media filter.
3	Tube well	Sand particle and inorganic debris, algae	Screen Filter, Hydro cyclone Filter, or Disc Filter.
4	Open well	Mud particle, algae and organic impurities.	Screen Filter, Hydro cyclone Filter, or Disc Filter.
5	Canal water	Mud particle, algae, and organic impurities.	Screen Filter, Hydro cyclone Filter, or Disc Filter.

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29. AGRICULTURAL WASTE AND MANAGEMENT 17409

Utilization of Sugar Industry Wastes in Agriculture

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Sugar industry is the second largest agro-based industry in India after textile industry. During the manufacturing of white sugar, processing of sugarcane generates huge solid wastes (*i.e.* pressmud, bagasse, bagasse ash) (Bhat *et al.*, 2016). In India, on an average, processing of 100 tons of sugarcane in a factory yields 10 tons of sugar, 30-34 tons of bagasse (of which 22-24 tons is used in processing and 8-10 tons is saved), 4.45 tons of molasses, 3 tons of filter mud, *i.e.* press mud (Solomon, 2011). Proper disposal of these wastes is a big problem and concern. Open dumping of these wastes often cause environmental contamination and several health problems in humans. There is vast scope to use these sugar industry wastes in agriculture for enhancing crop productivity and enriching soil fertility. Among the different organic manures used, application of bio-compost prepared from press mud and distillery spent wash @3 t/ha gives the highest rice yield (5.15 t/ha) over control (3.7 t/ha) with improved soil microbial activity (Khrishnakumar *et al.*, 2005). The application of bagasse ash @2% for wheat has been found most suitable for improving the yield and physico-chemical properties of calcareous soil (Jamil *et al.*, 2004).

The sugar industry wastes have wide application in fisheries also. The application of 10 t/ha of pressmud significantly increases the survival rate and production of common carp (Keshavanath *et al.*, 2006). Also soil contamination of heavy metals like cadmium can be minimised with the application of diluted molasses on to the top of the soil surface @ 2000 kg/ha at heading or one week after heading in the rice grains (Toshimitsu *et al.*, 2012). The increase in sugarcane production implies a proportional increase in sugar industry wastes also. As a consequence sugar industries can assist in reversing the trend of soil degradation and can help in safe disposal of sugar wastes through proper waste management, which are otherwise causing severe environmental problems (Bhatnagar *et al.*, 2016). Out of the various by-products, if the entire amount of press mud alone is recycled in agriculture; about 32,464; 28,077; 14,038; 3434; 393; 1030, and 240 tonnes of N, P, K, Fe, Zn, Mn, and Cu, respectively, can be made available resulting in saving of costly chemical fertilizers (Dotaniya *et al.*, 2016). Therefore, concerted efforts are required to use sugarcane wastes/by-products as nutrient source and soil amendment for overall improvement of soil health and for ensuring high productivity, profitability and long term sustainability in agriculture.

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30. AGROMEREOROLOGY AND REMOTE SENSING AND GIS 17459

Geographic Information System

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DEFINITION: Geographic Information System (GIS) is a computer system build to capture, store, manipulate, analyze, manage and display all kinds of spatial or geographical data. GIS application is tools that allow end users to perform spatial query, analysis, edit spatial data and create hard copy maps. In simple way GIS can be define as an image that is referenced to the earth or has x and y coordinate and its attribute values are stored in the table. These x and y coordinates are based on different projection system and there are various types of projection system.

INTRODUCTION: Geographic information (*i.e.*, land information, spatial information) is information that can be associated with a place name, a street address, section/township, a zip code, or coordinates of latitude and longitude. A multitude of government functions require geographic information; at least 70 percent of all information used by local governments is geographically referenced. For example, property records and assessment, planning and zoning, permit tracking, natural resource management, infrastructure and transportation management, economic development planning, and health and public safety. All of these applications consider the location of certain features on the landscape in relation to other features. For instance, in assessment, the location of soil types relative to property parcels is considered, whereas in planning and zoning, the location of animal confinement facilities relative to residential areas might be relevant. A geographic information system (GIS) allows the user to examine and visualize these relationships.

Components of GIS

1. Hardware
2. Software
3. Data
4. People
5. Methods

Hardware: Hardware is the computer on which a GIS operates. Today, GIS software runs on a wide range of hardware types, from centralized computer servers to desktop computers used in stand-alone or networked configurations.

Software: GIS software provides the functions and tools needed to store, analyze, and display geographic information. Key software components are

- Tools for the input and manipulation of geographic information
- A database management system (DBMS)
- Tools that support geographic query, analysis, and visualization
- A graphical user interface (GUI) for easy access to tools

Data: Possibly the most important component of a GIS is the data. Geographic data and related tabular data can be collected in-house or purchased from a commercial data provider. A GIS will integrate spatial data with other data resources and can even use a DBMS, used by most organizations to organize and maintain their data, to manage spatial data.

People: GIS technology is of limited value without the people who manage the system and develop plans for applying it to real-world problems. GIS users range from technical specialists who design and maintain the system to those who use it to help them perform their everyday work.

Methods: A successful GIS operates according to a well-designed plan and business rules, which are the models and operating practices unique to each organization.

Application Areas

1. **GIS in Mapping:** Mapping is a central function of Geographic Information System, which provides a visual interpretation of data. GIS store data in database and then represent it visually in a mapped format. People from different professions use map to communicate. It is not necessary to be a skilled cartographer to create maps. Google map, Bing map, Yahoo map are the best example for web based GIS mapping solution.
2. **Agricultural Applications:** GIS can be used to create more effective and efficient farming techniques. It can also analyze soil data and to determine: what are the best crop to plant, where they should go, how to maintain nutrition levels to best benefit crop to plant. It is fully integrated and widely accepted for helping government agencies to manage programs that support farmers and protect the environment. This could increase food production in different parts of the world so the world food crisis could be avoided.
3. **Disaster Management and Mitigation:** Today a well-developed GIS systems are used to protect the environment. It has become an integrated, well developed and successful tool in disaster management and mitigation. GIS can help with risk management and analysis by displaying which areas are likely to be prone to natural or man-made disasters. When such disasters are identified, preventive measures can be developed.
4. **Landslide Hazard Zonation using GIS:** Landslide hazard zonation is the process of ranking different parts of an area according to the degrees of actual or potential hazard from landslides. The evaluation of landslide hazard is a complex task. It has become possible to efficiently collect, manipulate and integrate a variety of spatial data such as geological, structural, surface cover and slope characteristics of an area, which can be used for hazard zonation. The entire above said layer can well integrate using GIS and weighted analysis is also helpful to find Landslide prone area. By the help of GIS we can do risk assessment and can reduce the losses of life and property.
5. **Flood damage estimation:** GIS helps to document the need for federal disaster relief funds, when appropriate and can be utilized by insurance agencies to assist in assessing monetary value of property loss. A local government need to map flooding risk areas for evaluate the flood potential level in the surrounding area. The damage can be well estimate and can be shown using digital maps.
6. **Natural Resources Management:** By the help of GIS technology the agricultural, water and forest resources can be well maintain and manage. Foresters can easily monitor forest condition. Agricultural land includes managing crop yield, monitoring crop rotation, and more. Water is one of the most essential constituents of the environment. GIS is used to analyze geographic distribution of water resources.
7. **Soil Mapping:** Soil mapping provides resource information about an area. It helps in understanding soil suitability for various land use activities. It is essential for preventing environmental deterioration associated with misuse of land. GIS Helps to identify soil types in an area and to delineate soil boundaries. It is used for the identification and classification of soil. Soil map is widely used by the farmers in developed countries to retain soil nutrients and earn maximum yield.

31. SOIL SCIENCE 17449

Conservation Agriculture: A Way of Enhance, Nitrogen Use Efficiency

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The ‘Green Revolution’ paradigm for production intensification in South Asia to improving of genetic potentials of crops; application of high external inputs such as nutrients, water and pesticides and higher mechanization. The approach of 'more inputs- more output production system' is generally ecologically intrusive and economically and environmentally unsustainable, and has led to sub-optimal factor productivities and yield levels that are difficult and expensive to maintain over time.

DEFINITION:"Conservation agriculture (CA) is a knowledge-intensive farming approach to manage agro-ecosystems for improved and sustained productivity, increased profits and food security while preserving and enhancing the resource base and the environment (FAO, 2014)"

Three Pillars of Conservation Agriculture

1. No tillage and minimum soil disturbance,
2. Permanent organic soil cover and
3. Diversified crop rotations; including legumes do influence the soil nutrient dynamics.

CA Based Strategies for Enhance Nitrogen Use Efficiency

- CA helps to improved nutrient use efficiency (NUE) due to reduced soil erosion therefore preventing nutrient loss from the field. N loss may be minimized in CA due to reduced runoff and through appropriate use of deep-rooting cover crops that recycle nutrients leached from the topsoil (FAO, 2001).
- CA resulted significantly improving fertilizer use efficiency (FUE) 10-15% in the rice-wheat system, mainly as a result of better placement of fertilizer with the seed drill as opposed to broadcasting with the traditional system (Hobbs and Gupta, 2004).
- Longer-term experiments, release of nutrients increased with time because of microbial activity and nutrient recycling (Carpenter-Boggs *et al.*, 2003).
- Emphasize that return of crop residues do increase soil organic matter, and additionally, the increase is greater as more fertilizer N is used and represents a build up of a potentially larger labile pool of organic N in no-till systems.
- Such distribution of organic matter in contrasting tillage systems influences the dynamics and efficiency of N as the rate of microbial activity increases at the soil-residue interface.
- The above discussion generally suggested that N recommendations could be higher in no-till systems than conventional tillage systems, at least at the initial phases of establishment of a continuous no-till system till new steady state equilibrium between immobilization and mineralization is reached at a later phase and supply of N from the labile organic pool increases (Singh and Gangwar (2018).

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32. SOIL SCIENCE 17484

Management of Phosphatic Fertilizers and Factors affecting on its Availability in Soil

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The chemical characteristics of the soils and the P fertilizer source determine the soil-fertilizer reactions, which influence fertilizer P availability to plant. Based on the principles of soils-P behaviour, a number of approaches can be suggested to ameliorate deficiencies and excess of phosphorus in soils.

1. **Patterning fertilizer rates to fit soil phosphorus status:** Where P-fixing capacity is grossly unsaturated, optimum crop yields will likely require fertilizer rates that considerably the plant uptake of this element. As the saturation point is approached, however, fertilizer rates should be decreased to supply no more than the amount being taken up by the plants to prevent P from moving into the drainage waters.
2. **Placement of Phosphorus:** By localized (band) placement of the added P fertilizer, reactions with the bulk of the soils can be minimized and the maintenance of P availability enhanced. Initial movement of p away from fertilizer application site seldom exceeds 3 to 5 cm.
3. **Combination of ammonium and phosphorus fertilizers:** The plant uptake of P can be increased, especially in alkaline soils, if ammonium and phosphorus fertilizers are

combined; apparently the HNO3 production in the oxidation of the NH4 ions slows the formation of the more insoluble calcium phosphate compounds.

4. **Cycling of organic matter:** The judicious application of organic materials such as animal manures, green manures and plant residues can increase P availability. During the microbial breakdown of these materials, P is released slowly and can be taken up by the plants before it reacts with the soils.
5. **Controls of the soil pH:** By maintaining PH between 6&7, the availability of P can be optimized in most systems. Proper liming of acid soils can be helping achieve this range.
6. **Enhancement of mycorrhizal symbiosis:** For most plants, the mycorrhizal symbiosis can best be enhanced by fostering appropriate soil conditions through crop rotation, organic matter addition and minimum tillage.
7. **Choice of phosphorus-efficient plants:** By choosing plant species known to be efficient in their foraging for P, the potential for good growth can be enhanced.
8. **Reduction of runoff and sediment losses, especially from fertilized and manured land:** Never apply manure or fertilizer to frozen land, since much of the soluble compounds will be washed into streams and rivers. Use conservation tillage practices that minimized runoff and erosion. Use cover and crop residues to maximize movement of water into the soil rather than off it.
9. **Capturing excess phosphorus before it enters main stream channels:** The use of natural or constructed wetlands to tie up the P before it enters streams should be encouraged.

Factors Affecting the Availability of Phosphorus in Soil

- Amount of clay
- Type of clay
- Time of application
- Aeration
- Compaction
- Moisture
- Phosphate status of soil
- Temperature
- Other nutrients
- Crop
- Soil pH

Most crops recover only 10 to 30% of fertilizer Phosphorus during the first year of application. Recovery percentage varies widely, depending on Phosphorus source, soil type, crop grown, application method and weather, but much of the residual will be available to succeeding crops.

1. **Amount of clay**: Soils high in clay content will fix more P than those containing less clay.
2. **Type of clay**: Soils high in certain types of clay minerals like kaolinite, Al, Fe oxides and hydroxides (common in the regions of high rainfall and temperatures), and amorphous clay minerals like allophone, imogolite and humus-Al complexes (common in soils formed in volcanic ash) retain or fix more added P than other soils. Regardless of clay type, fertilizer P is converted to less available forms.
3. **Time of application**: The longer the soil and added P are in contact, the greater the chances for fixation. On high-fixing soils, the crop must use fertilizer p before fixation sets in.
4. **Aeration:** Oxygen is necessary for plant growth and nutrient absorption. It is also essential for microbiological breakdown of soil organic matter, an important P source.
5. **Compaction**: Compaction reduces aeration and pore space in the root zone. This reduces P uptake and plant growth. Compaction also decreases the soil volume plants roots penetrate, limiting their total access to soil P. the fact that P moves such short distances in most soils adds to the problem of restricted root growth and nutrient uptake brought on by compaction.
6. **Moisture**: Increasing soil moisture to optimum levels makes P more available to plants. But excess moisture reduces O_2, limiting roots growth and slowing P uptake.
7. **Phosphate status of soil**: Soils that have received more P fertilizer than crops have removed for several years may show an increased level of available Phosphorus. Current fertilization may be reduced if the soil level is high enough. It is important to maintain high soil P levels to support optimum crop production.
8. **Temperature**: When temperatures are right for good plant growth, they affect P availability very little. High temperatures encourage organic matter decomposition. But when temperatures are too high or too low, they can restrict P uptake by the plant.
9. **Other nutrients**: Applying other nutrients may stimulate Phosphorus uptake. Calcium on acid soils and sulphur, on alkaline soils seem to increase Phosphorus availability, as does ammonium-N. But Zinc fertilization with borderline P deficiency tends to restrict P uptake further.
10. **Crop**: Some crops have fibrous root and others tap root systems. Therefore, crops differ greatly in their ability to extract available P from the soil. Time and methods of P fertilization should be matched to the cropping system to ensure most efficient use.
11. **Soil pH**: In soil dominated by 2:1 type clays, solubility of various P compounds are largely determined by pH. Phosphates of Fe, Mn and Al have low solubility. They dominate in acid soil. Insoluble Ca and Mg compounds exist above pH 7.0. The most soluble or available P forms exist in the 6.0 to 7.0 range.

33. SOIL SCIENCE 17487

Impact of Organic Farming on Soil Properties

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INTRODUCTION: The role of organic farming is to either enhance or sustain the overall quality and health of the soil ecosystem. Organic farming is aimed at producing high quality food produce that is not only rich in nutrients but also contributes to health care and well-being of mankind. Since organic farming eliminates the use of most 'conventional' fertilizers, pesticides, animal drugs and food additives, it can improve soil, water and environmental quality and thus improve the overall quality of life. The objectives of environmental, social, and economic sustainability are the basics of organic farming. The key characteristics include protecting the long-term fertility of soils by maintaining organic matter levels, fostering soil biological activity, careful mechanical intervention, nitrogen self-sufficiency through the use of legumes and biological nitrogen fixation, effective recycling of organic materials including crop residues and livestock wastes and weed, and diseases and pest control relying primarily on crop rotations, natural predators, diversity, organic manuring, and resistant varieties. A great emphasis is placed to maintain the soil fertility by returning all the wastes to it chiefly through compost to minimize the gap between NPK addition and removal from the soil.

Impact of Organic Farming on Soil Properties

Impact of Organic Inputs on Physical Properties of Soil

The physical properties of soil denote structure, texture, bulk density, porosity, water-holding capacity etc and positive effects of organic farming on soil physical properties *viz*. soil structure, water holding capacity, soil aeration and soil temperature are well-reported Papadopoulos *et al*. (2014). Reported that organic management can improve soil structure, organic matter content, and porosity in soil. Crop rotation is an important component under organic farming which directly and indirectly influences the physical structure of soil. Accumulation of organic matter in soil during the lean phase has a direct influence in the modification of soil structure. The architectural form of different root systems of several crops included in the crop rotation also helps to modify the soil structure. Mulching of soil surface with organic materials renders the soil soft, pulverized, and humid that ultimately creates a congenial environment for beneficial microbes to maintain bulk density and porosity in the soil. Organic farming adds more organic matter to the soil, which is the basic requirement for improving soil health. Presence of this organic matter in soil increases its moisture retention capacity. A combination of crop residue mulching and no-tillage increases soil fertility, crop production, and control soil erosion. Further, residue decomposition adds organic matter to the soil, which contributes to reduce the soil hydrological response, increase soil water repellency that reduces infiltration rates. Application of organic fertilizer not only provides nutrient

34. SOIL SCIENCE 17525

Soil Solarization

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INTRODUCTION: Soil solarization is an advanced field technology for the control of soil borne pathogens and weeds. This non-chemical control procedure has been adopted by farmers in several parts of the world. It offers multiple pest control based on trapping solar radiation by tightly covering the soil usually with transparent polyethylene sheets. This result in a significant increase of 10-15 c above normal temperature of soil, temperature up to the point where most pathogens and weeds are vulnerable to heat effects.

Soil Solarization

Soil solarization is a non-chemical and nonhazardous technique of controlling many soil born pathogen and pest including weeds. This simple technique captures radiant heat energy from the sun, thereby causing physical, chemical and biological changes in soil. In this technique, transparent polyethylene film are placed on moist soil during hot summer month, increases soil temperature to levels lethal to several soil borne plant pathogens weed seeds and seedlings, nematodes and some soil inhabiting mites. Soil solarization treatment would raise the surface soil temperature by 8-12°C as compared to non-solarized soil.

Twelve Steps for Successful Soil Solarization

1. Plan to solarize a portion of your garden when solar radiation is optimal (June through August).
2. Avoid areas with shadows or north-facing slopes.
3. Roto till the soil to incorporate current weeds, crop residues, compost, fertilizers, etc.
4. Remove any sharp sticks, stalks, etc. that could puncture the plastic.
5. Thoroughly moisten the soil (or wait for a good soaking rain).
6. Cover the moist soil with clear, polyethylene plastic sheeting.
7. Bury the edges of the sheeting with soil, landscape timbers, etc. to prevent wind from getting underneath the plastic or hot air from escaping.
8. To achieve the highest solarization temperatures, cover the first sheet with another sheet of clear, polyethylene sheeting. (The first sheet may be black if the second sheet is clear.)
9. If you use two layers, create an air "gap" between the layers of sheeting with strips of insulation, small blocks of wood, bricks, etc. Avoid materials with sharp edges. Bury the edges of the second sheet.
10. Keep the top surface free of dust and water during the solarization period.
11. Remove the plastic after 4 to 6 weeks (perhaps sooner if hot, sunny clear days have been common).
12. When planting your field, avoid the outer edge (1-2 ft) of the solarized area.

Principles of Soil Solarization

Soil solarization involves trapping of solar heat / energy through polythylene covering to raise the soil temperature to the level where it becomes lethal. It was first introduced on a commercial scale in 1993, the characteristics that lead to its wide spread use are its relatively low cost, easy provability, excellent chemical resistance, toughness and flexibility, freedom from odour and toxicity, low water vapour permeability and in thin films transparency. Its density is about 0.92 g/cm. It is highly transparent to light in the spectrum of 0.3-3.6 cm except for two absorbance bands around 7 and 14 µm in the infra red spectrum. It reduces hest convection and water evaporation from soil to the atmosphere.

Component of Soil Solarization

1. Quality of Polyethylene film:
   - **a) Colour**: Clear or transparent polyethylene films should be used but not black films.
   - **b) Thickness**: Polyethylene film having 19-25 micrometer and 25-100µm thickness are more efficient.
2. **Soil Preparation**: Soil should be disked or turned over and raked smooth to provide even surface and to improve water penetration and to moisture the soil profile.
3. **Soil Moisture:** Soil can be moistened by 40-50 mm pre irrigation or by drip or furrow irrigation following laying of the polyethylene film, but care must be taken to apply the film as soon as possible to avoid water loss.
4. **Time and duration of soil coverage:** Killing of weed seeds and seedlings is related to time and temperature exposure. April-June in northern part is the best time for solarization of soil.

Solarization Cover

Effect of Soil's Physico-Chemical Properties

1. Soil Moisture and Temperature
2. **Chemical changes:** When soil is heated much of the resident micro-biota is killed and degraded, thus liberating the mineral nutrient (increase NH_4-N / NO_3-N, P_2O_5 & K_2O)
3. **Biological changes:** Effect of Solarization on soil microbiota are more selective Thermophilic and Thermotolerant fungi, bacteria survive and even flourish under solarization.

Beneficial Side Effects

1. Control of weeds and other pests.
2. Increase plant growth response (IPGR) – beyond disease control.
3. Combined with other method.

Limitation and Constraint

1. The major constraint in soil solarization is the high cost of polyethylene films.
2. In many part of India land is also left fallow during summer show their scope for utilizing soil solarization as weed management method without any adverse effect on succeeding crops.

Conclusion: It is user-friendly non hazardous, environmentally safe and after effective for more than one growing season or a year.

Soil solarization is a same and effective alternative for weed management other than chemical.

35. SOIL SCIENCE 17545

Effect of Soil Contaminants on Soil Health and Crop Performance

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INTRODUCTION: Soil contamination occurs by continuing accumulation of toxic compound, salts, radioactive material or disease-causing agent in soil more than its threshold concentration which causes undesirable changes in the soil environment and has the adverse effect on plant growth. It is mainly as a result of agricultural activities, industrial activities, and urban activities. The agricultural activities include the excess application of pesticides and herbicides. The industrial activities such as mining and smelting of metals, burning of fossil fuels, Toxic fumes, accidental spills of chemicals used for industrial purposes and direct discharge of industrial wastes to the soil. Improper disposal of urban waste, percolation of contaminated surface water to subsurface strata and leaching of wastes from landfills have also been the source of contamination. The commonly found chemical contaminants are petroleum hydrocarbons, polynuclear aromatic hydrocarbons, solvents, pesticides and heavy metals such as lead.

Common Sources of Soil Contaminants

- Accidental Spills
- Industrial accidents
- Nuclear waste
- Landfill and illegal dumping
- Mining and other industries
- Oil and fuel dumping
- Buried waste
- Disposal of coal ash
- Electronic waste
- Disposal of ammunitions and agents of war
- Agricultural practices
- Drainage of contaminated surface water into the soil

Some of the important sources are discussed below in detailed:

- **Pesticides:** When pesticides are sprayed over the crop, some parts get absorbed by crop, some get solubilizes and leach down below root zone, some get degraded by bacterial oxidation and chemical hydrolysis and remaining get to adhere to soil particle which moves through runoff towards lake and river and contaminates it. It remains in the soil for a long time and contaminates the soil because of its persistent in nature such as DDT, Chlordane, BHC, Aldrin having persistent timing 10, 11, 12 and 9 years, respectively.
- **Fertilizer:** Fertilizer contaminates the soil with impurities present in their raw material used for their manufacturing such as As, Pd, and Cd present in traces in rock phosphate transfer to superphosphate fertilizer. As metals are non-degradable, Heavy metals get accumulate in soil surface above at toxic level due to their indiscriminate uses.
- **Industrial waste:** Medicine, Metal, Paint, Leather, Oil, Pesticides, Plastics and Textile producing industries produce hazardous wastes mainly heavy metals (Lead, Mercury, Cadmium etc.), Organic chlorine compounds, organic solvents, Cyanides etc. Improper disposal of these hazardous wastes will contaminate the soil.
- **Garbage dumps/ Landfill:** Contribution of municipal waste generation in Bangalore city was higher by residential areas (52%) followed by Hotel and restaurants (19.30%) and by markets (14%). With the improper disposal of municipal waste will contaminate the soil by altering the physicochemical properties and also surrounding areas will get affected.
- **Accidental oil spills:** At most of the fuel station, oil leaks can happen during storage and transportation of chemicals which deteriorates the health of the soil and make it unsuitable for cultivation. These chemicals can enter into groundwater through the soil.
- **Rainwater:** Toxic chemical present in the atmosphere come back through rain and get deposited on the soil where they are held firmly with the soil particles by electrostatic forces.
- **Radioactive pollutants:** Nuclear dust radioactive wastes are being produced from explosions of nuclear testing laboratories and industries, which enters into the soil system and accumulates. Strontium90, Iodine-129, Cesium-137, and isotopes of Iron are the radioactive wastes which are toxic in nature.

What Happen to Soil Contaminant in Soil?

Once contaminants are added in soils, where they go and how quickly they travel depends on many factors. Contaminants can be organic or chemical element. Organic contaminants (carbon-based) undergoes chemical changes or degrade into products that may be more or less toxic than the original compound but chemical elements (such as metals) contaminants cannot break down, but their characteristics may change so that they can be more or less easily taken up by plants or animals. As in figure 1, through different sources surface water bodies get contaminated and using this contaminated irrigation water in agriculture field will deteriorate the soil quality along with produce contaminated food of poor quality. Through subsoil infiltration, contaminate moves and pollute groundwater. So directly or indirectly, human and health is getting affected.

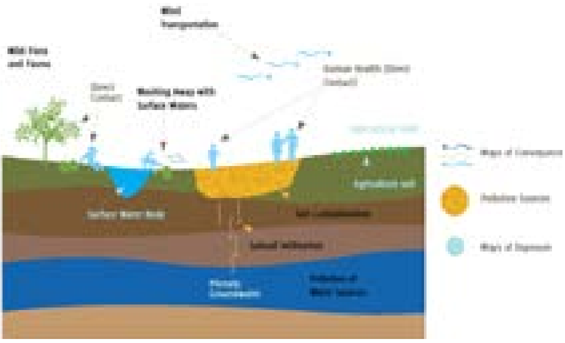

FIGURE 1. Fate of contaminants in soil

Effects of soil contamination on soil and crop: Soil contaminates which are highly toxic in nature will affect the soil health by declining number of soil organism, lack of essential nutrients and highly toxic element in soil. When we used contaminated soil for crop cultivation, it produces poor quality crop and fruits. As crop uptake toxic metal from contaminated soil and accumulates into it. Human being and livestock are being exposed to contaminated food by their consumption and drinking contaminated drinking water.

Steps to Reduce Soil Contamination

- **Proper dumping of unwanted waste:** Excess waste by man and animal pose a disposal problem. Open dumping is the most commonly practiced technique, which will contaminate soil environments.
- **Production of natural fertilizer:** Biopesticide should be used in place of toxic chemical pesticides. Organic fertilizers should be used in place of synthesized chemical fertilizer. Ex. Organic wastes in animal dung may be used to prepare compost manure instead of throwing them wastefully and polluting the soil.
- **Proper hygienic condition:** people should be trained regarding sanitary habits.
- **Public awareness:** Informal and formal public awareness programme should be imparted to educate people on health hazards through environmental education. Example: Mass media, educational institutions and voluntary agencies can achieve this.
- **Recycling and reuse**
- **Ban on toxic chemicals:** The chemicals which are more persistent in nature should be banned.

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36. AGRICULTURAL CHEMISTRY 17410

Transformation of Pesticides in the Environment

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SUMMARY: In order to feed the increasing human population, the food production has increased over the years. So the use of pesticides has also increased worldwide in order to protect the crops from pests and diseases. Once released into the environment, the pesticides undergo various fate processes including adsorption, volatilization, leaching, run off, biotic and abiotic transformation etc. It is an important mechanism for detoxification of pesticides in the environment. The transport and transformation of pesticides affect the persistence of the compounds in the environment. The misuse and overuse of pesticides has lead to problems of pesticide resistance, resurgence and contamination of different components of the environment. So an understanding of the fate processes of pesticides will help in risk assessment and taking probable measures to reduce the pollution load in the environment.

INTRODUCTION: Human population has almost doubled in the past 50 years, so has the global food production. Food plants of the world are damaged by more than 10,000 species of insects, 30,000 species of weeds, 100,000 diseases (caused by fungi, viruses, bacteria and other microorganisms) and 1000 species of nematodes (Dhaliwal *et al.*, 2010). So the use of pesticides has increased worldwide in order to protect the crops from pests and diseases. When a pesticide is applied to a field, it becomes distributed in the environment.

Various pesticide fate processes in the

environment include

A. Transfer: It is the way in which a pesticide is distributed between solids and liquids (*e.g.*, between soil and soil water) or between solids and gases (as between soil and the air it contains).

B. Transport: The movement of pesticides from one environmental compartment to another, such as the leaching of pesticides through soil to ground water, volatilization into the air, or runoff to surface water.

C. Transformation: Biological and chemical processes that change the structure of a pesticide or completely degrade it.

Adsorption and factors affecting it:

Once the pesticides are released into the environment, the first and foremost process happening to the pesticides is adsorption. Adsorption is probably the most important mode of interaction between soil and pesticides and controls the concentration of the latter in the soil-liquid phase. The process of adsorption, may be chemical in nature (as with electrostatic interactions) or purely physical (as with van der Waals forces). In the case pesticides, adsorption is the result of the electrical attraction between charged particles, pesticide molecules (sorbate) and soil particles (adsorbent). Frequently, pesticide molecules that are positively charged are attracted and can bind to negatively charged particles of clay and organic matter. The extent of adsorption depends on the properties of soil and the compound, which include size, shape, configuration, molecular structure, chemical functions, solubility, polarity, polarizability and charge distribution of interacting species, and the acid-base nature of the pesticide molecule (Senesi, 1992; Pignatello and Xing, 1996). From a toxicological point of view, binding of xenobiotics to humus lead to a decrease of material available to interact with biota, a reduction in the toxicity of the compound, and immobilising the pesticide, thereby reducing its leaching and transport properties. Adsorption affects other transport and transformation processes in the environment.

Various transport and transformations processes include volatilization, leaching, run off, microbial degradation etc.

Volatilization

Volatilization is defined as the process by which a compound evaporates to the atmosphere from another environmental compartment. The volatilization of pesticides from the soil and their subsequent dispersion in the atmosphere is a common occurrence. Volatilization is perhaps the most important route by which pesticides dissipate. The potential volatility of a pesticide is closely related with its vapour pressure, the pressure exerted by the vapour of a compound on its own solid or liquid surface at equilibrium, although it also depends on soil temperature, colloidal composition, porosity, structure, water content and pH, and on the nature and concentration of the pesticide in the soil, together with its degree of adsorption. It should be noted that pesticides showing physical (weak) adsorption volatilise much more readily than those showing strong (chemical) adsorption since they are easily substituted by water molecules.

Leaching

Leaching is the downward movement of pesticide through soil profile along with water. Pesticides that readily leach beyond the root zone of the soil are suspected to have the greatest potential to pollute ground water. Pesticides are frequently leached through the soil by the effect of rain or irrigation water but, for this to happen, the product must be sufficiently soluble in water.

Run Off

Run off is associated with erosion. Pesticides deposited in a soil remain closely bound to it, whether it is by adsorption or through simple mixing. The soil, therefore, acts as conveyor of the pesticide when its particles are moved from one place to another through the effects of wind or run-off, leading in certain cases to the contamination of surface waters (rivers, seas, lakes). A variety of factors intervene in this process, among the most important being the soil slope, the formulation of the pesticide and the time since its application, the soil's structural stability and the type of plant cover, rainfall intensity, and the physicochemical characteristics of the molecule in question and its degree of adsorption. In general, pesticide losses in run-off are most likely to occur when a heavy rainfall or excessive irrigation takes place shortly after a pesticide is applied to the soil surface.

Transformation of Pesticides

Once released into the environment, pesticides are subject to processes of abiotic and biotic transformation, often inducing the formation of stable compounds. These are most important mechanisms for detoxifying pesticides in soils. Generally pesticide transformation products will have a lower toxicity to biota than the parent compound. However, in some instances a transformation product may be more toxic

Eg: Transformation of Aldrin to Dieldrin (Aldrin: Rat acute oral LD_{50} = 67mg/kg

Dieldrin: Rat acute oral LD_{50} = 37mg/kg)

Various transformation processes include oxidation, reduction, hydrolysis, microbial degradation, etc. Various environmental factors and the structural variations affect the persistence of the compounds. Persistence is expressed in terms of half life which is the time required to degrade half of the initial quantity. The pesticides can be broadly divided into 3 classes based on persistence-low ($T_{1/2}$, 30 days) *e.g.*: captan, aldicarb, malathion, etc; moderate ($T_{1/2}$, 30-100 days) *e.g.*: aldrin, atrazine, carbaryl, etc. and high persistent compounds ($T_{1/2}$ > 100 days) *e.g.*: lindane, DDT, paraquat, picloram, etc.

Understanding of these fate processes will help in risk assessment and in taking appropriate measures to reduce the pollution load in the environment.

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37. HORTICULTURE 17434

Pro Tray Nursery Raising Technique For Vegetable Crops

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The Protray nursery is an upcoming technique for quality vegetable seedling production, where seedlings are produced under shade net and such seedlings have better germination, appears healthy and are protected from pest and diseases and build up well developed root system within 25-30 days. Presently, the commercial vegetable growers are quite aware about the importance of hybrid varieties as they are high yielding, uniform in maturity and can tolerate the effect of abiotic and biotic stresses and have better quality produce as compared to standard varieties / cultivars. Though the seeds of many hybrids are made available to the farmers, they lack the technical knowhow of producing quality seedlings. Hence, the production and timely distribution of quality seedlings of vegetables would be a greater scope to meet the growing demand. With this background the technology "Pro tray production of vegetable seedlings" is developed.

Protrays

Protrays are shallow plugs in which germination media remains warm and provides better aeration and seed are sown directly into plugs. Plugs per tray varies from 48-96 per tray. Trays are made of soft plastic to facilitate removal of seedling without damaging its roots. 96 celled trays which are 54 cm X 27 cm and 4 cm deep are commonly used for tomato seedling. Life of the tray depends on the handling and quality of trays.

Growing Media for Pro Trays

Coco peat, a by-product of coir industry having high water holding capacity is commonly used as media in protrays. Coco peat has 6 times water holding capacity to its weight. Coco peat should be supplemented with nutrients. Sterilizing the growing media reduces diseases and pest introduction and attack. Other recommended media are Coco peat + vermi-compost or vermi-compost + sand or soil loam + FYM in equal proportion.

The seedling raising techniques in protrays are as follows:

- Pro tray is to be filled with appropriate growing media (coco peat).
- Small depressions (0.5 cm) is to be made at the center of the plugs with finger tips to sow the seeds.
- One seed per cell to be sown in each cell followed by covering with medium.
- After sowing, 10 trays one over the other can be kept and is to be cover with a plastic sheet for about 3- 4 days. This helps in increasing temperature of media, maintains the humidity level and also enhances the seed germination.
- The trays are to be shifted to net house on germination of seeds and spread over the beds.
- Light irrigation is provided to trays with a fine rose spray depending upon the weather conditions. Over irrigation results in nutrient leaching and fungal attack.
- Coco peat is deficient in nutrients and therefore needs nutrient supplementation. Water soluble fertilizer (19:19:19) is sprayed @ 3 grams / liter of water on 12^{th} and 20^{th} days after sowing.
- Manual weeding should be carried out as and when necessary.
- The trays to be provided with protective cover from rain, hails, etc by covering polythene sheets in the form of low tunnel whenever it rains.
- The seedlings at the right stage of transplanting are hardened by withholding water and gradual reduction of shade. The seedlings are then transplanted at around 21 days after sowing. Before uprooting, the seedlings are irrigated to facilitate easy removal and minimum root damage.

Benefits of pro tray nursery raising technique: The benefits of pro tray nursery includes

- Production of pest free quality seedlings,
- Have independent area for each seed,
- Improves seed germination,
- Better root development,
- Minimizes seedling mortality and damping off disease,
- Provides uniform, healthy and early maturity,
- Easy handling and cheaper transportation and good main field establishment and crop stand.
- Since the hybrid seeds are expensive, this method helps to reduce cost by minimizing the

seed wastage.

38. HORTICULTURE 17454

Tamarillo, an Underexploited Fruit: Cultivation and Nutritional Importance

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INTRODUCTION: Tamarillo (*Cyphomandra betacea* Sendt.) belongs to the family Solanaceae, having basic chromosome number 12. It is native to Central and South America, predominantly in the Andes of Peru, Chile, Bolivia and Ecuador region. It is also known as tree tomato, Mexican husk tomato, tamamoro, Arbol de Tomate etc. Some of the other available species related to it are Casana (*Cyphomandra casana*), Mountain Tomato (*C. crassifolia*), Guava Tamarillo (*C. fragrans*). In India, it is majorly found in the north eastern region, but is not cultivated as much elsewhere due to its limited exploitation.

Photo: Tamarillo fruits

History: In the late 1800s, tree tomato was first introduced to New Zealand from Asia. There are only two available strains of the fruit in the original form *i.e.*, yellow and purple. In 1920, a red strain of tamarillo was developed from South American seed. The demand of tree tomato grew during World War II, because supply of high vitamin C enriched fruits were restricted. It is cultivated commercially in New Zealand, Argentina, Brazil, Colombia and Venezuela. In 1967, the name "tree tomato" was officially changed to "tamarillo" to avoid confusion with the common tomato.

Botany: Tamarillo is a small, semi woody, evergreen or somewhat deciduous shrub that has a brittle shallow rooting system. In India, it is mainly grown as a house plant but normally it grows up to a height of about 10-18 ft. Leaves are heart shaped, odorous, alternate, ovate and pointed at the apex regions. Flowers are pink in colour, small, self pollinating and born in loose clusters near the branch tips. Fruits are borne in clusters (3 to 12) or sometimes singly. The fruits are smooth and vary in colour (dark red, red and yellow), 2-4 inches long and 1-2 inches wide, egg-shaped but pointed at both the ends. Flesh colour varies accordingly. The flesh is slightly firm, succulent, bland and orange-red/ orange-yellow in colour. The pulp is soft, juicy, and sweet/tart (the yellow type is a little sweeter). The seeds are edible, thin, flat, circular, hardy and longer than common garden tomato.

Uses and Nutritional Importance

In North East India, tree tomato is eaten raw as a fruit or in salads. It seems like it has a great demand in the near future as the fruits are used to prepare products like sauces, jams, juices, ice creams etc. The nutritional values given in table-1, clearly indicate that tamarillo is a rich source of vitamins (A, C, E, niacin, thiamine and riboflavin) and minerals (Iron, Phosphorus and Calcium).

Tamarillo is an excellent source of antioxidants, which helps protect the skin, liver, pancreas etc. from oxidative stress due to the presence of anthocyanin, phenols and flavonoids. It helps improve the immune system of our body because of its high nutrient value. The fruits have anti-microbial, anti-aging and anti-inflammatory properties. The fruit contains potassium that counters the harmful effects of sodium on the heart and magnesium, which facilitates the proper functioning of the cardiovascular system. It protect the eyes from infections (*i.e.*, cataract, macular degeneration etc.) and maintains a healthy eyesight because of its high Vitamin-A content. Tamarillo juice acts as detoxifier and also helps in weight loss due to its acidic nature. It helps cure tonsillitis, prevent cancer, and reduce pain. Its chlorogenic acid content helps in lowering blood sugar levels in type-II diabetes mellitus. Tamarillo helps arrest the absorption of bad cholesterol in the body due to its high fiber content.

TABLE 1: Nutritional values of Tamarillo fruits (per 100 g of edible portion)

Composition	Values	Composition	Values
Moisture	82.7-87.8	Calcium	3.9-11.3 mg
Protein	1.5 g	Iron	0.66-0.94 mg
Carbohydrates	10.3 g	vitamin A	540 I.U.

Composition	Values	Composition	Values
Fat (ether extract)	0.06-1.28 g	Thiamine	0.038-0.137 mg
Fiber	1.4-4.2 g	Riboflavin	0.035-0.048 mg
Ash	0.61-0.84 g	Niacin (with seeds)	1.10-1.38 mg
Phosphorus (with seed)	52.5-65.5 mg	Niacin (without seeds)	1.011 mg
Phosphorus (without seeds)	13.1 mg	Ascorbic acid	23.3-33.9 mg

Cultivation Practices

Tamarillo grows best in partial shade and can even survive in fairly low temperatures, but is sensitive to water logged, hot and dry conditions. It requires light soil which is enriched in organic matter and is well drained. Some of its available cultivars are Goldmine, Inca Gold, Ecuadorian Orange, Oratia Red, Ruby Red, Solid Gold. It is propagated both through seeds and cuttings. Seed propagated plants develop high branching erect trees, as compared to cutting propagated plants which are shorter and bushy. Cuttings of 18 to 30 inches length (taken from a 1-2 year old plant) can be directly planted in the field, but does not bears fruits in the first year. A recommended dose of 0.5-2 lbs of 5:6:6 NPK should be given per tree. The fruits are ready to harvest when the yellow or red colour develops. Tamarillo is highly tolerant to pests and diseases; however under severe conditions, it is attacked by green aphids, fruit flies, powdery mildew, cucumber mosaic virus and potato virus. It shows resistance against tobacco mosaic virus. The fruits can be stored for 10 weeks in a refrigerator, but show skin discolouration under temperature below 38°F.

39. HORTICULTURE 17464

Hydro Seeding and Hydro Mulching

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Hydro Seeding

Hydro seeding is applying a slurry of water, wood fiber mulch, seed and fertilizer to prevent soil erosion and provide an environment conducive to plant growth.

On steep, highly erosive slopes which have been partially or completely denuded of vegetation due to a land disturbance such as fire. This is a fairly expensive erosion control method which is often reserved for areas which are close to roads, bridges, homes and other structures. Use is often restricted due to lack of access roads and a nearby water supply. Slope lengths of 125 to 225 feet can be treated.

Hydro Mulching

Hydromulching is similar to hydroseeding, but it adds a fibre-mulch to the mixture of seed, fertiliser and water. The mulch acts as a cover for the seed, helping it retain moisture for faster germination and growth, while protecting the soil from erosion and the seeds from washing away in the rain.

The hydromulching mix is applied in the same way as hydroseeding and typically consists of a slurry of seed, fertiliser, water, tackifiers, biologically active soil conditioners, an optional colour dye, and organic mulch fibres which will degrade over several months.

Hydroseeding and Hydromulching Benefits

Hydroseeding and hydromulching are efficient and sustainable methods of rehabilitating and revegetating cleared lands on construction or mine sites, especially when compared to traditional forms of seeding.

Hydroseeding and Hydromulching

- Low initial cost compared to other treatments.
- Are faster and easier to install than traditional seeding methods.
- Typically cost less than laying turf or hand seeding.
- Hold soil moisture to support faster vegetation growth.
- Protection from surface erosion due to raindrop impact.
- Minimise erosion to support strong, healthy vegetation growth.
- Retain water so that far less water is required.
- Are completely safe, non-toxic and environmentally friendly seeding methods.
- Conforms closely to the soil surface which may result in less erosion due to surface rilling.
- Vegetation provided by seed provides long-term control of erosion.

Limitations

- Surface Treatment only - does not improve underlying soil structure, improve soil

microbiology, restore nutrient reserves, or restore compacted soils and may not provide the conditions necessary for successful vegetative cover.
- Higher application rates required for steeper slopes may inhibit germination of seed and establishment of long-term vegetation.
- Consider using Erosion Control (Seeding) instead.
- Inefficient technique to treat disturbed areas less than 0.5 acre.


FIG: Spraying of Hydromulching and Hydroseeding

40. HORTICULTURE 17467

Vertical Farming: A High Tech Indoor Farming

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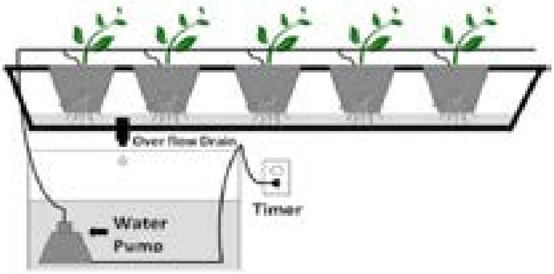
The population of cities in India continues to expand exponentially. It is predicted that by 2050, 55% of Indians will be living in urban areas. Traditional agricultural industry is challenged to keep pace with this as it is estimated that agricultural land capacity can increase by 2% only. One solution to our need for more space might be found in the abandoned warehouses in our cities, new buildings built on environmentally damaged lands. This solution, called **vertical farming**. Vertical farming a possible replacement to conventional farming in future. It involves growing crops in controlled indoor environments, with precise light, nutrients, and temperatures. In vertical farming, growing plants are stacked in layers that may reach several stories tall. The concept of vertical farming has gained the serious attention of planners and academic communities in India. Vertical farming represents a proactive thinking approach that aims to ensure the sustainability of cities by addressing the issue of food security. The current practices of supplying food to urban areas suffer from environmental and economic problems, such as the inefficient practice of transporting food great distances. As an answer to these problems, the vertical farm will grow food efficiently and sustainably by saving energy, water, and fossil fuels, reducing toxins and restoring ecosystems, as well as providing new opportunities for employment. Therefore, the vertical farm may offer opportunities in the three pillars of sustainability: environment, society, and economy.

Types of Vertical Farms

Vertical farms come in different shapes and sizes, from simple two-level or wall-mounted systems to large warehouses several stories tall. But all vertical farms use one of three soil-free systems for providing nutrients to plants-hydroponic, aeroponic or aquaponic. The following information describes these three growing systems:

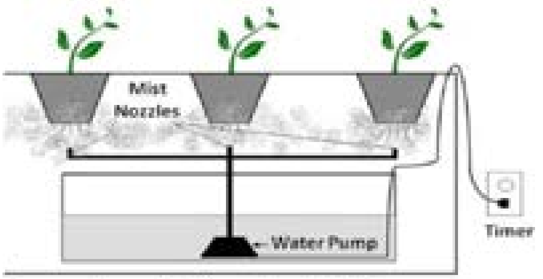
1. **Hydroponics:** The predominant growing system used in vertical farms, hydroponics involves growing plants in nutrient solutions that are free of soil. The term is derived from the Greek

words hydro and ponos, which translates to "water doing labor" or "water works". The plant roots are submerged in the nutrient solution, which is frequently monitored and circulated to ensure that the correct chemical composition is maintained



Hydroponic graphic. Illustration: NCAT

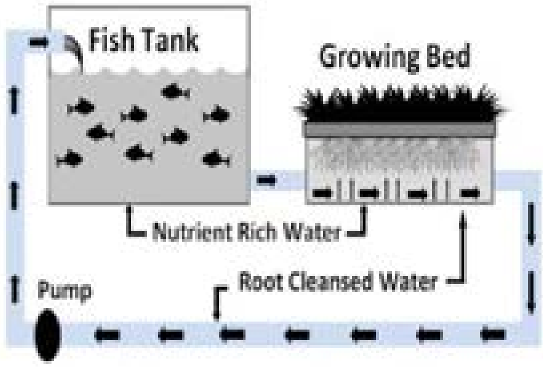
2. **Aeroponics:** They defined as "growing plants in an air/mist environment with no soil and very little water". Aeroponics systems are still an anomaly in the vertical farming world, but they are attracting significant interest. An aeroponic system is by far the most efficient plant growing system for vertical farms, using up to 90% less water than even the most efficient hydroponic systems. Plants grown in these systems have also been shown to uptake more minerals and vitamins, making the plants healthier and potentially more nutritious.



Aeroponic graphic. Illustration: NCAT

3. **Aquaponics:** An aquaponic system takes the hydroponic system one step further, combining plants and fish in the same ecosystem. Fish are grown in indoor ponds, producing nutrient-rich waste that is used as a feed source for the plants in the vertical farm. The plants, in turn, filter and purify the wastewater, which is recycled to the fish ponds. Although aquaponics is used in smaller-scale vertical farming systems, most commercial vertical farm systems focus on producing only a few fast-growing vegetable crops and don't include an aquaponics component. This simplifies the economics and production issues and maximizes efficiency.

Aquaponic graphic. Illustration: NCAT



What are the Pros and Cons of Vertical Farms?

1. **Continuous Crop Production:** Vertical farming technology can ensure crop production year-round and the production is much more efficient than land-based farming.
2. **Elimination of Herbicides and Pesticides:** The controlled growing conditions in a vertical farm allow a reduction or total abandonment of the use of chemical pesticides. Some vertical farming operations use biological controls when needed to deal with any infestations.
3. **Protection from weather-related variations in crop production:** Because crops in a vertical farm are grown under a controlled environment, they are safe from extreme weather occurrences such as droughts, hail, and floods.
4. **Water Conservation and Recycling:** Hydroponic growing techniques used in vertical farms use about 70% less water than normal agriculture (and aeroponic techniques, which involve the misting of plant roots, use even less water).
5. **Climate and People Friendly:** Growing crops indoors reduces or eliminates the use of tractors and other large farm equipment commonly used on outdoor farms, thus reducing the burning of fossil fuel. Some common occupational hazards that are avoided in vertical farming are accidents in operating large and dangerous farming equipment and exposure to poisonous chemicals.

In spite of these perceived advantages of vertical farms, Below is a summary of the perceived disadvantages of vertical farming:

1. **Land and Building Costs:** Urban locations for vertical farms can be quite expensive. Some vertical farms are based in abandoned warehouses or superfund sites, which can be more economical for construction.
2. **Energy Use:** Although transportation costs may be significantly less than in conventional agriculture, the energy consumption for artificial lighting and climate control in a vertical farm can add significantly to operations costs.

3. **Pollination Needs:** Crops requiring insect pollination are at a disadvantage in a vertical farm, since insects are usually excluded from the growing environment. Plants requiring pollination may need to be pollinated by hand, requiring staff time and labor.

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41. HORTICULTURE 17472

Mariculture

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INTRODUCTION: Mariculture is the farming of aquatic plants and animals in salt water. Thus, mariculture represents a subset of the larger field of aquaculture, which involves the farming of both fresh-water and marine organisms. The major categories of mariculture species are seaweeds, mollusks, crustaceans, and finfish.

Recent information indicates that the total amount of seafood (including fresh-water species and aquatic plants) is about 140 million metric tons annually. Over 20 percent of the total comes from aquatic plants (mostly seaweeds). Marine fish account for only 2 percent of the total.

Mollusks (clams, oysters, abalone, scallops, and mussels) represent the most important species cultured in marine waters. Seaweeds (brown, red, and green) are a close second. While most people do not think that they eat much (or any) seaweed, extracts from seaweeds can be found in everything from toothpaste and ice cream to automobile tires. Seaweeds themselves are dried and used directly as human food in many parts of the world.

Crustaceans include shrimp, crabs, lobsters, and crayfish. While shrimp culture has become a major industry in Asia and Latin American since the early 1980s, global production is far less than that of mollusks and seaweeds. Marine fish production is even smaller. Top finfish groups include Atlantic salmon, milkfish, sea bream, sea bass, red drum, yellowtail, striped bass, and hybrid striped bass.

The top mariculture-producing countries include the following:

Country	Species Produced
China	mollusks, shrimp
Japan	algae, mollusks, yellowtail, sea bream
Taiwan	mollusks, shrimp, eels
Philippines	algae, shrimp, milkfish
United States	mollusks, shrimp, Atlantic salmon, red drum
Norway	Salmon
Ecuador	Shrimp
Republic of Korea	algae, mollusks
Indonesia	algae, shrimp, milkfish

Types of Operations

Various levels of technology are involved in mariculture, the lowest giving nature the major role in producing the crop. The culturist may help prepare the growing area but does little else. For example, oyster culturists may place old shells on the bottom to provide places for a new generation of oysters to attach.

The oysters feed on wild **phytoplankton** and are harvested when they reach the proper size. The next level would be to spawn oysters in a hatchery and allow the larval oysters (called spat) to settle on oyster shell, after which the shell is placed on the oyster bed in bays or suspended on ropes from a raft. Mussels and scallops also can be grown on ropes below rafts.

The culture of blue mussels on long ropes is common in the bays and inlets of Nova Scotia, Canada. This mollusk is economically important to local growers, even though it represents only a small fraction of the province's mollusk production.

Ponds: Shrimp and various species of marine fishes are often grown in ponds. The young shrimp and fish are usually produced in hatcheries, though collection of young animals from nature has been used in the past and is still used in some cases. The ponds may be filled with sea water by pumping water, or through tidal flow (the farmer opens the floodgate when the tide is rising and closes it when the pond is full). Depending on the particular species being produced and the size at stocking, the time required for the animals to reach market size can range from a few months to nearly 2 years.

Pens and Cages: In addition to ponds, marine fish also are being reared in floating pens or cages in protected bays. Most cultured salmon are produced in these types of facilities, primarily in Norway, Canada, the United States, Scotland, and Chile. Various other fish species also are being produced in pens and cages in Japan, Europe, and the Middle East. In recent years, there has been interest and a limited amount of activity associated with cage culture in offshore waters.

Indoor Facilities: The highest level of technology is associated with indoor facilities in which the animals are grown in raceways or tanks (circular raceways) that receive pumped seawater that may be taken directl y from the ocean. The water may be flowed through the tanks and discarded, or it may be recirculated, that is, reused by passing it through an elaborate water treatment system. Marine species can be reared to market size in such facilities, but they are most commonly used as hatcheries and to hold broodstock (adults used for reproduction).

Considerations: While a number of species are being reared successfully by mariculturists, several desirable ones have not yet been produced economically. This lack of commercial production is because their life cycles either are difficult to control under culture conditions or are very complex. In addition, a number of popular food animals are highly cannibalistic. Various species of crabs and lobsters, for example, are difficult-to-rear species that also are cannibalistic.

Opposition to mariculture has developed in several countries since the 1980s. Many people do not want to see pens and cages in their bays, and they are concerned about possible environmental impacts associated with mariculture. Scientists are attempting to address these and a variety of other issues that have been raised. The goal is to produce high-quality seafood in an environmentally responsible manner.

Although world fish production from capture fisheries leveled off during the 1990s, demand for seafood continues to increase. This is because of the growth of the human population and also the view that seafood is healthy food.

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42. HORTICULTURE 17478

Heavy Metal Contamination and Health Risk in Vegetable Crops

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Vegetables being rich sources of essential nutrients and antioxidants are taken as a common diet by populations throughout the world. However, now a days vegetables grown in industrial areas are getting contaminated with heavy metals which disturbing biological and biochemical processes in the human body. The term heavy metal refers to any metallic chemical element that has a relatively high density and is toxic or poisonous at low concentrations. The heavy metals contamination is one of the problems that arise due to the increased uses of fertilisers and other chemicals to meet the higher demands of food production for human consumption. Heavy metals are the major contaminants of food supply and may be considered the most important problem to our environment. Most common heavy metals are lead (Pb), mercury (Hg), cadmium (Cd) and arsenic (As). Among these cadmium and lead are the most toxic element to human beings.

Properties of Heavy Metals

- They have high densities (> 5.5 g/cm^3)
- They are toxic in nature
- They are non-degradable and considered as "conservative pollutant" because they are not degraded by bacteria and permanent

Sources of Contamination of Heavy Metals

Although heavy metals are naturally present in the soil but geologic and anthropogenic activities mainly increases the concentration of these elements to amounts that are harmful to plants, animals and human beings.

Natural Sources

- Natural phenomena such as weathering and volcanic eruptions have also been reported to significantly contribute to heavy metal pollution

- Forest fires was found to contain high levels of arsenic, cadmium, copper and lead which can lead to soil solution and water resources contamination\
- Leaching to river, seas and ocean due to the action of water can also play a major role in the heavy metal contamination.

Anthropogenic Sources

1. **Agricultural Activities:** Phosphatic fertilizers contain various amounts of Zn, Cd, and other heavy metals depending from which parent rock the fertilizer has been produced. Pesticides are used for insect and disease control in high-production agriculture and can be applied as seed treatment, by spraying, dusting, or by soil application. Their application lead to increased accumulation of heavy metals, especially of Hg from methyl mercurials of As, and of Pb from lead arsenate into soils and groundwater.
2. **Mining and Smelting of Metal:** Mining activities can lead to the generation of large quantities of heavy metal laden wastes which are released in an uncontrolled manner, causing widespread contamination of the ecosystem. Though some heavy metals classified as essential are important for normal life physiological processes, higher concentrations above stipulated levels have deleterious effects on human health and biota.
3. **Sewage Sludge:** Sewage sludge is a by-product of domestic sewage and waste water treatment. Sludge consists mainly of organic matter rich in nutrients such as N and P and can therefore be used to replenish farmlands of depleted soil. Due to the nature of the physicochemical process involved in waste water treatment, sludge tends to concentrate heavy metals and other harmful constituents present in waste water.
4. **Burning of Fossil Fuel:** Fossil fuels, which include coal, natural gas, petroleum, shale oil, and bitumen, are the main sources of heat and electrical energy. All these fuels contain—besides the major constituents (carbon, hydrogen, oxygen)—other materials including metal, sulfur, and nitrogen compounds.

Toxic Effect of Heavy Metals in Vegetables

HMs have adverse effects on physiological and biochemical function of plants, most obvious effects are the inhibition of growth rate, chlorosis, necrosis, leaf rolling, altered stomatal action, decreased water potential, efflux of cations, alterations in membrane functions, inhibition of photosynthesis, respiration, altered metabolism, and activities of several key enzymes. The excessive intake of heavy metals from the soil creates dual problems; first the harvested crops get contaminated, which serve as a source of heavy metal in our diet, and secondly the crop yield decline due to the inhibition of metabolic processes. It is observed that excess Cr decreased the water potential and transpiration rate with increasing diffusive resistance and relative water content in cauliflower. Mercury toxicity in plants leads to reduction of photosynthesis. Cadmium toxicity show visible symptoms of injury reflected in terms of chlorosis, growth inhibition, browning of root tips and finally death.

TABLE: Effect of heavy metal toxicity on vegetables

Heavy metal	Crops	Toxic effect on plant
As	Tomato	Reduced fruit yield; decrease in leaf fresh weight
Cd	Garlic	Reduced shoot growth; Cd accumulation
Co	Tomato	Reduction in plant nutrient content
Cr	Tomato Onion	Decrease in plant nutrient content. Inhibition of germination process; reduction of plant biomass.
Hg	Tomato	Reduction in germination percentage; reduced plant height; reduction in flowering and fruit weight; chlorosis

Health Risk due to Heavy Metal Contamination

Ingestion of vegetables containing heavy metals is one of the main ways in which these elements enter the human body. Once entered, heavy metals are deposited in bone and fat tissues, overlapping noble minerals. Slowly released into the body, heavy metals can cause an array of diseases. Mercury can lead to skin burns, damage to the kidneys, damage to vision, Minamata disease and irritation of nose and skin. Lead can damage nervous system, liver and kidney, mental retardation in children, breaks the blood-brain barrier and interferes with the normal development of brain in infants. Arsenic can cause bronchitis, lung cancer, diarrhea, severe vomiting, Dermatitis whereas cadmium can cause lung diseases, lung cancer, Kidney problems and severe pain in joints

Conclusion: Food safety is a major concern worldwide. Consumption of vegetables grown in polluted sites can cause serious consequences on human health. Therefore, there is a relevant necessity for regular assessment and monitoring of these heavy metals in urban grown vegetables especially in industrially polluted areas to ascertain the level of heavy metal contaminants. Besides emphasis should be given in selection of vegetables for cultivation on such contaminated soils depending on their metal uptake potential and their distribution to edible part.

43. HORTICULTURE 17490

Nutritional Management in Citrus Orchards

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In sub mountain zones of Punjab and Haryana, surveys revealed that wide spread of potassium deficiency in the Kinnow orchards, with most of the orchards surveyed having soil and foliar potassium levels are below optimum. Now a day's deficiency of zinc and manganese was also observed in citrus orchards.

Nutritional status of citrus plants can be judged through the leaf analysis technique. This technique is most reliable guide to diagnose or to confirm deficiencies or toxicities and to determine nutritional status of macro and micro elements of citrus plant. Four to eight month old leaves immediately behind the fruit or the middle leaf from non fruiting shoots are taken for the analysis. April growth is suitable for judging the nutrient status of the citrus tress. Take 4-8 leaves per tree, two from each side at the working height of 1-2 meter, and take a total of at least 100 leaves. Take sample diagonally, from about 10-15 % trees representing uniform area and plant material. Collect leaf samples in a polythene bag, keep the bags in an ice box and then send to leaf analysis laboratory.

Potassium deficiency is very common in the soils of sub mountain zone of Punjab and Haryana. With potassium deficiency, fruits become small with a very thin, smooth and well colored rind and may be subject to splitting or drop. Three foliar sprays of Potassium nitrate (1.0%) at the end of May, June, July may also be helpful in improving the fruit quality in Kinnow mandarin. The deficiency of potassium may be ameliorated by applying muriate of Potash as soil application.

In citrus, Zinc deficiency is very common in the bearing orchards, and symptoms first appear on new leaves as irregular chlorosis commonly known as "mottled leaf". The terminal leaves become small and narrow and internodal length is reduced. Fruit bud formation is severely reduced, giving rosette appearance to the twigs followed by die-back. Excessive use of nitrogenous and phosphate fertilizers may also induce zinc deficiency in citrus. To control zinc deficiency, spray Zinc sulphate solution 0.47% (4.7 g/lit of water) on spring flush in end April and late summer flush in mid- August. Foliar application should be given to fully developed flushes.

In the initial stage of manganese in citrus, the leaf lamina becomes light green with a fine network of green veins. Leaf size remains normal. Generally, the deficiency of manganese occurs in the alkaline soils. The combined foliar application of 1000 ppm Zinc (4.7 g Zinc sulphate /lit of water) and 1000 ppm Manganese (3.3 g Manganese sulphate/lit of water) during end-April and mid-August to Kinnow mandarin improve yield and fruit quality by correcting the deficiencies of these micro-nutrients.

Managed nutrition programme is a key to economize the use of inputs for quality production of citrus fruits. Citrus plant needs application of the manures and fertilizer at critical growth stages, when the plant has a demand for nutrition. The quantity of fertilizers can be adjusted as per the soil testing report and nutritional status of the soil.

TABLE 1: Fertilizer schedule for citrus plants (other than Kinnow)

Age of the tree (year)	Dose per tree		
	Farm yard manure (kg)	Nitrogen (g)	Urea (46 % N) (g)
1-3	5-20	50-150	100-300
4-6	25-50	200-250	400-500
7-9	60-90	300-400	600-800
10 and above	100	400-800	800-1600

TABLE 2: Fertilizer schedule for Kinnow mandarin

Age of the tree (year)	Dose per tree				
	Farm yard manure (kg)	Nitrogen (g)	Urea (46 % N (g)	Phosphorous (g)	Super Phosphate (16 % P_2O_5)
1-3	10-30	110-330	240-720	-	-
4-7	40-80	440-770	960-1680	220-385	1375-2400
8 and above	100	880	1920	440	2750

Fertilizer experiments shows that application of potassium (K_2O) equivalent to the amount of nitrogen give good result in terms of better growth, productivity and fruit quality in Kinnow. It has also been observed that successful citrus growers in Punjab and Haryana apply 1.5 to 2.0 kg muriate of Potash every year along with farm yard manure to the bearing Kinnow plants. Entire farm yard manure should be applied during December. Nitrogen has to be applied in split doses, first half is to be applied in February (before flowering) and second half has to be applied from April-May (after fruit set). Apply the full phosphorous dose along with the first dose of nitrogen.

44. HORTICULTURE 17496

Role of Bio-Fertilizers in Organic Vegetable Production

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INTRODUCTION: Organic farming has emerged as an important priority area globally in view of the growing demand for safe and healthy food and long term sustainability and concerns on environmental pollution associated with indiscriminate use of agro-chemicals. Though the use of chemical inputs in agriculture is inevitable to meet the growing demand for food in world, there are opportunities in selected crops and niche areas where organic production can be encouraged to tap the domestic export market.

Bio-fertilizers are being essential component of organic farming are the preparations which contains living microorganisms, when applied to seed, plant surfaces, or soil, colonizes the rhizosphere or the interior of the plant and promotes growth by increasing the supply or availability of primary nutrients to the host plant. Bio-fertilizers add nutrients through the natural processes of nitrogen fixation, solubilising phosphorus, and stimulating plant growth through the synthesis of growth-promoting substances. It can also defined as the biologically active products containing active strains of specific microorganisms like bacteria, fungi, algae or combinations which may help in increasing crop productivity by the way of biological nitrogen fixation, Solubilization of insoluble nutrients, Stimulating plant growth or decomposition of plant residue. These are totally harmless, pollution free and low-cost renewable agricultural inputs.

Why Biofertilizers?

Biofertilizers are eco-friendly, inexpensive and ensure constant supply of almost all nutrients throughout the growth. In contrast chemical fertilizers are not eco-friendly these have an adverse effect on soil and environment, second reason is Increasing the irrigation needs of the land, Chemicals causes environmental hazard, Reduction in natural fertility of the soil like destruction of soil structure, aeration and water holding capacity. Biofertilizers are supposed to be safe alternative to chemical fertilizers to minimize the ecological disturbance. The other plus points being, after using 3-4 years continuously, there is no need of application of biofertilizers because parental inoculums are sufficient for growth and multiplication.

Concept of Biofertilizer

Biofertilizer concept goes back as early as 300 BC when our ancestors realized the importance of legume crops bearing nodules. The perspective of biofertilizer came into existence through discovery of many organisms capable of nitrogen fixation, P-solubilization, P. mobilization, potash solubilization and micronutrient transformation in the soil. The role of biofertilizers assumes special significance due to increased cost of chemical fertilizers and their ill effects on soil health.

Biofertilizers used in Vegetable Crops

1. **Rhizobium:** It is aerobic bacteria fixes atmospheric nitrogen in legumes symbiotically. *Rhizobium* enters the roots of legumes either through root hairs or at the point of emergence of lateral roots. The pink coloured nodules due to the presence of the pigment legheamoglobin are called as effective nodules. This legheamoglobin limits oxygen supply and helps the nitrogenase enzyme activity. Nitrogenase enzyme is responsible for reduction of atmospheric N_2 to NH_3 in the process of N-fixation. Nitrogen fixed by the *Rhizobium* is translocated through xylem vessels of the host plant mainly in the form of aspergine and to some extent as glutamine. The rhizobium-legume association yield increases by 10-30%.
2. **Azotobactor:** These are hetrotrophic free living N fixing bacteria is present in neutral and alkaline soils. It also synthesizes IAA, GA, vitamins-B etc. Azotobacter is important culture containing cells of *Azotobactor chrococum* spp. It has ability to produce antifungul antibiotics and fungistatic compounds against *Fusarium*, *Helminthosporium* and *Alternaria*. Azotobacter can be used for rice, cotton, bajra, sorghum, sugarcane, wheat and vegetables. It is capable of fixing 20-30 kg N/ha and increases the yield by 10-15 %.
3. **Azospirillium:** It is an associative nitrogen fixing bacteria. The bacteria live on root surface, sometimes penetrates but do not produce any visible nodule and outgrowth on the root tissue.

Apart from nitrogen fixation they also produce growth promoting substances like IAA, IBA, GA and vitamins. Increase mineral & water uptake, root development, vegetative growth & crop yield. It increases the yield about 5 to 50 % and fix nitrogen up to 40 kg /hectare.

4. Phosphate Solubilizing Biofertilizers
   a) **Phosphobacteria:** It is a soil bacterium capable of solubilising the insoluble inorganic phosphorus in soil and makes it available to the plant. They are also known to produce amino acids, vitamins and growth promoting substance like IAA and GA which helps in better growth of plants. It can increase the yield to the extent of **10-20%.** Some PSB are *Bacillus megaterium* var. phosphaticum, *Bacillus circulens, and Pseudomonas striata.*
   b) **Arbuscular Mycorrhizal Fungi:** AMF, a fungus, colonize the plant root system and increase the growth and yield of crop. Increased nutrient uptake particularly P, Zn and other micronutrients and also increase the growth of associated plants by producing auxins, antibiotics etc. We can save **50% Phosphatic fertilizer** without affecting the yield.

Potential Role of Biofertilizers in Vegetable Production

The incorporation of biofertlilzers play an important role in improving the soil fertility, yield attributing characters and thereby final yield of the vegetable crops. There application in soil improves soil biota and minimizes the sole use of chemical fertilizers. Under temperate condition, inoculation of Rhizobium improves number of pods per plant, number of seed per pod etc. Use of biofertlizers harvests good sustainable yield of various vegetable crops.

Conclusion: From the foregoing discussion it can be concluded that, the biofertilizers are not a replacement to fertilizers, but can supplement plant nutrient requirements. Nitrogen and phosphorus can be saved by about 25% by treating the seeds/seedling with nitrogen fixing biofertilizers (*Rhizobium, Azotobacter* etc.) and phosphorus solublizing biofertilizers (*Pseudomonas*, *Bacillus*, AMF etc.) respectively. Biofertilizers restore the natural soil fertility by improving its physical, chemical and biological property. Thus, the biofertilizers are the eco-friendly, technologically feasible and socially acceptable input to the farmer.

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45. HORTICULTURE 17549

Factors Affecting Pigment Production in Vegetable Crops

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INTRODUCTION: The pigment found in plants play important role in plant metabolism and visual attraction in nature (Goodwin, 1976, Kost, 1988). They are also important for humans, attracting our attention and providing us with nutrients. Major plant pigments include carotenoids, anthocyanins, and other flavonoids, betalains, and chlorophyll. Consumer interest in the quality of vegetable products has increased in recent years especially for the beneficial effects of vegetables on health. Vegetable quality is a broad term and includes physical properties, flavour, colours and health–related compounds.

Factors which effect pigments of vegetables: Anything that reduces the production of pigments will result in reduced color. Chlorophyll gives the green color for cucumbers, zucchini, green peppers and other green fruit. Chlorophyll production can be impacted by many factors.

- Under high populations or heavy leaf cover, less chlorophyll is produced in shaded fruits and therefore they are lighter in color. On the other hand, over exposure of fruits subjected to high temperatures will result in degradation of chlorophyll and sun scalding. In fruits that develop red, orange, yellow, or purple colors, light are also critical for good color development. It is critical to maintain a balance between enough leaf cover to prevent over-heating, pigment destruction, and sun scalding with enough light penetration to develop color.
- **The chlorophyll molecule:** apart from carbon, hydrogen, and oxygen; also contains nitrogen and magnesium. Production of all pigments requires enzymes that contain nitrogen and sulfur. Deficiencies of these nutrients can lead to reduction in color.
- Pigment production requires significant plant

resources (carbohydrates as building blocks and energy sources) so any factors that reduces the production of these resources may have an impact on initial or ripening color. For example, with the hot year we are having, many vegetables will have higher respiration and reduced photosynthesis leading to less food resources to go into fruit pigments, again leading to reduced or less intense color. Other stressors such as drought, insect damage, or loss of leaf area to disease can also lead to poor color because of the reduction in carbohydrate resources to produce pigments.

- **Ground Contact:** Ground contact will result in loss of light sensitive pigments, particularly chlorophyll. Therefore you will often see white or yellow colors on fruits where they touch the ground. For instance, dark rind watermelons will not have much chlorophyll on the ground spot but will still have carotenoids therefore showing the yellow color when ripe. Crops that are trellised or that vine up windbreaks or nearby plants will have more uniform color.
- **Destruction of Pigments by Pests:** Disease organisms, insects and mites can destroy pigments when infecting or feeding on fruits. For example, many plant viruses will cause loss of color, mottled color, or irregular color in fruits.
- **Plant Hormone Activity:** Plant hormones can help maintain or cause deterioration in color depending upon the hormone involved. For example, cytokinins help to maintain green color while elevated ethylene will cause premature yellowing. Plant hormone activity is tied closely to stress and environmental responses.

TABLE 1: Different colours and vegetables with their nutritional values:

Vegetable Colours	Importants
Red vegetables	Vegetables get their red colour from natural plant pigments called lycopene or anthocyanins. Lycopene is found in: tomatoes, watermelon. It may help reduce risk of several types of cancer. Anthocyanins act as a powerful antioxidant to help protect your body's cells from damage. Antioxidants are also linked with keeping your heart healthy.
Orange / yellow vegetables	These are coloured by natural plant pigments called carotenoids. Foods high in carotenoids can help reduce risk of cancer, heart disease and can improve immune system function. Beta-carotene, an organic compound found in orange and yellow fruits, is converted to vitamin A, which helps maintain healthy mucous membranes and healthy eyes. It can be found in abundance in sweet potatoes, pumpkins and carrots. Carotenoids have been found to be good for your heart.
Green vegetables	These are coloured by natural plant pigment called chlorophyll. Lutein, a naturally occurring carotenoid is in spinach and other dark leafy greens, green peppers, peas, cucumber and celery. These chemicals can help reduce risk of cataracts and age-related macular degeneration, which can lead to blindness if untreated. Indole, an organic compound found in broccoli, cauliflower, cabbage and other vegetables in the cabbage family, may help protect against cancer. Leafy greens such as spinach and broccoli are excellent sources of folate, a B vitamin that helps reduce risk of birth defects.
Blue and purple vegetables	These are coloured by natural plant pigments called anthocyanins. Anthocyanins act as powerful antioxidants that protect the body's cells from damage. They may also help reduce the risk of cancer, stroke and heart disease.

Agronomic factors: Fernández-García *et al.* observed in tomato that grafting had a strong effect on lycopene than carotene, fruits from grafted 'Fanny' had doubled the lycopene concentration of ungrafted 'Fanny' under the same conditions. Proietti *et al.* demonstrated that mini-watermelon grafted onto the commercial rootstock of squash hybrid rootstock ('PS 1313' - *Cucurbita maxima* Duchesne × *Cucurbita moschata* Duchesne) increased the lycopene concentration by 40% in comparison to those recorded on ungrafted plants. Similarly, Davis *et al.* reported that grafting watermelon increased lycopene and total carotenoids by 20%.

Effect of Cultural Practices: Rising EC-values of the nutrient solution increased also health promoting substances like vitamin C, lycopene and ß-carotene in fresh fruits up to 35%.

Effect of Irrigation management and salinity: Field studies with two cultivars of watermelon showed that deficit irrigation practices reduced total marketable yield by 15 to 36%, respectively, but had no effect on fruit quality (lycopene content) Pascale *et al.* observed that the optimum total carotenoids and lycopene content in tomato was reached when salinity was 4.0–4.4 mS cm-1, Similar results for ß -carotene were found by other authors.

Effect of Fertilization: In general, plant metabolites which lack N in their structure such as lycopene, ß -carotene, phenolics and flavonols are favored under N-limiting conditions although photosynthetic activity is not simultaneously reduced, Phosphorus increased the level of some phytochemicals like ascorbic acid, anthocyanins, flavonoids and lycopene, although interactions with climatic factors and growing season may occur foliar K applications during melon fruit development resulted in significantly firmer fruits with higher K, soluble solids, total sugars and ascorbic acid and -carotene concentrations than fruits from unsprayed plants.

Effect of Growing Conditions: The color of vegetables plays also a major role for consumers making purchasing decisions on fresh vegetables. For example, green lettuce and spinach, as well as red tomatoes or radish always signify high product qualities. Schreiner *et al.* investigated the color development of radish throughout the whole year, partly cultivated in the greenhouse and partly in the field and found positive correlations between light intensity and color of radish. Dorais *et al.* reported that low light intensity reduced pigment synthesis by tomatoes, resulting in uneven fruit coloring.

Effect of Temperature: The effect of temperature on color of vegetable fruits is well known. The red color of ripe tomato fruits is attributed to lycopene, a carotenoid synthesized and stored in the chromoplastes and most probably the key for carotenoid biosynthesis is the temperature. According to Robertson *et al.*, temperatures between 18 and 26°C favor the biosynthesis of these compounds; Helyes *et al.* reported three times higher lycopene contents in cherry greenhouse grown tomatoes at 16°C than in 25°C, and Dorais *et al.* recommended to kept temperatures inside the greenhouse between 12°C and 21°C for best tomato fruit color. However, in agreement with all authors, very low air temperature (<10°C) could fully inhibit lycopene production.

46. HORTICULTURE 17553

Use of Novel Nursery Containers for Propagation of Various Planting Materials

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A nursery container could be anything that holds growing media, drains excess water, allows frequent supply of air healthy root growth and development, have least breaking chances before out planting, and allows separation with a minimum of disturbance to the plant. It is therefore important to know how the characteristic properties of containers affect plant health, as well as nursery operations, thereby increasing choice for the farmers to choose the containers. Container variability and their dimensions effect rhizospere development, placement of right amount of water and nutrients at proper time through proper ways at right place, production scheduling, and plant transportation method all are kept under consideration while selection of planting material and their growing containers. Container choice for a particular plant species depends on root system morphology, target plant criteria and economics.

Container Characteristics affecting Plant Development

- **Volume:** It dictates how large a plant can be grown in it. Optimum container size is related to the species, target plant size, growing density, length of the growing season, and growing medium used.
- **Height** It determines the depth of the root plug, which may be a consideration on dry out planting sites. Height is also important because it determines the proportion of freely draining growing medium within the container.
- **Diameter** It is important in relation to the type of species being grown. Broad-leaved trees, shrubs, and herbaceous plants need a larger container diameter so that irrigation water applied from above can penetrate the dense foliage and reach the medium. Diameter also affects growing density in the nursery.
- **Plant Density** The distance between plants is another important factor to consider. Spacing affects the amount of light, water, and nutrients that are available to individual plants
- **Drainage Holes** Containers must have a bottom hole or holes large enough to promote good drainage and encourage "air pruning."
- **Root Temperature** Color and insulating properties of the container affect media temperature, which directly affects root growth. Black containers can quickly reach lethal temperatures in full sun whereas white ones are more reflective and less likely to have heat buildup. Another option is to use white plastic, Styrofoam™, or other insulating material around the outside perimeter of the container.

Types of Conventional Containers

- **Polybags** are the containers most commonly used in tree nurseries in developing countries. They are usually made of black polyethylene and have several drainage holes at the bottom.
- **Polysleeves** are made from the same material are cut from a continuous roll and have no bottom. They come in various gauges and volumes between 0.3 and 45 liters.
- **Jiffy pots** are made from compressed peat and need to be filled with a growth substrate. Roots can easily penetrate the container walls, so root curling does not occur.
- **Jiffy pellets** are made from compressed peat and held together with a biodegradable net.

Upon use, they are irrigated and expand to approximately 5–10 cm height. Seeds or cuttings can be directly planted into them.

- **Root trainers**. The containers are set on frames or beds above the ground to allow air-pruning of roots as they emerge from the containers. The latest developments also encourage lateral air root pruning through vertical slits.
- **Fiber Pots** Containers of various sizes round or square, are pressed into shape from peat plus wood fiber, with fertilizer added. Dry, they will keep indefinitely.
- **Paper Pots** Paper pots or paper tube pots are more popular with seed plug and cutting propagation of ornamentals, & vegetable species. They allow for greater mechanization with pot-filling machines, automatic seeders, and wire benches that allow air pruning of the root system.
- **Petroleum-Based Plastic Nursery Containers** Plastic containers specifically manufactured for container nursery production eventually replaced metal cans. High rates of plastic nursery container recycling or reuse and greater use of recycled plastics in nursery containers could substantially increase the sustainability of using petroleum-based plastic nursery containers.

R3 Containers (Recycled Plastic and/or Bio-based Plastic Containers)

Containers in this class are made from either recycled plastics or a blend of petroleum based plastics, bioplastics and natural fibers. Containers in this class can be made to mimic the form and function of conventional plastic containers or provide an alternative such as a fabric container. Although fabric containers made from recycled plastic and natural fibers do not decompose, they will disintegrate over time due to the natural fiber component.

Advantages and Disadvantage of Nursery Containers

Advantages

- Very hardy and is not affected to exposure to high temperature and moisture stress
- Faster establishment and growth after planted out
- Longer period of storage time on site
- Recommended for harsh and hostile environments
- Polysleeves allow for air pruning when placed on raised propagation beds, for example on a thick layer of gravel.
- Seedlings grown in root trainers have more vigorous and rapid root growth than seedlings grown in polybags.
- These containers are ideal for research studies.

Disadvantages

- More costly to produce
- Longer period to prepare, 4 -5 weeks or more
- Large volume and heavy load for transport, *i.e.* higher delivery cost
- They are less resilient in transport, because the potting substrate can easily fall out and damage the roots.
- Polysleeves should never be placed straight onto soil because roots will grow into the ground and the main roots break off when you lift the plants.
- The discarded polybags and polysleeves are a problem for nursery waste management, as they do not decay and are often burned, producing serious air pollution.

47. HORTICULTURE 17554

Propagation Techniques in Stone Fruit Crops

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Prunus fruit are defined as drupes/stone fruits, because the fleshy mesocarp surrounding the endocarp (pit/stone) is edible. The major commercial stone fruit are peach and nectarine, European plum, Japanese plum, sour cherry, sweet cherry, apricot and almond. Nowadays seed propagation method is not commonly followed since seed developed by cross-fertilization may yield undesirable trait combinations, therefore, vegetative propagation techniques has recently been standardized in order to produce more number of plants with the less juvenile phase in comparison to the plants propagated plants. Beside the vegetative growth of the plants, reproductive growth is also influenced by the method of propagation. Modern stone fruit varieties are propagated vegetatively to maintain desirable fruiting traits. Some of the fruits possess a poor root system due to which several varieties become susceptible to various biotic and abiotic stresses *viz.* pests, pathogens, or environmental stress. Hence to cope up with these stresses, standardized propagation techniques like budding and grafting we take into the consideration.

Method of Propagation for Stone Fruits

Earlier stones fruits were propagated by employing their own seedling. But the seedlings plants have high juvenile phase in comparison to vegetatively propagated plants.

1. **Seed propagation:** Currently, the propagation of scion genotypes by seeds is restricted and used only in the initial phase of breeding programs, when it aims at obtaining genetic variability.
2. **Vegetative Propagation:** When some portion of plant is wounded, mitosis division takes place. This forms base for asexual propagation. The plants raised through asexual process are identical to mother plants. Cutting, budding, grafting, and layering are main techniques of asexual propagation.

Need of Budding and Grafting

- For decreasing juvenile phase in fruit crops and to get accelerated growth rate.
- Accelerated plant growth rate and reducing production time.
- Study and elimination of viral diseases and plant developmental and physiological processes.

1. **Tongue grafting:** Tongue like sloping cut (2.5-6cm) is made upward on the rootstock that should match the scion wood with tongue pointing downward (one third of the distance of the tip from the base). Similar upward and downward incision is given on rootstock. After this both the scion and stocks are joined. It must be ensured that maximum contact between the vascular tissue has been attained. The joint must be covered with a 5 mm wide polythene strip and finally seal with grafting wax.

Benefits

- Higher success rate
- Here 3 buds are taken in scion wood which ensure more chances of stability of the plant.

2. C**left grafting**: This method of propagation is mainly adopted in older plants during the dormant season and is useful for joining a thin scion about 1 cm (3⁄8 in) diameter to a thicker branch or stock. Slanting cut of (5.0cm) is provided to the scion on both sides. The scion is inserted in chisel like shape. It is practiced in Apricot, Peach, Plum, and Almond.

Benefits

- It is widely used for top working purpose.
- This method allows the union of a rootstock limb that is much larger in size than the scion piece.

3. **Shield/T-budding:** T-budding is the most common style, whereby a T-shaped slit is made in the stock plant, and the knife is flexed from side to side in the lower slit to loosen up the bark. A T-shaped cut of 15-30cm (6-12in) from the base, with the horizontal cut about 13mm (½in) long and the vertical cut 2-4cm (1-1½in) long is made in the stock. Buds (taken from budsticks or budwood) are inserted under the bark of small seedling stock plants a few inches above ground level. After growth starts the tops of the seedling rootstocks are cut off. T-budding is usually done in the late summer.

Benefits

- It has been found that buds can be set quite rapidly by this method.
- It may also be used in top working old trees to new varieties.

4. **Chip budding:** A similarly shaped chip is cut out of the rootstock, and the scion bud is placed in the cut, in such a way that the cambium layers match. The bud will usually not begin growing until the following spring, though we can determine if the grafting succeeded before that by seeing whether the bud swells or shrivels. The next spring, all other shoots from the scion bud are removed, which will then become the source for the new top of the plant.

Benefits

- Ability to change cultivars to meet market demands without removal and replanting of old orchard.
- Ability to propagate plants throughout the year.
- Easier and faster than other methods of field grafting.

5. **Ring/Annular budding:** In this method of propagation, we remove the complete ring of bark from the rootstock without leaving a bark strip which joins the upper and lower portions of the rootstock. This leads to the girdling of stem similar to that of air layering process. The ring should be joined in such a way that central part of bark should be bud. For this, length of the bark ring should be 2.0-3.0 cm which is detached from the smooth part removed between nodes of the rootstock plant.

Benefits

- Take less time to come to come into the bearing compare to sexual method of propagation
- Less expensive compared to the most of methods available.

6. **Clonal propagation:** Multiplication of genetically identical copies of a cultivar by asexual reproduction is called “clonal propagation,” and a plant population derived from a single individual by asexual reproduction constitutes a clone.

Benefits of Clonal Propagation

- Seeds may have lengthy and complex dormancies
- Thousands of virus free plants may be obtain from single explant within a year.
- Out crossing plants produce highly variable progeny.
- Cloning allows for combining genotypes in one plant and produce clone are uniform.

Recent Advanced Methods of Propagation of Stone Fruits

- **Stenting**: It is the simultaneous grafting and rooting of the plant in the formation of the union and adventitious roots on the rootstock occurs together. The scion is grafted onto non-rooted rootstock cuttings. Stenting is tried in rose and fruit crops (peach, plum, pear apple).

Advantages of Stenting

1. Produced plant faster and take less time for graft union.
2. Plants produced by stenting have less juvenile period.

48. HORTICULTURE 17562

Scientific Propagation Technology for Pointed Gourd in Odisha

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Pointed gourd, collequolly known as parwal or potal is widely cultivated perennial vegetable of high economic and nutritional value. Immature fruits contain 2% protein, 0.3% fat, 2.2% carbohydrates, 153 IU vitamin A and 29mg vitamin C per 100g. It is easily digestible diuretic, and laxative. It invigorates the heart and brain and is useful in disorders of the circulatory system. The fruits are used as vegetable in curry and in pickles. Apart from the usage as vegetable, a sweet is prepared by putting in sugar syrup, in some parts of the country.

A. Climate and Soil

Pointed gourd requires warm and humid areas where rains are abundant, though without water logging. It can be grown successfully in sandy loam to loam soil and should not be grown in heavy soils. The climatic condition prevailing in Odisha is well suited for the cultivation of pointed gourd.

Varieties

Swarna Alaukik: A high yielding variety, it produces light green fruits with blunt ends. The fruits are 5-8cm long, solid, thin skinned and good for vegetable as well as for preparation of sweets. Its yield ranges from 23-28 t/ha on vertical staking. It is recommended for the plains of Odisha.

Arka Neelachal Kirti: A high yielding variety with spindle shaped fruits having solid core and soft seed which fetch premium price in the market due to its attractive green stripes. The fruits also have long shelf life at ambient temperature. The yield ranges from 25-30 t/ha. Being developed at Central Horticultural Experiment Station, Bhubaneswar, this variety is well suited for Odisha state.

B. Propagation

Printed gourd is usually propagated through vine cutting and root suckers. Seeds are generally not used for commercial propagation owing to poor germination and unpredictable sex. The vine cutting can be planted during October-November or February-March by following any one of the following methods.

1. Stem Cuttings

When vine or stem cutting are selected as propagation material, following methods are used for planting.

1. **Lunda or lachhi method:** In this system, young vines of 1 to 1.5m long with 8-10 nodes per cutting are taken and folded into a figure of eight (8) commonly known as lunda or lachhi. This lachhi should be placed flat in the pit and pressed 3-5cm deep into the pits filled with FYM and soil. Fresh cow dung may be applied over the central part of the pit to enhance the sprouting in moisture deficient conditions.
2. **Moist lump method:** In this method 60cm long vine is encircled over a lump of moist soil leaving both ends 15cm free. Such lumps are buried 10cm deep into the well prepared pits leaving the ends of vine above the soil. Underground vine develops in to root and the exposed ends give sprouts.
3. **Straight vine method:** In this method, the vine cutting are planted end to end horizontally 15cm deep into the furrows filled in with a mixture of farmyard manure and soil.
4. **Ring method:** In this method, the vine cutting is coiled into a spiral or ring shape and planted directly on the mounds, covering one-half to two-third of the ring under the soil.
5. **Vine cutting method:** The cutting from the mature vines (3-4 nodes) are treated with Rootex No. 1 and planted in sand beds. After 15 days, the rooted vine cuttings are shifted to poly bags filled with FYM, sand and garden soil. The cuttings will be ready for planting between 15-20 days after shifting in poly bags. The success rate will be high during rainy season.

2. Root Suckers

Tuberous roots of pointed gourd are uprooted and planted on the mounds. The propagation through this method is easier and faster and gives assured success. Care should be taken to discriminate between tubers collected from male and female vines.

49. HORTICULTURE 17575

Vegetable Crop Production Modules in Odisha

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Solanaceous Vegetables	**Variety:** *Potato* – Kufri Pukhraj/ Kufri Chandramukhi/ Kurif Jyoti. *Brinjal* – Utkal Anushree/ Utkal Tarini/ Utkal Keshari/ Bluestar. *Tomato* - Utkal Raja/ Utkal Pragyan/ Utkal Kumari/ Aloke *Chilli* – Pusa Jwala/ Utkal Ragini/ Utkal Rashmi/ Utkal Ava **Nutrient Management** *Potato* – FYM@ 15t/ha.+ RDF (N:P:K::150:100:120 kg/ha) *Brinjal* - FYM@ 15t/ha.+ RDF (N:P:K::125:75:125 kg/ha) *Tomato* - FYM@ 15t/ha.+ RDF (N:P:K::120:75:100 kg/ha) *Chilli* - FYM@ 15t/ha.+ RDF (N:P:K::120:75:75 kg/ha) **Plant Protection**: Pre-emergence application of Oxyflourfen @ 1 ml/ lt. of water + post emergence appln. of CuSO4 @ 1 gm/ lt. of water for control of weeds. Seeds & Seeding treatment with Carbendazim @ 2g/ kg + Streptocycline 0.1g/lt. with need based appln. of Copper – Oxychloride @ 3g/lt. for controlling wilt diseases. Seed soaking with imidachloprid @ 1g/lt. + alternate spraying ofneem pesticide & Aceamiprid @ 1ml / 3lt. + Fixing of sticky yellow trap + destroying affected plant parts for controlling the vector of leaf curt viral diseases. Spraying Btk @ 1.5kg/ ha. + Neem oil @ 3ml / lt. or Three alternate sprayings with HaNPV @ 250 L.E./ ha. & Bt @ 1.5kg/ ha. to control Fruit & Shoot borers. Appln. of Neem oil cake @ 1q/ ha. + seed, soil & seedling treatment with Trichogramma viridae @ 5g/ kg of seed for controlling Phomoposis blight, fruit rot & wilt.	All district of the Odisha state.
Cole Vegetable	**Variety:** *Cabbage* – Pride of India / Golden Acre / Konark / Sujata / Vijay. *Cauliflower* – Hemlata / Himani / Snow Ball / Improved Japanese. **Nutrient Management:** *Cabbage* – FYM @ 15t/ha.+Neem cake @ 1q/ha.+N:P:K @ 125:50:75kg./ha. +foliar application of Borax @ 2g / lt. of water + application of Calcium Nitrate @ 0.2%. *Cauliflower* - FYM @ 15t/ha. Incubated with Azopirillum, Azotobacter & PSB @ 5kg/ ha each + Neem cake @ 100kg/ha. + N:P:K @ 120:40:60 kg./ha. + Borax @ 2g/ lt. of water. **Plant Protection:** Need based application of Cartap Hydrochloride @ 1ml / lt. & DDVP @ 1ml. / lt. alternatively at 10 days interval to control Dimond back moth & Spodoptera attack. Spraying Profenophos @ 1lt. / ha. Or Thiomethaxone @ 0.2% or Imidacloprid @ 1lt. / ha. At 7-10 days interval alternatively to control thrips & aphids.	Koraput. Kandhamal. Jajpur, Kendrapara, Kalahandi, Baragarh, Dhenkanal, Nabarangapur, Angul, Bolangir, Deogarh, Cuttack, Khurda, Puri, Sundergarh, Boudh & Sonepur.

Okara	**Variety:** Arka Anamika / Utkal Gourav / NOH-15 **Nutrient Management:** FYM @ 10t/ha. + RDF (N:P:K::80:40:40 kg/ha.) **Plant Protection:** Application of Bt @ 1.5kg/ha. Twice at 15 days interval to check fruit borer incidence. Seed treatment with Imidachloprid @ 1g/kg seed and foliar application of it @ 1ml/3lt. after 30 DAS to check YMV vector. Three spraying of Carbendazim @ 0.2% at 10 days interval to manage leaf spot disease.	All districts of the state.
Pointed gourd	**Variety:** Swarna Rekha/ Swarna Alukik **Nutrient Management:** FYM @ 15t/ha. with RDF (N:P:K::120:80:80 kg/ha.) **Plant Protection:** Spraying Endosulfan @ 1lt./ha. Or Carbaryl @ 20 kg / ha. Alternatively to control insect pests. Spraying Bavistin @ 0.5kg /ha. To control leaf blight desease. Spraying Planofix @ 20 ppm twice to check flower & fruit drop.	Puri, Jajpur, Boudh, Cuttack, Khurda, Ganjam, Kendrapara, Dhenkanal, Bolangir, Baragarh & Malkangiri.

Fruit / Plantation Crops Production Module

Coconut	**Variety:** Sakhigopal local / TxD / Andaman / West Cost Tall **Nutrient Management:** FYM: 50kg + N:P:K:: 500:250:1000g + Borax:: 100g **Plant Protection:** Root feeding with Nemazol @ 3ml/lt. and imidachioprid @ 3ml/lt. for controlling Eriophylid mite, Red palm weevil and Rhinocerous bettles.	Puri, Khurda, Ganjam, Cuttack, Balasore, Bhadrak, Kendrapara, Jajpur & Jagatsinghpur.
Banana	**Variety:** T.C. banana var. Robusta/D.C. / G-9 and Bantala / Patakapura/Champa. **Nutrient Management:** Pit filling with 10-15kg. FYM + N:P:K:: 25:30:100g per plant/ month up to six months. Plant Protection: Repeated spraying of combined format ratio (1:1) of Metalaxyl and Mancozeb @ 2.5ml / lt to control sigatoka disease.	All district of the state.
Papaya	**Variety:** Farm Section-5, Coorg Honeydew, Red Lady, CO-2 **Nutrient Management:** FYM @ 15kg / plant with 250:200:200:: N:P:K g / plant / annum **Plant Protection:** Spraying of Metasystox @ 2ml / lt. to control vectors of YMV disease, All districts of the state.	All district of the state.

50. HORTICULTURE 17577

Health Benefits of Coconut (Cocos nucifera)

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INTRODUCTION: Coconut *(Cocos nucifera)* belongs to the Palm family *(Arecaceae)*. In Sanskrit, the coconut palm is known as Kalpa Vriksha - 'tree which gives, all that is necessary for living' because nearly all parts of coconut tree can be used. Even the husks and leaves are used. Coconut is also considered as a 'functional food' because it provides additional health benefits apart from its nutritional constituents. Coconuts are highly nutritious and rich in fibre, vitamins C, E, B1, B3, B5 and B6 and minerals including iron, selenium, sodium, calcium, magnesium and phosphorous. Unlike cow's milk, coconut milk is lactose free so can be used as a milk substitute by those with lactose intolerance. Since it is rich in many vital nutrients, value addition to coconut increase the utilisation of coconut and improve health benefits also.

Health Benefits

1. **Coconut Water Cleanse Liver thoroughly:** One of the most outstanding health benefits of coconut water, besides a balancing mechanism, is the capability to detoxifying any part of your body, including the liver waste. With the moderate absorption of coconut water, you can experience the detoxification of it and the energy-boosting effect without taking any chemical medical treatment or overdosed drug.
2. **Coconut Water is a Natural Diuretic Good for Kidneys:** Coconut water is considered a fantastic natural diuretic substance, therefore, your kidneys will maintain the good health and other function like urine flow will be improved thoroughly. In case of urinary problem, it's time to consume some coconut water to flush all the toxins from your kidneys system.
3. **Coconut oil Controls Diabetes:** Coconut oil helps in controlling blood sugar and improves the secretion of insulin. It also promotes the effective utilization of blood glucose, thereby it helps in preventing and treating diabetes.
4. **Coconut oil for Heart Diseases:** It contains about 50% lauric acid, which helps in actively preventing various heart problems like high cholesterol levels and high blood pressure. Coconut oil does not lead to increase in LDL levels, and it reduces the incidence of injury and damage to arteries, and therefore helps in preventing atherosclerosis.
5. **Coconut oil Boosts Energy:** Coconut helps to increase energy by burning fat. The triglycerides found in coconut oil increase 24 hours of energy expenditure by 5% leading to weight loss in the long run. It is also known to reduce hunger pangs. This is directly related to the way fatty acids in the body are metabolized as ketone as appetite reducing effect. People who consistently use coconut products have a stronger ability to go without eating for several hours with no effects of hypoglycaemia. It also promotes healthy thyroid function and helps to relieve the symptom of chronic fatigue.
6. **Coconut Oil can Kill Harmful Microorganisms**
   a) The 12-carbon lauric acid makes up about 50% of the fatty acids in coconut oil.
   b) When lauric acid is digested, it also forms a substance called monolaurin.

   For example, these substances have been shown to help kill the bacteria Staphylococcus aureus (a very dangerous pathogen) and the yeast Candida albicans, a common source of yeast infections in humans
7. **Coconut for Immunity:** It strengthens the immune system because it contains antimicrobial lipids, lauric acid, caprice acid and caprylic acid, which have antifungal, antibacterial and antiviral properties. Coconut nutrition is excellent for the immunity system. It is antiviral, antifungal, anti-bacterial, and anti-parasitic. Intake of coconut oil can help the body to mount resistance to both viruses and bacteria that cause illness. Consuming coconut in its raw form can help to treat some of the worst and most resilient illness like throat infections, bronchitis, urinary tract infection, tapeworms and other ailments caused by microbes.
8. **Coconut Oil for Weight Loss:** It contains short and medium-chain fatty acids that help in taking off excessive weight. It increases the body's metabolic rate by removing stress on the pancreas, there by burning more energy and helping obese and overweight people lose weight.
9. **Helps in Kidney Problems:** People having kidney problem or those who have stone in their kidney are advised to get regular consumption of coconut water along with their medication as coconut water helps in breaking the stones in smaller pieces so that they easily get pass out from the urinary canal.
10. **Coconut has Anti-Ageing Benefits:** In the coconut water, many researchers can see the cytokinins which have a positive impact on the tissues and cells, thereby reducing the possibility to catch age-related diseases. Coconut water, as mentioned above, contains nutritious properties beneficial for skin, so if you can make a paste from coconut water and sandalwood powder and then apply to your skin. It will obviously boost the health of your skin making you look younger than others who not use it. So take some of the coconut water to stay healthy and youthful all the time.
11. **Best Beverage for Women during Pregnancy:** Having rich value of chlorides and magnesium, dietary fiber and vitamin C along with adequate amount of salt, sugar and sodium and protein, the coconut water proves to be an outstanding beverage during pregnancy; which helps in regulating the blood pressure and proper heart functioning.

    Coconut water is sterile and is very good for pregnant ladies. It improves the immunity and health of the mother and baby and prevents infection and other diseases. It also boosts the levels of amniotic fluid to improve the overall health of the fetus.

Conclusion: Coconut is considered as a healthy food, it protects against heart diseases by increasing good cholesterol and lowering the ratio of bad and good cholesterol, it can be an effective measure to treat malnutrition, kills disease causing bacteria, fungi, yeasts and viruses, boosts metabolism and increases energy etc.

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51. HORTICULTURE 17541

Role of Potassium In Fruit Crops

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Role of potassium in plant physiology: Potassium activates more than 60 enzyme systems, aids in photosynthesis, favors high energy status maintains cell turgor, regulates opening of leaf stomata, promotes water uptake regulates nutrients translocation in plant. Potassium favors carbohydrate transport and storage and enhances N uptake and protein synthesis.

Effects of K on fruit quality are: The application of potassium Increases protein content of fruits, increases starch and sugar, vitamin C and total soluble solids content. The potassium improves fruit color, flavor, and Improves size of fruits. The K increases peel thickness, reduces physiological disorders (eg: creasing and cracking in citrus). It also reduces incidence of pests, diseases and enhances storage and shipping quality.

Factors affecting K availability: Soil CEC: The larger the CEC, the more K that can be held by the soil

Soil test K: Higher soil test K increases the available K, by increasing the amount and balance of K relative to other cations.

Cation balance: Significant imbalance between available K and the other major cations, may affect the availability of K to the crop

Soil moisture: Water deficiency results in less K absorption

Soil pH: As the soil pH is reduced, the availability of K is often reduced.

Soil Temperature: Cold soils often reduce the availability of K

Soil compaction: Compacted soils often reduce the availability of K.

Soil Drainage/Aeration: Improved soil drainage typically improves K uptake

Soil Salinity: Saline soils often have excess sodium (Na). One of the negative effects of excess Na is that it reduces the availability of K.

Ideal Situations For The use of Different K-Fertilizers:

Potassium Chloride: Crops of low unit value, non-saline conditions, no sulphur deficiency, chloride-tolerant crops, low rates of K application.

Potassium sulphate: Crops of high unit value, salinity build up, sulphur-deficient soils Chloride-sensitive crops, high rates of K application.

Loss of K from soil: Continuous removal by crops without adding FYM and K-containing minerals. Leaching, erosion, high content of Ca and Mg restrict K uptake by plants. Lack of soil moisture

Deficiency symptoms:

- First appears on the recently matured leaves as yellowing of the tips and margins
- With more acute deficiency, the yellowing zones extend nearer to the centre or towards the leaf base
- As the growing period advances, the yellow parts become necrotic, turning reddish brown or brownish grey.
- Leaves are smaller than usual and tips are tapered out to a very fine point.
- Immature leaf fall
- Fruit size will be small.
- Low yield and poor quality of the fruits.

Correction of K deficiency:

- Diagnosing the deficiency by foliar analysis.
- Soil application recommended dose of K fertilizers.
- Split application of fertilizers.
- Foliar sprays of potassium nitrate.
- Fertigation
- Addition of FYM to heavier soils improve K uptake by fruit trees.
- Maintaining sufficient soil moisture.

52. MEDICINAL AND AROMATIC PLANTS 17244

Senna: A Traditional Medicinal Plant and its Cultivation Practices

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Senna is a large genus of flowering plants in the legume family Fabaceae, and the subfamily Caesalpinioideae. *Senna* includes herbs, shrubs, and trees. The leaves are pinnate with opposite paired leaflets. The inflorescences are racemes at the ends of branches or emerging from the leaf axils. The flower has five sepals and five usually yellow petals. There are ten straight stamens. The fruit is a legume pod containing several seeds.

Production Technology

Climate: Grown in irrigated as well as rainfed conditions. Adversely affected by heavy rainfall and severe cold.

Soil: It is largely raised on red loams including coarse gravelly soils or alluvival loams. It is very sensitive to water logged conditions and thus avoid crust forming sticky soils which hinder germination.

Varieties: KKM (Se) 1, ALFT-2, Sona are suitable varieties for cultivation. KKM (Se) 1 is suitable for cultivation under rainfed conditions in Tirunelveli and Tuticorin regions.

Sowing: Sowing can be done thrice in a year. Generally first sowing during February - March, second in September - October are recommended.

Duration: Season wise: 90-140 days, for pod purpose: 150 days.

Seed rate: About 15 - 20 kg/ha of seed is required. The seeds are scarified with sand or can be soaked overnight in water and sown in beds at a spacing 45 x 30 cm.

Manuring: Apply FYM 10 - 15 t/ha and N, P and K at 40:40:40 kg/ha as basal are recommended. Apply 40 kg N at 40 days after sowing.

Irrigation and Interculture

- In the beginning, the field is irrigated at an interval of 6-7 days and later the interval is widened to 15-20 days depending on the weather and soil conditions.
- Plots are kept weed free by earthing up the soil after 6 weeks of sowing and after each harvest.

Plant Protection

- **Major insects:** White ants, cut worms and pod eating caterpillars
- **Major diseases**: Damping off, seedling blight, leaf spot and leaf blight.

Schedule

- The crop is sprayed with 4 g of carbaryl in 1 litre of water at 70-80 days after sowing to combat the attack to pod eating caterpillars.
- If leaf spot and leaf blight is seen the crop is sprayed with 0.1% benlate at about 7080 days after sowing.
- Spray neem kernel extract to control sucking insects.

Harvesting, Processing and Yield

- When bulk of the leaves are fully grown and are thick and bluish in colour, they are stripped by hand.
- The crop is usually harvested at 90 days and the subsequent two harvest will be at an interval of 30-35 days.
- Pods are picked after 15 days from sets as and when they mature and turn to golden yellow colour.
- The leaves and pods so harvested are spread indoors on a clean floor for 7-10 days and dried until 20 per cent moisture.
- The dried state is indicated by their light yellow colour.
- Drying of leaves and pods in sun should be avoided.
- On an average it may yield, 2,000 kg of dry leaves and 800-1000 kg of pods per hectare under irrigated and good management practices.

Under rain fed conditions the yield may be about 1000 kg of leaves and 400 kg of pods, respectively, per hectare.

Marketing of Senna: Millions of farmers sell their material to local traders and we purchase senna from local traders. Senna is having good national as well as international market. Moreover, the demand if Indian Senna is increasing in the international market (specially desert Senna – due to its potential).

Medicinal Uses

Senna plant contains sennosides which is used as a laxative for thousands of years.

- The leaf of the Senna plant is used for the treatment of constipation traditionally. It is also used to clear the bowel before a colonoscopy.
- Senna plant is also used for treatment of hemorrhoids.
- It is also used for weight loss.
- Senna is useful in the treatment of bronchitis.
- It fights against cough, cold, and asthma.
- This is useful in the treatment of skin disorder.
- This is also helpful in the treatment of leucodermia.

- Senna is useful in the treatment of typhoid and cholera.
- It is proved useful in the treatment of gout and jaundice.

53. MEDICINAL AND AROMATIC PLANTS 17415

Cultivation and Processing of Senna

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INTRODUCTION: Senna (*Cassia angustifolia* Vahl.) belongs to the family caesalpinaceae. It is cultivated for its leaves and immature pods, which are used as laxatives. The strong laxative properties are due to the presence of dianthone glycosides, sennoside A and sennoside B in the leaves and pods. In India, senna is cultivated in Tamil Nadu, Gujarat, Rajasthan and Andhra Pradesh. The National Medicinal Plants Board has prioritized 32 plants for promotion of cultivation and senna is one of them. Senna is the second largest earner of foreign exchange through exports. Indian senna pods and leaves are highly valued in the international trade.

FIG 1. Senna plant

Cultivation and Processing

Varieties: ALFT-2 and Sona are suitable varieties for cultivation. ALFT-2 is a late flowering type, produce higher yield of foliage crop. Sona identified by the central institute on medicinal and aromatic plants, Lucknow.

Soil and Climate: Well drained sandy or sandy loam or laterite soils are suitable for cultivation of senna. It is a hardy warm weather crop mostly cultivated under rainfed and also irrigated conditions. The soil pH suited for cultivation is 7.0 – 8.5.

Seed Rate: The crop is propagated by seeds and about 15 kg seeds are required per hectare. The seeds can be soaked overnight in water for easy germination.

Land Preparation and Sowing: It does not require fine tilth. Hower, weed and pebble free land is recommended. The field should be twice ploughed, harrowed once or twice and appropriately leveled during February-March. The seed is drilled in rows 30 cm apart. After germination, the crop is thinned to give a spacing of 30 cm within the rows and 30 cm between the rows.

Irrigation: Depending upon the soil moisture condition, apply 4-6 irrigations. However, two irrigations are very crucial, one immediately after sowing, and the other at 30 days after sowing if soil moisture is inadequate.

Intercultural Operations and Fertilizer: One weeding is done 45 days after sowing of the crop. Apply FYM 10 - 15 t/ha and N, P and K at 40:40:40 kg/ha as basal. Apply 40 kg N at 40 days after sowing. It is advisable to grow senna using organic farming practices.

Pests and Diseases: Leaf spot caused by *Alternaria alternata* and leaf blight caused by *Phyllostica* species cause severe damage to the crop through leaf drop. Spraying of carbandazim (0.03%) or dithiocarbamate (0.03%) at fortnightly intervals three times is recommended to control diseases.

Harvesting and Drying: The plants start flowering at 60 days after sowing and the first flush is removed to encourage vegetative growth. About 90-100 days after sowing, fully developed bluish green colored leaves and golden yellow colored immature pods are stripped manually. A second harvest is taken 30-45 days after the first harvest. The leaves and pods are shade dried for 10-15 days to retain the green color before packing.

Yield: Under irrigated conditions, 1.0 to 1.5 tonnes of leaves and about 300 kg of pods are obtained per hectare. If the crop is raised under rainfed conditions, the yield would be about half of that from the irrigated crop.

Processing of the Leaves and Value Addition: The leaves are stripped from the branches and dried in shade for 10-15 days to a moisture content of 8-10 %. The leaves are processed manually or mechanically depending upon the quantum of the trrade. They are winnowed to remove dust and stones and then passed through sieves of different sizes to sort them into different grades. The different grades are given in Table 1. The leaves of Prime 1, 2 and 3 grades are exported and grades 4 and 5 are traded in the internal market. Prime 5 is known as the pharma grade and is used for extraction of sennosides.

FIG 2. Processing unit.

FIG 3. Processing unit.

TABLE 1. Different grades of senna leaves.

S.No	Grade	Length (cm)
1	Prime No 1	> 3.5 cm
2	Prime No 2	2.5-3.5 cm
3	Prime No 3	1.5-2.5 cm
4	Prime No 4	0.5-1.5 cm
5	Prime No 5	0.5 cm and less

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54. SEED SCIENCE AND TECHNOLOGY 17432

Seed Science and Technology Seed Packaging and Labeling

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INTRODUCTION: Seed packaging or bagging is essentially the last operation before storage or marketing. After processing and treatment, seeds are packaged into containers of specified net weight. The packaging consists of the following operations:

- Filling of seed bags/ containers to an exact weight.
- Placing leaflets in the seed bags/ containers regarding improved cultivation practices
- Attaching labels, certification tags on the seed bags / containers, and closing them.
- Storage/shipment of seed bags / containers.

Choice of packaging material depends on: crop and amount of seeds to be stored, transported or offered for sale, the cost of seed, the cost of packaging material, duration of storage, storage environment, seed moisture content and the geographical area where the seeds will be stored.

Types of Packaging Material

1. Moisture Vapour Permeable Container

e.g., jute bag, cloth bag, paper bag, multiwall paper bag, non-wooven bags

2. Moisture Vapour Resistant Container

e.g., jute bag laminated with thin polythene film, polythene bags (200-300 gauge)

3. Moisture Vapour Proof Container

1. *e.g.* tin can, polythene bags (>700 gauge), aluminimum foil pouches, glass bottles.
2. The packaging materials should protect most physical qualities of seeds and should have sufficient tensile strength, bursting strength and tearing resistance to withstand the handling stresses.

Equipment Used for Packaging of Seeds

1. Automatic weighing, packaging and sewing machine
2. Manual weighing, packaging and sewing machine
3. Automatic weighing and sealing machines for small seeds like vegetable crops
   a) Volumetric based machines
   b) Weight based machines
4. Weighing, tin packaging and sealing machines


Automatic Weighing, Packaging and Sewing Machine


Automatic Weighing and Sealing Machines or Pouch Packing Machines

Labelling

All seed bags/ containers must carry information about:

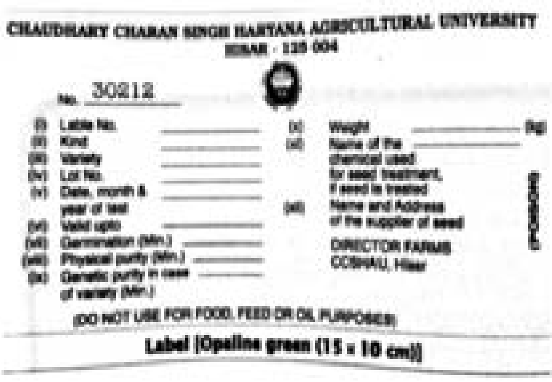
1. Crop
2. Variety
3. Class of seed
4. Address of the producer

Bags / containers should be labelled with tags according to the class of seed.

Seed tag should contain information about:

1. Physical purity (%)
2. Genetic purity (%)
3. Moisture (%)
4. Germination (%)
5. Date of test
6. Net content

These tags are attached to seed bags/ containers and they must carry signature of authority under which seed have been produced.



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No. 30212

(i) Lable No. ____
(ii) Kind ____
(iii) Variety ____
(iv) Lot No. ____
(v) Date, month & year of test ____
(vi) Valid upto ____
(vii) Germination (Min.) ____
(viii) Physical purity (Min.) ____
(ix) Genetic purity in case of variety (Min.) ____
(x) Weight ____ (kg)
(xi) Name of the chemical used for seed treatment, if seed is treated ____
(xii) Name and Address of the supplier of seed

DIRECTOR FARMS
CCSHAU, Hisar

(DO NOT USE FOR FOOD, FEED OR OIL PURPOSES)

Label [Opaline green (15 x 10 cm)]

55. PLANT BREEDING AND GENETIC 17506

Steps in Development of Synthetic Variety

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Synthetic Variety

In practical plant breeding, heterosis can be fully exploited in the form of hybrids in cross pollinated species, and also in some self pollinated crops. In cross- pollinated species, heterosis can also be exploited partially in the form of synthetic and composite varieties.

Definition of Synthetic Variety

A Variety which is produced by crossing in all combination a number of inbred lines that combine well with each other. Once synthesized, a synthetic is maintained by open-pollination in isolation is referred as synthetic variety.

Steps in Development of Synthetic Variety

Development of synthetic variety consists of three major steps. *i.e.*

1. Evaluation of lines for GCA.
2. Production of synthetic variety,
3. Multiplication of synthetic variety.

1) Evaluation of Lines for GCA

The lines that make up a synthetic variety may be inbred lines, clones, open pollinated variety of short term inbred lines. Inbred lines are evaluated for general combining ability because synthetic variety exploit that portion of heterosis which is produced by GCA. There are three different methods of evaluating, which is produced by GCA. There are three cross, Polycross and single cross.

In top cross, the inbreds are crossed with a common tester and the progeny are evaluated in replicated trials for general combining ability of yield and yield contributing characters. In Polycross, selected inbreds are allowed to intermated by open pollination in isolation and in single cross all possible single crosses are made among selected inbreds. These crosses are evaluated for GCA of yield in replicated that using local variety as a check. Thus, inbred lines with good GCA are identified and finally selected for development of synthetic variety.

2) Production of Synthetic Variety

A synthetic variety may be produced in one of the following two ways:

1. Equal amount of seed from the parental lines (syno) are mixed and planted in isolation. Open-pollination is allowed and produce crosses in all combinations. The seed from this population is harvested in bulk; the population raised from this seed is the Syn1 generation.
2. All possible crosses among the selected lines are made in isolation. Equal amount of seed from each cross is composite to produce the synthetic variety. The population derived from this composited seed is known as synthetic one generation.
3. Multiplication of Synthetic Variety: After a synthetic variety has synthesized. It is multiplied in isolation for one or more generation, before its distribution for cultivation. This is done to produce commercial quantities and is a common practical in most of the crops. E. g Grasses, Clover, Maize.

The open – pollinated progeny from the syn1 generation is termed as syn1that, syn2 as syn3 etc. the performance of syn2 is expected to be lower than that of syn1 due to the production of new genotype and decrease. In heterozygosity as a consequences of random mating. However, there would net be a noticeable decline in the subsequent generations produced by open – pollination (syn3, syn2, syn5, etc). Since the zygotic equilibrium for any gene is reached after one generation of random mating. The synthetic varieties are maintained by open pollinated, seed, and may be further improved through population improvement, particularly recurrent selection.

Merits, Demerits and Achievement of Synthetic Varieties

Merits of Synthetic Varieties

1. Synthetic varieties offer a feasible means of utilizing heterosis in crop species, where pollination control is difficult.
2. Farmers can use the grain produced from a synthetic varieties as seed to raise the next crop.
3. In variable environments synthetic are likely to do better than hybrid variety.
4. The cost of seed in synthetic variety is relatively lower than hybrid varieties.
5. Seed production in case of synthetic variety required less skill operation than hybrid.
6. Synthetic varieties are good reservoirs of genetic variability.
7. The performance of synthetic varieties can be considerably improved through population improvement without reducing variability, which is not possible with hybrids.

Demerits of Synthetic Varieties

1. The performance of synthetic variety is usually lower than best single or double cross hybrid.
2. Synthetic variety can be produced and

maintained only in cross- pollinated crop.

3. The performance of synthetic variety is adversely affected to relatively poorer GCA.

Achievements of Synthetic Varieties

Synthetic varieties have been developed in cross-pollinated crops like maize, pearl millet, sunflower, Sugarbeet, alfalfa, lucerne, etc. in U.S.A. In India synthetic varieties have been evolved in pearl millet at ICRISAT and in Sugarbeet at pantnagar. Ex. Sugarbeet- pant synthetic – 3, Cauliflower- synthetic -3, bajara- ICMS-7703.

56. PLANT BREEDING AND GENETICS 17408

Designer Crops: Future of Crop Production Technology

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Innovation in agriculture has always contributed to the increase in productivity and sustainability. The biotechnological approach has added a new dimension to such innovation, thus offering a very efficient and cost-effective means to produce crops having novel characteristics. In the above context, the emerging technology is named as the Designer Crops. The basic principle behind this technology is to merge the diverse array of novel properties of different crops or their species in a single specific crop. They are genetically-engineered crops with respect to higher yields, resistance to diseases and pests, taste, colour, size etc. The genetic engineering is done by inserting the DNA originating from any organism with the trait of interest into the target plant. So far much work has been accomplished in conferring traits to plants such as herbicide resistance, insect resistance, disease resistance and stress tolerance. However, there is a growing interest in producing drugs and industrial proteins in plants as well as enhancing the nutrition of plant products.

Method

1. The first step in making a designer crop is the transfer of desired DNA which is done by cutting or removing a gene segment from the DNA chain using the enzymes or molecular scissors.
2. The second step is to then cut an opening in the recipient DNA using the molecular scissors where the gene can be inserted. As the cut ends of both the gene segment and the recipient DNA are chemically "sticky", they get attached to each other making a chain of DNA that contains the new gene of interest.
3. The third step is done to complete the process in which we make use of another enzyme to paste or secure the new gene in place.

History

- The first whole genetically-engineered plant which was commercialized and grown was a virus-resistant tobacco in China in 1993.
- Following which was the first transgenic food crop, Flavr Savr tomato, in 1994, developed by Calgene Company.

Current Designer Crops

- Bt Cotton, containing *Bacillus thurengensis* (Bt) gene making it resistant to bollworm.
- Golden Rice, having the gene for -Carotene (precursor of Vitamin A).
- Round-up Ready crops, having resistance to herbicide Glyphosate.

Pros

- **Pesticide resistance:** The consumers who do not wish to eat food that is treated with the pesticides because of potential health hazards and environmental pollution, the growing of these designer crops can eliminate the application of chemical pesticides and also reduce the cost of cultivation of the crop.
- **Herbicide tolerance:** The crop plants which are genetically-engineered to herbicide tolerance can reduce the amount of herbicide use, thus prevent environmental damage.
- **Disease resistance:** The genetically-engineered crop plants can be resistant to plant disease caused by fungi, bacteria and viruses.
- Nutrition: These designer crops can help in the prevention of some of the world's largest nutrition problems.
- **Phytoremediation:** Some of the genetically-engineered plants can clean up the heavy metal pollution from the contaminated soil.
- **Pharmaceuticals:** Scientists are working for the development of the edibles vaccines and drugs in crop plants products which will make it easier to ship, store and administer than the traditional injectable vaccines.

Cons

- **The risk to non-target organisms:** Some of the pest-resistant crops can kill non-target insects with the poison they produce.

- **Resistance in the target organisms:** Due to the prevalent of the same designer crops for pest resistance may lead to a build-up of resistance in the target pests.
- **Transfer of gene to other species:** Some scientists also make their concern about the transfer of the gene for herbicide resistance to the weeds leading to the formation of "Superweed" in nature.
- **Ethical issues:** Some of the genes which are used in the designer crops are obtained from animal source leading to a boycott of these plant products by a certain society of the people.

Future Prospects

- Food crops without allergens
- Grains, fruits and vegetables with improved nutrition.
- Longer shelf life and better taste of the plant produces.
- Rice having enhanced iron content to prevent anaemia.
- Foods used as vaccines, so we can say bye-bye to needles.

Bottom line: The designer crops are as safe as the market crop produces and they also promise for more nutritious food. Some of the crops have a less environmental impact than the conventional crops or even promises to remediate the polluted lands. The genetic-engineering is also an important tool for plant breeders. The benefits of these crops will be spread between the producing institutions, farmers and consumers.

57. PLANT BREEDING AND GENETICS 17417

Importance of Wild Relative in Crop Gene Pool

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Introduction

Gene Pool

- In population genetics, a gene pool is the complete set of unique alleles in a species or population. The concept of gene pool was proposed by Harlan and De Wet in 1971.
- A large gene pool indicates extensive genetic diversity, which is associated with robust populations that can survive bouts of intense selection.

Types of Gene Pool

The gene pool is classified into following three groups-

1. Primary Gene Pool

- The primary gene pool consists of the taxa, including cultivated, weedy and wild forms of a crop. It includes all the strains of the concerned crop species.

2. Secondary Gene Pool

- The members of secondary gene pool are all those taxa that hybridize with the members of the primary gene pool with some to considerable difficulty and the hybrids are at least partially fertile.

3. Tertiary Gene Pool

- The species belonging to this group represent the extreme outer limit of the potential germplasm.

Gene Pool of some Crops

We can see in below table that wild species and wild relative of crop plants can acquire their place in any of the gene pool.

TABLE 1: Gene pool of some important crops

Crop	GP1	GP2	GP3
Barley	*H. vulgare, H. spontaneum*	*H. bulbosum*	*Hordeum spp., Triticeae spp.*
Wheat	*T. aestivum*	*Triticum spp., Aegilops, Secale, Thinopyrum*	Other Triticae spp.
Chickpea	*C. arietinum, C. reticulatum*	None	*C. bijugam, C. pinnatifidum*
Lentil	*L. culinaris*	None	*L. nigricans*
Sugarcane	*S. officinarum, S. bar. beri*	*Erianthus spp., Imperata spp.*	------------

Need to Broaden the Crop Gene Pool

Today, modern agriculture and, for that matter, human existence is dependent onthe cultivation of a few highly productivecrop species. These food crops were firstdomesticated from wild species about10,000 years ago during the transition fromnomadic huntergatherers to life in agrariansocieties. Considering that flowering plantsfirst evolved over 150 million years ago, crop plants as we know them have existedfor the mere blink of an evolutionary eye. Following domestication, the geneticvariation in crop plants has continued to bereduced by another force—modern plantbreeding. Over the past century, the developmentand successful application of plantbreedingmethodologies has produced the high yielding crop varieties on which modernagriculture is based. Yet, ironically, it isthe plant-breeding process itself that threatensthe genetic base on which breedingdepends. Because new varieties are usuallyderived from crosses among genetically relatedmodern varieties, geneticallymorevariable, but less productive, primitive ancestorsare excluded. Soybeans and wheatare good examples of crops with very narrowgenetic bases. Virtually all modern U.S. soybean varieties can be traced back to adozen strains from a small area in northeasternChina, and the majority of hard redwinter wheat varieties in the United Statesoriginated from just two lines importedfrom Poland and Russia. The limited genetic diversity of cropsrenders them more vulnerable to diseaseand insect epidemics and jeopardizes thepotential for sustained genetic improvementover the long term. This risk wasbrought sharply into focus in 1970 with theoutbreak of Southern corn leaf blight. Thisdisease drastically reduced corn yields in theUnited States and was attributed to extensiveuse of a single genetic male sterilityfactor that, unfortunately, was geneticallylinked to disease susceptibility.

What are Wild Relatives?

We can define wild relatives as an organism taxonomically related to a domesticated organism but living wild and serving as a potential source of useful genes to improve the domesticated organism.

Why Wild Relatives' are Important?

Wild relatives of crop plants have great significance in crop improvement. Few reasons of their importance are given below -

- Elite germplasm has reduced levels of genetic variation due to use of genetically similar material repeatedly for many years.
- Wild species harbour gene for important traits like yield and quality
- Wild species have ability to resist biotic and abiotic stresses.
- Use of wild relatives facilitates the study of genomic relationship for drawing phylogenetic inferences.

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58. PLANT BREEDING AND GENETICS 17433

Relevance of Mutation in Crop Improvement

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Mutation is a sudden and heritable change in the phenotype of an organism, which does not arise due to segregation or recombination. In molecular terms it can be defined as the permanent and relatively rare change in the number or sequence of nucleotides. The term is coined by Hugo De Vries (1901) and he pointed out that spontaneous mutations are potential sources of creating new variability in the natural populations, these new variations created by spontaneous mutation are heritable and play important role in the process of evolution.

Mutation Breeding: The genetic manipulation of crop plants for various traits through the use of induced mutation.

Characteristics of Mutation

1. Mostly recessive
2. Harmful
3. Random (they may occurs any gene)
4. Recurrent (same mutation may occur again and again)
5. Showing Pleiotropic effects
6. Frequency of occurrence is low.

Effects of Mutation

1. Lethal (all the individual carrying such mutation are killed)
2. Sub-lethal (mortality is more than 50%)
3. Sub-vital (mortality is less than 50%)

4. Vital (all mutants survive)

Classification of Mutations

1. **Dominance Relationship:** Dominant, Recessive, Co-dominant & Incomplete Mutation
2. **Cause of Mutation:** Spontaneous Mutation & induced Mutation
3. **Tissue of origin:** Somatic Mutation & Germinal Mutation
4. **Effect of Survival:** Lethal, Sub-lethal or Sub-vital, Vital & Super-vital Mutation
5. **Environmental influence:** Morphological, Conditional lethal & Biochemical Mutation
6. **Quantum of Morphological effect:** Macro Mutation & Micro Mutation
7. **Cytological basis:** Gene Mutation & Chromosomal Mutation

Why mutations are required: In classical plant breeding variation is generated by hybridization and then selections are made from the resulting segregating generations. Induced mutagenesis can supplement hybridization or replace as a source of variability thus mutation provides the raw material for crop evolution and it also provides fundamental variability required for crop improvement. Induced mutations are used for large extent in genetic research they have contributed directly to the improvement of cultivars in various crop species

Numerous works has been done on induction of mutation in different crops and its utility in creating the crop prospects. Mutation breeding has been acclaimed as an excellent tool in the hands of a breeder. The mutation breeding has been successfully employed for improving both oligogenic and polygenic characters. Mutation breeding is more successful in diploid, sexually reproducing and self pollinating crops. Some of the major applications of mutation breeding are

- Induction of new variation that is not available in existing germplasm.
- Improving specific character of variety without change in genetic makeup.
- Improving the yielding ability for broadcasting the genetic base of population by way of treating the F_1 hybrid with mutagens.
- Different recurrent mutagenic treatment to enlarge mutagenic tools.
- Induction of male sterility and to overcoming self incompatibility (Lewis-1954)
- Production of haploids by irradiating pollens.
- Reduction of toxic substances.

Limitations

- The frequency of desired mutation is very low.
- Need to screen large number of population.
- Mutation produces pleiotropic effect, which can affect other gene.
- Most of the mutations are recessive.
- Identification of micro mutation is very difficult.
- The registration of a mutant variety may face problems.

59. PLANT BREEDING AND GENETICS 17443

Ideotype Breeding and their Utilization in Crop Improvement

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Crop Ideotype refers to the conceptual model plant having all such characteristics which are considered ideal for the given environment. Ideotype can also be defined as a model plant that optimally armed for the maximum yield under the expected environment. The term ideotype was introduced by Donald (1968); it exactly means a form denoting an idea. He defined ideotype as a biological model which is expected to perform or behave in a predictable manner within an expected environment. A crop ideotype is a plant model selected before growing the crop which is expected to yield a greater quantity or quality of grain, oil or other useful product when developed as a cultivar. It is also known as model plant type, ideal model plant type, and ideal plant type.

Types of Ideotype: In 1976, Donald and Hamblin proposed the concepts of isolation, competition, and crop or communal ideotypes.

Isolation Ideotype: It is the model plant type that performs best when the plants are space-planted. In case of cereal crops, isolation ideotypes are lax, free-tillering, leafy, spreading plant that is able to explore the environment as fully as possible. It is unlikely to perform well at crop densities.

Competition Ideotype: It performs well in genetically heterogeneous populations, such as the segregating generations of crosses. In the case of cereals, it is tall, leafy, the free tillering plant that is able to shade its less aggressive neighbors and thereby, gain a large share of radiation, nutrients, and water. In the case of annual seed crops, such ideotypes will include features like annual habit, tallness, leafy canopy, tillering or branching, seed size, the speed of germination and root characters.

Crop Ideotype/Communal ideotypes: It performs best at commercial crop densities because it is a poor competitor. Communal plants may give low individual plant yields in isolation, but when grown in a pure stand at a density sufficient to interplant completion, they are capable of higher crop yields. In case of cereals, crop ideotype is erect, sparsely tillered plant with small erect leaves.

Several other ideotypes that include traits concerned with specific features:

- **Market Ideotype**: It includes traits like seed color, seed size, cooking and baking quality etc. which are considered essential to determine the market acceptability of the produce.
- **Climatic Ideotype**: It includes traits important in climatic adaptation *e.g.* early maturity, thermo period-insensitivity etc.
- **Edaphic Ideotype**: denotes soil characteristic traits like salinity tolerance, mineral toxicity/ deficiency tolerance etc.
- **Stress Ideotype:** includes traits like resistance to the concerned abiotic and biotic stresses

Main Features of Ideotype Breeding

1. Emphasis on an individual trait like morphological and physiological traits which enhance the yield.
2. Includes yield-enhancing traits *i.e.* characters that exhibit a positive association with yield is included in the model.
3. Exploits physiological variations-makes use of genetically controlled physiological variations in increasing crop yields.
4. Slow progress
5. Selection
6. Designing of the model the phenotype of a new variety to be developed is specified in terms of morphological and physiological traits in advance.
7. Interdisciplinary approach

Steps in ideotypes breeding: Ideotype breeding may be viewed as consisting of the following four steps:

1. Development of a model plant type *i.e.* ideotypes
2. Creation of adequate genetic diversity for the concerned traits
3. Selection of plants/lines with the desired phenotypes
4. Evaluation of the phenotype in several genetic and cultural backgrounds.

Factors affecting Ideotypes

- Crop species: In monocots tillering is more but in dicots branching is important.
- Cultivation: The features of irrigated crops differ from that of rainfed crops.
- Socio-economic condition of farmers *e.g.* dwarf sorghum is ideal for mechanical harvesting in the USA, but it not suitable for Africa's farmers
- Economic use.

Merits of the Ideotype Concept

- It exploits both morphological and physiological variation
- Provides a solution to several problems at a time
- An efficient method of developing cultivars for a specific situation or environment
- Genes for specific traits are introduced from unimproved into the elite gene pool

Demerits of Ideotype Concept

- It is a slow method of cultivar development
- It has been difficult to identify individual traits that enhance yield universally or in limited genetic and environmental situations

60. PLANT BREEDING AND GENETICS 17457

Genetic Hitchhiking or Genetic Draft

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INTRODUCTION: The process of favourable mutation which increases the fixation results into the fortuitous advantage to all the genes with which it was originally associated was termed as `hitchhiking' by Maynard Smith & Haighin (1974). They showed that in large populations, it could reduce neutral diversity much more than random genetic drift. The term was originally coined to describe the effects of the substitution of a favourable mutation on linked loci and is sometimes still used in this restricted sense (Barton, 2000). Selection on one or more genes inevitably perturbs other genes, even when those genes have no direct effect on fitness. This is because of genetic hitchhiking which is also called genetic draft. Genetic hitchhiking is nothing but a change in allele frequency not because it is under natural selection, but due to nearly located another gene that is undergoing a selective sweep and that is on the same DNA chain.

Newly appeared mutations which are advantageous in nature and increases the allelic frequency of concerned gene results into the selective sweep. Both genetic hitchhiking and background selection are random evolutionary forces, like genetic drift (Gillespie, 2001). The allelic frequency of neutral allele which favours to the adaptation will keep on increasing and in some cases until it becomes fixed in the population. In contrast, allelic frequency of neutral allele having the harmful version will decrease, in some cases until extinction.

Overall, hitchhiking reduces the amount of genetic variation. Genetic hitchhiking is especially apparent in predominantly asexual organisms such as bacteria. It is also a component of bacterial sex where DNA is transferred between individuals and then acquired as relatively small pieces, with increases in the fitness of the resulting recombinant organism potentially dependent on the functioning of only one or a few of multiple genes acquired. For example, resistance plasmids.

Genetic Draft versus Genetic Drift

Genetic draft (genetic hitchhiking) is entirely different from the genetic drift although both are random evolutionary processes and in a way that is not correlated with selection at the concerned gene. In any finite population, genetic drift generates random associations between polymorphic loci and hence causes selection on one locus to spill over onto others. Any one locus experiences random perturbations, which on average interfere with selection (Robertson 1961; Hill & Robertson 1966). This kind of hitchhiking can thus be understood as causing an amplification of random sampling drift, and a reduction in effective population size (barton, 2000). Genetic drift refers to the change in allelic frequency of a population due to random sampling in each generation whereas genetic draft refers to the change in the allelic frequency due to the randomness of what other non-neutral alleles it happens to be found in association with (Masel, 2011). Assuming genetic drift is the only evolutionary force acting on an allele, the new variance due to change in allelic frequency across the population can be estimated with the following formula (Gillespie, 2001).

$$= pq/2N$$

Where, populations each of size N, each starting with allele frequencies of p and q.

The above equation clearly depicts the dependency of genetic drift on population size which is defined by the actual number of individuals in idealised populations. Genetic draft also results in similar behaviour to the equation of genetic drift but in contrast to it draft depends on the effective population size which may have no relationship to the actual number of individuals in the population (Gillespie, 2001). Effective population size may depend on the recombination rate and the frequency and strength of beneficial mutations.

Importance

Hitchhiking is important for many reasons (Barton, 2000).

1. It was first proposed as an explanation of why very abundant species do not show correspondingly high levels of genetic diversity (Maynard Smith & Haigh 1974).
2. The pattern of marker variation can reveal the action of selection in the surrounding genome.
3. It provides a way of inferring the overall amount and nature of selection.

Applications

A. **Sex chromosomes:** The Y chromosome is more prone to the fixation of deleterious mutations particularly via hitchhiking because it does not undergo recombination. This may be a possible reason, why there are few functional genes on the Y chromosome (Rice, 1987).

B. **Gene surfing:** Genetic hitchhiking can be intensified at the invasive species front, when a population is expanding geographically where adaptive alleles get a double advantage like they are adaptive and they also arrive first in new territories. This phenomenon is known as gene surfing (Barton *et al.*, 2013).

C. **Mutator evolution:** Hitchhiking is necessary for the evolution of higher mutation rates to be favoured by natural selection. A mutator allele increases the general mutation rate in the nearby allele which may be mutated into a new advantageous allele.

D. **Neutral theory of molecular evolution:** This theory assumes that mostly new mutations are either deleterious or else neutral with very few being adaptive. Genetic hitchhiking has therefore been viewed as a major challenge to neutral theory, and an explanation for why genome-wide versions of the McDonald-Kreitman test appear to indicate a high proportion of mutations becoming fixed for reasons connected to selection (Hahn, 2008).

Outcomes

If neutral polymorphism is in linkage disequilibrium with a second locus which is undergoing a selective sweep also leads to hitchhiking. Deleterious “passenger” mutations can also hitchhike, not just neutral mutations (Good and Desai, 2014). In an asexual population, hitchhiking can be seen directly through the phenomenon of `periodic selection’ (Dykhuizen 1990). The steady increase in diversity at a marker locus caused by neutral mutation is punctuated by an abrupt loss of variation whenever a favorable substitution occurs. Even in a sexual population, any variants associated with a favorable mutation will increase until separated from it by recombination. Recombination plays a dissentious role for genetic hitchhiking. Recombination can end the hitchhiking before neutral or deleterious allele becomes fixed or goes extinct (Fay and Wu, 2000). If polymorphism to the gene which is going under the selection is closer, recombination has rare opportunity to occur. This leads to a reduction in genetic variation near a selective sweep that is closer to the selected site (Braverman *et al.*, 1995).

61. PLANT BREEDING AND GENETICS 17460

Photo and Thermo-Sensitive Genetic Male Sterility and its Use

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Male sterility: It is the failure of plants to produce functional anthers, pollen, or male gametes. It mainly occurs in bisexual plants. Koelreuter (1763) observed anther abortion within species & species hybrids and it more prevalent than female sterility. In this there is Failure to develop normal microsporogenous tissue. Abnormal microsporogenesis lead to the development of in-viable pollen. There are two types of male sterility **a). Genetic male sterility b). Cytoplasmic male sterility.** In this we will discussed only about the types and the significance of genetic male sterility.

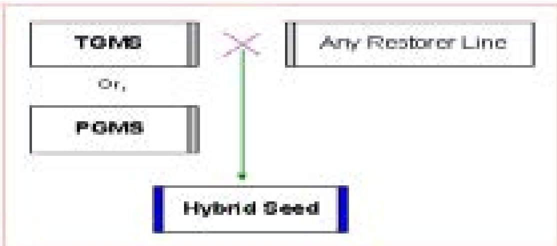
Types of Genetic male Sterility

Environment insensitive GMS: *ms* gene expression is much less affected by the environment.

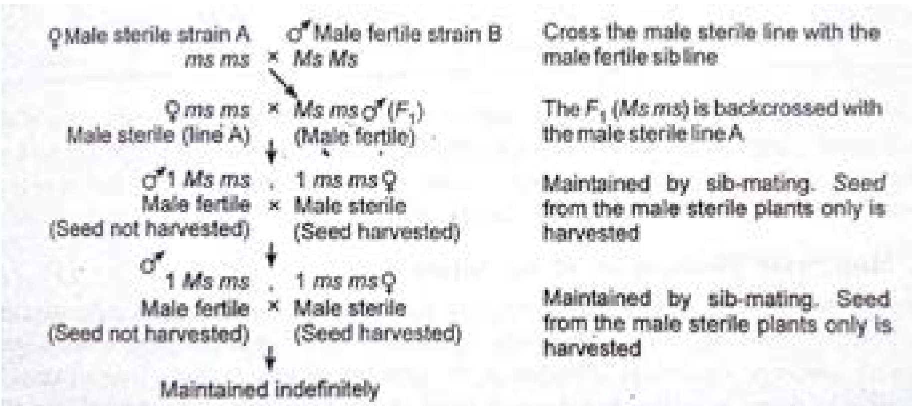
Environment sensitive GMS: ms gene expression occurs within a specified range of temperature and /or photoperiod regimes (Rice, Tomato, Wheat etc.).

Thermo-sensitive genetic male sterile (TGMS):- sterility is at particular temperature *e.g.* In rice TGMS line (Pei- Ai645) at **23.3^{0}C** (China). TGMS at high temperature is due to failure of pairing of two chromosomes at metaphase was evident. This abnormality led to abnormal meiosis, abnormal or sterile pollens. Anthers were shriveled and non-dehiscence-Male sterile However, these lines produced normal fertile pollen at low temp. and sensitive period range from PMC formation to Meiosis.

Photoperiod-sensitive genic male sterility (PGMS): Governed by 2 recessive genes. Sterility is obtained in long day conditions while in short days, normal fertile plant. **Rice:-** Sterile under Long day conditions (13 hr. 45 min + Temp. 23-29^0 C) but fertile under short day conditions. Sensitive period ranges from differentiation of secondary rachis branches to PMC formation.



Maintenance of male Sterile Line



Significance of P(T)GMS

- Two line hybrid rice system was established by using a photoperiod sensitive genetic male sterile– mutant discovered (1973) from a japonica cultivar "Nongken".
- According to yuan's china hybrid shifted from three line system to two line.
- P(T)GMS has wider restorers, therefore its combination can be more easily obtained.
- The frequency heterotic hybrids is higher in two line hybrid than in three line hybrid, thereby increasing hybrid breeding effeciency.

Advantages

- Simplified procedure of hybrid seed production.
- Multiple and diverse germplasm available as parents.

- Increased chance of developing desirable & heterotic hybrids.
- Yield performance and resistance and so on, two line hybrids is obvious superiority.
- There is no need of restorer gene in male parents of two line hybrids.
- There is no need of maintainer line for seed multiplication.

Disadvantages

- Environmental effect on sterility could cause seed purity problem.

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Allele Mining: A Potential Approach to Break Yield Plateau

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INTRODUCTION: Allele mining is an approach to find out naturally occurring allelic variants of a candidate gene controlling key agronomic traits which has potential in crop improvement. New alleles are evolved either naturally by recombination in divergent population or mutation as SNPs (single nucleotide polymorphism) or InDels (Insertion and Deletion). It has wide applicability in discovery of superior alleles, detection of new haplotypes, intra- and inter-species similarity analysis, evolution study, gene expression pattern study and functional molecular marker development for MAS. True Allele Mining comprises the analysis of non-coding and regulatory regions of the candidate genes in addition to analysing sequence variations in the coding regions of gene. It has tremendous potential in identification of alleles conferring resistance/tolerance to biotic & abiotic stresses, improving yield & quality and greater nutrient use efficiency, assessing and discovering the hidden alleles in hereditary diversity for more efficient utilization of genetic and genomic resources to break yield plateau in crop improvement, hastening in mutation detection and validating specific genes controlling the trait.

Approaches in Allele mining: Three major approaches for allele mining are as follows:

1. **Eco- TILLING or Modified TILLING:** TILLING (**T**argeted **I**nduced **L**ocal **L**esions **IN** **G**enome) concept was given by Claire McCallum in 1990's while working with characterization of the function of two chromo-methylase gene (*CMT2*) in *Arabidopsis i.e.* a reverse genetic technique to identify artificially induced point mutations in gene of interest by combining chemical mutagenesis with PCR based screening employing heteroduplex analysis, whereas, Eco-TILLING concept was given by Comai *et al.*, 2004 *i.e.* a modified TILLING to detect naturally occurring allelic variants (SNPs and/or INDELs) of a target gene from landraces, wild population and cultivars. Bajaj *et al.*, 2016 exploited Eco-TILLING based approach to delineate functionally relevant natural allelic variants of the candidate genes governing agronomic traits (seed weight) in chickpea.
2. **Sequencing-based Allele mining:** It identifies nucleotide variation in alleles by various DNA sequencing techniques through PCR amplification of alleles in diverse population (Table 1). Imam *et al.*, 2016 subjected sequencing based allele mining to study the selective patterns of rice blast (*Magnaporthe oryzae*) resistance genes on *Pi9* locus in a set of rice landraces from India.

TABLE 1: Various DNA sequencing techniques for allele mining and their read length

Sequencing techniques	Developed	Principles	Read length
Maxam-Gilbert or Chemical degradation sequencing	Alan Maxam&Wlater Gilbert, 1977	Sequencing by chemical chain degradation	100 bp
Sanger-Coulson or Enzymatic degradation sequencing	Fredrick Sanger & Alan Coulson, 1975	Sequencing by enzymatic chain termination	750 bp
SOLiD sequencing (Sequencing by Oligoligation& Detection)	Life technologies, USA and commercially since 2006	Sequencing by ligation	35 bp
Illumina/ Solexa sequencing	Shanker Balasubramanian & David Klenerman, Cambridge University	Sequencing by synthesis	300 bp
Heliscope sequencing	Helicos BioSciences company	Sequencing by synthesis	35 bp

Sequencing techniques	Developed	Principles	Read length
SMRT sequencing (Single Molecule Real Time)	PacBio company	Sequencing by synthesis	10-20 Kb
Ion torrent sequencing	Ion Torrent Systems Incorporation	Sequencing by synthesis	400 bp

3. **Association Mapping based Allele mining:** This concept was given by Jennings, 1917 to map the allelic diversity present in the population by testing marker-trait association using linkage disequilibrium (LD), also known as population mapping or LD mapping. It is based on principle linkage disequilibrium or gametic phase disequilibrium *i.e.* non-random association between alleles at different loci. Hufnagel *et al.*, 2018 used association mapping based allele mining on the Alt_{SB} locus in sorghum genetic diversity for enhance the aluminium (Al) tolerance.

Various Bioinformatic Tools for Allele Mining in Public domain: such as PLACE, plantCARE, TRANSFAC, JASPAR, MEME, Plantprom DB, DCPD, SCPD, BioEdit, ClustalW etc.

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63. PLANT BREEDING AND GENETICS 17498

Transgenic Crops: A Boon to Agriculture

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INTRODUCTION: A transgenic crop may be defined as the plant which bears the foreign gene introduced into it from the organisms belonging to a completely different species through the process of genetic engineering. These crops are also known as genetically modified crops. The introduced gene is known as transgene.

Need to develop Transgenic Crops

1. By 2025, the world's population is projected to reach 8.5 billion. Thus, it is imperative to produce the plants with improved quality and quantity through genetic engineering to feed this population.
2. The indiscriminate use of pesticides causes environmental hazards and harm non-target organisms and humans. Transgenic plants can resist the attack of the pests; diseases etc. and thereby reduce the expenditure incurred in purchasing the chemical protectants.
3. In developing countries, the majority of the population relies completely on a single staple food crop thereby, increasing a concern for nutritional content. Transgenic crops combat deficiencies in food by enhancing proteins, vitamins and micronutrient composition.
4. Through biotechnology it is possible to develop an improved variety within a short time span.
5. Genetic engineering can be carried out under laboratory conditions, is comparatively more efficient and is less time consuming.
6. Genetic engineering makes it possible to develop the plants that can mitigate the effects of biotic and abiotic stresses and increase the crop yield.

Development of transgenic crops: It begins with the identification of the desired trait in the organism (plant or microbe) followed by isolation of specific gene or genes and its transfer to the plant where they may express themselves. Transgenic crops are developed under the laboratory conditions. Most of the genetically modified plants are generated by *Agrobacterium tumefaciens* (natural genetic engineer) mediated transformation method or by the biolistic method (particle gun method). Gene gun method is most commonly employed in crops like corn, rice and the monocot plants for which *Agrobacterium tumefaciens* mediated transformation method cannot be applicable.

Merits of Transgenic Crops

1. **Nutritional Content:** Vitamin A Deficiency (VAD) kills nearly two million children per year. The precursor of Vitamin A is beta carotene which is absent in cereal grains. The Golden Rice Project was initiated to introduce two genes: psy (phytoene synthase) from daffodil and crt1 (carotene desaturase) from *Erwinia uredovora* into rice endosperm to allow beta-carotene synthesis. In the year 2005 Golden rice 2 was developed having 23 times more beta-carotene than the original golden rice. Only 40 grams of golden rice when consumed daily prevents death and blindness, with no possibility of overdosing, as the human body only converts the required amount of beta-carotene to vitamin A and excretes the rest unchanged.
2. **Herbicide Resistant**
   a) **Roundup soybean:** Glyphosate interferes with the synthesis of three essential amino acids (phenylalanine, tyrosine and tryptophan) for humans in plants. The glyphosate resistant gene was isolated from *Agrobacterium* strain CP4 (CP4 EPSPS) and introduced into soybean.
   b) **Transgenic maize:** Imidazolinone resistance (IR) XA17 gene was introduced into maize lines which conferred resistance to imazaquin and nicosulfuron herbicides used against *Striga hermonthica* (a parasitic weed).
   c) **Transgenic tobacco:** Bromoxynil binds to photosystem II and blocks electron transport chain. Transgenic tobacco was developed by introducing *bxn* genes isolated from *Klebsiella pneumonia* subsp. *ozaenae*, found in bromoxynil contaminated soil.
3. **Insect Resistant Crops**
   a) **Bt Crops (Transgenic Cotton):** Recently, cotton has been genetically modified with an insecticidal protein (Tma12) present in ferns to be resistant against whiteflies. Tma12 binds to the chitin polymers of insects' exoskeletons thereby, killing them.
   b) **Protease Inhibitors (PI):** A Bt-corn called Bt- Xtra contains three genes *i.e.* Cry 1Ac from *Bacillus thuringiensis*, bar from *Streptomyces hygroscopicus* and potato proteinase inhibitor (pinII) provides resistance towards pests and glufosinate ammonium herbicide.
   c) **Lectins:** Plant lectins are particularly effective against the sap sucking insect order Hemiptera. Transgenic rice with *Galanthus nivalis* (snow drop) agglutinin (GNA) lectin shows resistance to *Nilaparvata lugens*.
   d) **Alpha-amylase inhibitors:** The bean (*Phaseolus vulgaris*) amylase inhibitor gene expressed in seeds of transgenic garden pea (*Pisum sativum*) and other grain legumes, provides resistance to storage pests such as bruchid beetles and field pests such as pea weevil *Bruchus pisorum*.
4. **Virus Resistance:** Transgenic papaya and cassava with viral coat protein sequence as a transgene encode for resistance to many viral diseases.
5. **Reduction in Pesticide Usage:** Bt cotton reduces pesticide applications by 50% and avoids at least 2.4 million cases of pesticide poisoning among Indian farmers every year. On an average, genetic engineering technology adoption has reduced chemical pesticide use by 37%, increased crop yields by 22%, and increased farmer profits by 68%.
6. **Abiotic Stress Tolerance:** To promote stress tolerance in plants transgenic regulations of solutes such as mannitol and proline have been used. Over-production of a superoxide dismutase (SOD) gene increases chilling tolerance in plants. The tropical maize inbred line CML216 transformed with isopentenyltransferase (IPT) enzyme shows enhanced tolerance to drought in transgenic crops by delaying drought-induced leaf senescence gene.
7. **No Adverse Effect on Soil Microbes:** The concentration of Cry 1Ac protein decreases quickly after soil incubation. Also, there is no significant change in the population sizes, diversity of the soil bacteria, fungi and archaebacteria.
8. **Transgenic Plants can be used to Obtain Diagnostic and Therapeutic Proteins:** An anti- cancer antibody recently expressed in rice and wheat seeds recognizes cells of lung and colon cancer and hence could be useful in both diagnosis and therapy in the future.
9. **Miscellaneous Transgenic Plants**
   a) **Transgenic *Arabidopsis*:** it has been developed by inserting Polyhydroxybutyrate (PHB) producing gene from bacteria that helps in the degradation of plastics.
   b) **Transgenic Tomato:** 35-40% of produce is lost due to quick ripening. A transgenic FlavrSavr tomato is produced where ripening is delayed by lowering polygalacturonase activity.
   c) **Transgenic Apple:** Golden Delicious apples were developed in 2015 by using a technique called gene silencing whereby the apple's DNA is engineered to produce less polyphenol oxidase, or PPO, the enzyme that causes the flesh to turn brown.

Conclusion: Ever increasing population is a matter of great concern. It is strenuous to fulfill the food demand of every individual from the limited land resources resulting in food shortage. However, the transgenic crop offers a potential solution to food shortages around the globe. These crops are not only adaptable to the extremes of environment but are also eco-friendly, pose no risk to human health and are profitable to farmers. In other words, transgenic crops are the boon to agriculture.

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Proteomics: A Treasure in the Genome-World

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What is Proteomics?

Proteomics is a leading technology for the high-throughput analysis of proteins on a genome-wide scale. This field aims to elucidate the roles of the vast number of proteins made from various unique combinations of 22 genetically-encoded amino acids. The proteome is the total set of proteins possessed by an organism; it is never constant and differs from cell to cell and changes over time. To some degree, the proteome reflects the underlying *transcriptome*,(the total RNA present in the cells at a given stage/time). The word *proteome* is a portmanteau of *prote*in and gen*ome*; it refers to the protein composition of the genome, and was coined by Marc Wilkins in 1994 while he was a Ph.D. student at Macquarie University. Macquarie University also founded the first dedicated proteomics laboratory in 1995.

Proteomics has enabled the identification of ever increasing numbers of protein. This varies with time and distinct requirements, or stresses, that a cell or organism undergoes. For example, in case of the same individual, the proteome of his liver cells would be entirely different from that of the cells of his eyes. The proteome also keeps on changing along with the development stages; the proteome of a plant at vegetative stage will be far more different than its proteome at maturity stage. In plant breeding, it may prove of immense importance to compare the proteome of a plant at normal *vs* stress conditions. Proteomics is an interdisciplinary domain that has benefitted greatly from the genetic information of various genome projects, including the Human Genome Project.[8] It covers the exploration of proteomes from the overall level of protein composition, structure, and activity. It is an important component of functional genomics.

Aims/Objectives of Proteomics

- The initial objective of proteomics was the large-scale identification of all protein species in a cell or tissue.
- The applications are currently being extended to analyze various functional aspects of proteins such as post-translational modifications, protein-protein interactions, activities and structures.
- To find out when and where proteins are expressed; rates of protein production, degradation, and steady-state abundance.
- To investigate how proteins are modified, for example, post-translational modifications (PTMs) such as phosphorylation.
- To monitor the movement of proteins between subcellular compartments.
- To investigate the involvement of proteins in metabolic pathways and how proteins interact with one another.

Tools to Study Proteomics

Due to the complex nature of the proteome, the constant development of new methods and techniques for the chromatographic separation of the proteins and their detection is important for the correct identification of peptides and proteins.

In proteomics, generally three methods are preferred for separation:

1. Denaturing polyacrylamide gel electrophoresis (PAGE) or sodium dodecyl sulfate polyacrylamide gel electrophoresis (SDS-PAGE).
2. Two-dimensional gel electrophoresis.
3. High-performance liquid chromatography (HPLC).
4. Other useful tools include capillary electrophoresis and affinity chromatography.

After separation of the proteins, its identification is necessary and is carried out using Mass Spectrophotometry (MS). There are two types of MS instruments:

1. **MALDI-TOF:** Matrix Assisted Laser Desorption Ionization-Time of Flight; MALDI is a method of ionization, TOF is a mass analyzer.
2. **ESI Tandem Mass Analyzer:** ESI is a process by which the ions are produced in the source of the instrument; Tandem Mass analyzer are able to perform two stage (multi-stage) mass analysis.

A computer program is required to read the complex mass spectrophotometer information. The program/database matches the information on each peptide's mass against the mass of theoretical predicted peptide, based on the known proteins in the database.

Applications of Proteomics

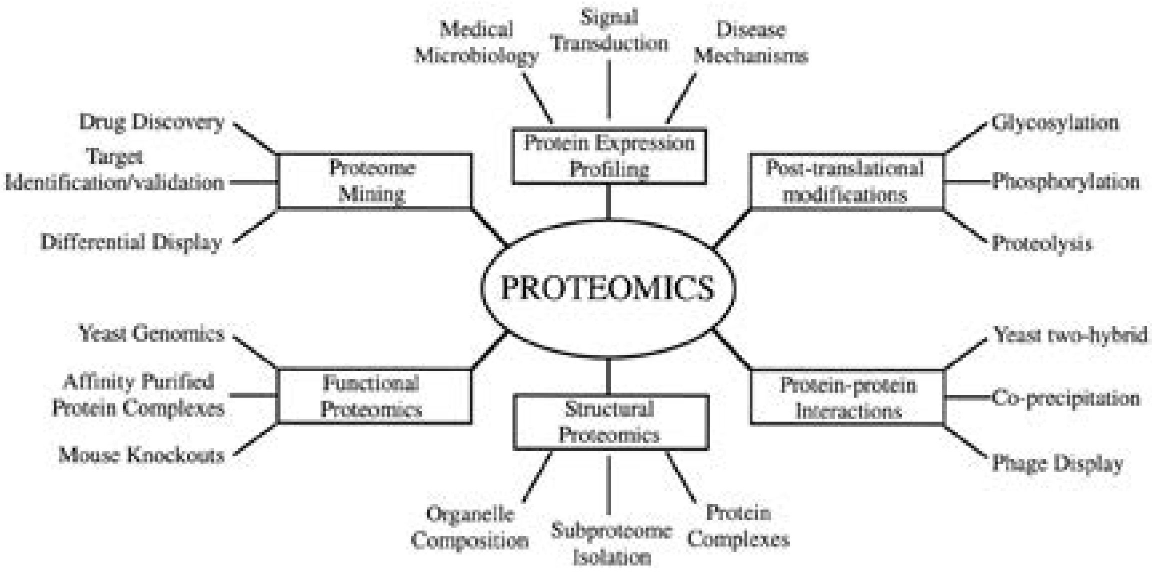

FIG : Applications of Proteomics

- **Protein mining:** Identification of all the proteins present in a particular sample.
- **Protein network mapping:** To determine protein-protein interaction within a living system.
- **Protein expression profiling:** Identification of proteins in a sample as a function of particular state of a cell *i.e.* two or more states of a particular system are compared.
- **Mapping of protein modifications:** Identification of the location and mechanism of post-translational modification of proteins.

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Genome Wide Association Mapping

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It has already been known that variations at the genetic level between two and more individuals can cause alterations in the phenotypes. Identification of the genetic variations at DNA level help in understanding gene functions. Biparental quantitative trait locus (QTL) mapping and genome wide association mapping (AM) are the two most valuable approaches for genetic basis of phenotypic variations.

In recent years, association mapping has been found more robust as compared of the traditional biparental QTL mapping. Originally, the AM approach was developed for measuring the genetic proximity of the loci and to map them in humans. Subsequently, the importance of AM approach in plant genetics for QTL mapping was identified and implicated due to its two major advantages over the biparental QTL mapping:

1. In biparental QTL mapping approach, segregating generation(s) derived from a cross between two contrasting inbred of same species are utilized, this limits the amount of possible genetic variations in the assay. By contrast, the mapping population for AM consists of a diverse set of individuals (popularly known as an association panel) drawn from a mendelian population, provides a wider swath of possible recombination events and allelic variations across the genome at a single time.
2. Since, AM involves the leverage of history of recombination events across a lineage it allows to map the QTL with much finer resolution as compared to the traditional QTL mapping, at the cost of lesser time and labour.

The general procedure for a typical genome wide association mapping is as follow:

1. **Mapping population:** a mapping population should consist of as much as possible number of genetically divers individuals from a natural population. This may include breeding line,

wild relatives, population derived from multiparent crosses, germplasm core collection. An association panel comprised of at least 96 genetically diverse individual is recommended for a valid AM study.

2. **Phenotyping:** a precise phenotyping is a key of a successful association mapping with ridge and reproducible results. For trait(s) interest, the mapping population should be evaluated under multiple environments and locations in replicated trials.
3. **Genotyping:** this is a process of identifying variations in the DNA sequences between two or more individuals with the help of molecular markers. At present, vast range of molecular markers such as SSR, DArT, SNP, etc. are available. SNP(s), due to their enormous advantages over other molecular markers, are the most preferable marker system for the AM however, under the Indian lab conditions where the research budget is a major limitation SSR markers are preferred. While genotyping with the SSRs one should select as much as practically possible number of markers covering the whole genome of the species as densely as feasible.
4. **Association mapping:** this final step involves the implication of a number of statistical methods and models which are mainly carried out with the help of computer based statistical and bioinformatic tools, discussion on them is beyond the objectives of this article. However, some of the major are outlined here, briefly:
   a) **Population Structure and Kinship analysis:** the basic fundamental of this analysis is to group the population in a given number of clusters and estimating the allelic frequencies in each cluster and the membership of each individual in that cluster, assuming the Hardy-Weinberg principle and linkage disequilibrium with in cluster. The kinship analysis provides the possible genealogical relationship among the individuals. The structure of the given panel is estimated with the help of STRUCTURE, a tool based on the Bayesian model-algorithm used for the clustering of the genetic data. The output files of STRUCTURE are used to assay the kinship however, a number of freeware (*e.g.* TASSLE) are available for kinship analysis, we at our lab generally prefer R language based suitable packages.
   b) **Association Mapping and Linkage Disequilibrium analysis:** in this step linkage disequilibrium between the molecular markers and the loci governing the trait(s) of interest is detected and estimated with a suitable model-based (BLUP, MLM, GLM, etc.) analysis of relatedness between the genotypic and phenotypic data. The possibilities of false association between the markers and the loci of interest is minimised by using the estimates of population structure and kinship as covariates in the model. The computer programmes which are most frequently used by plant scientists for this analysis are TASSLE and GAPIT-R (package). The results are typically represented with the help of Manhattans plot.

Factors those affect our results during AM

1. Type and Size of population
2. Methods of phenotyping (design, numbers of replication and number of environments)
3. Type of molecular markers and techniques used for the genotyping of the AM panel
4. Statistical methods and models used for the analysis

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66. PLANT BREEDING AND GENETICS 17565

Genetic Improvement for High Yielding Varieties in Lemongrass [*Cymbopogan flexuosus* (Steud.) Wats.]

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INTRODUCTION: Lemongrass (*Cymbopogan flexuosus* (Steud.) Wats.) is an important aromatic grass. It belongs to the family of Gramineae and genus cymbopogon, which consist of more than 80 species. Lemongrass can be cultivated successfully in subtropical and tropical plains of India ranging from North to South and East to hot humid conditions which are ideal for good vegetative growth and oil biosynthesis. Lemongrass can be cultivated in the areas where average day temperature remains more than 15°C having sufficient sunshine and rainfall. High temperature and ample sunshine are conducive for the growth and development of crop and essential oil biosynthesis. The sandy loam to loam soil with assured drainage facility and average soil fertility are considered ideal for its cultivation. India produces around 1000 tons of lemongrass oil per year and is exported to America, England, Germany, Australia and Japan.

FIGURE 1: Photo of Lemongrass (*Cymbopogan flexuosus* (Steud.) Wats.)

Botanical Description of Lemongrass

Cymbopogon flexuosus (Nees ex Steud) Wats is commonly known as lemongrass and locally it is called Cochin or Malabar grass. It is tufted perennial grass, with numerous stiff stems arising from a short, rhizomatous rootstock. The leaf-blade is linear, tapered at both ends and can grow to a length of 50 cm and width of 1.5 cm. The leaf-sheath is tubular in shape and acts as a pseudo stem. This plant produces flowers at matured stages of growth. Conversely, flowering has never been observed under cultivation due to rapid harvesting time. The rhizome produces new suckers that extend vertically as tillers to form dense clumps.

Cultivars Released in India

Some of the improved cultivars recommended for cultivation Cauvery, Krishna, Nima, Pragati, Praman, Suwarna and Sikhar etc. development from CSIR-central Institute of Medicinal and Aromatic Plants, Lucknow, India (Table1). Lemongrass varieties developed by CSIR-CIMAP are in cultivation in India on around 3000 hectares producing around 320 tones of essential oil. Currently Krishna is the most popular variety in India farmers. Lemongrass is indigenous to India and grown in Kerala, Assam, Maharashtra and Uttar Pradesh. Apart from India, lemongrass is also cultivated in large scale in Brazil, Mexico, Dominica, Haiti, Madagascar, Indonesia and China. The oil from lemongrass is referred as East Indian lemongrass oil. The first variety of lemongrass selected was OD-19 from Kerala in India followed by OD-408 and OD-440. Thereafter, a number of important cultivars have been developed during the course of study of genetic diversity and chemo genetical improvement in a citral producing lemongrass (cultivar OD-19). Some of the important lemongrass cultivars are GRL-1 (geraniol rich lemongrass), Krishna, Cauveri, Pragati, Chirharit, CKP-25 and SD-68. Among these Krishna is most popular throughout India and was developed at Central Institute of Medicinal and aromatic Plants (CIMAP), Bangalore centre. Krishna yield high bio mass (25-28 Mt/hectare) with high oil yield (230-250 kg. / hact.) due to high % of oil in bio mass. CKP-25 is another successful variety which gives good result even in less rainfall area. CKP-25 was developed by Regional Research laboratory (RRL), Jammu. Chirharit is very popular in Tarai region of Uttarakhand as same remains green throughout year producing high quantity of bio mass although % of oil recovery is less due to cold climate in such region. Nima variety is known for its unique citrus clean odor as same contains less grassy component like methyl heptenone. Also, this variety can be grown in west land containing very high salt. All of the above cultivars of lemongrass yield essential oil highly rich in citral except GRL-1 which yields geraniol rich essential oil. Thus, could be easily distinguished from other cultivars by the presence of high amount of geraniol (89.39%). Lemongrass has been used in medicine in India for more than 2000 years. However, its use for distillation is about 100 years old and the first distillation in India was started in about 1890 during the British period from wild grass in Kerala. The total annual world production of East Indian lemongrass oil used to be 1500 tonnes.

TABLE 1: Details of the improved cultivars cultivated of Lemongrass in India

Cultivars	Herb Yield (q/ha/year)	Oil Yield (kg/ha/year)	Constituents (in %)	Origin/Development	Suitable Area
Pragati	350	200	Citral (85%)	Half-sib seed followed by clonal selection	North Indian p370lains
Praman	370	225	Citral (75-80%)	Clonal selection	Drought/Marginal land
Chirharit	256	260	Citral (80%)	Clonal selection in OPSPs	Frost resistant variety
T-1	364	181	Citral (45-50%)	Half seed followed by clonal selection	Drought/Marginal land
Nima	289	261	Citral (89%)	Half-sib seed followed by clonal selection	High pH, alkaline soils, Drought prone areas and marginal land

Cultivars	Herb Yield (q/ha/year)	Oil Yield (kg/ha/year)	Constituents (in %)	Origin/Development	Suitable Area
GRL-1	275	185	Citral (60-65%)	Clonal Selection	Drought prone areas and marginal land
Suwarna	549	208	Citral (80%)	Clonal Selection	Drought prone areas and marginal land
Krishna	250-300	200-240	Citral (75-80%)	Clonal variety through recurrent selection	North Indian plains and South India
Sikhar	200-250	280	Citral (86%)	Clonal Selection	North Indian plains and South India

Varieties developed by other universities and institutes are, Jor Lab L-2, OD-19, SD-68 (*Cymbopogan flexuosus*), RRL-16(*Cymbopogan pendulus*) and CKP-25 (hybrid of *Cymbopogan khasianus* and *Cymbopogan pendulus*). The hybrid lemongrass CKP-25 different from other citral-rich varieties with respect to a number of minor compounds.

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67. PLANT BREEDING AND GENETICS 17590

Nutrigenomics: A New Science of Nutrient – Genome Interaction

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INTRODUCTION: The success of the Human Genome Project (HGP) has brought forth the whole information about the genome and is now used to study the interface between our genes and factors from the environment like nutrition, related to a state of health or disease. Food intake is a main factorsthat affect the health or illness of an individual. Studies innutritional area have increased the understanding to maintain a group of individuals healthy in different dietary conditions with new insights including (i) influence of gene expression on health in response to metabolicprocess, at cellular level (ii) result ofthe interaction between genotype and environment/ nutrient in the form of gene expression and metabolic response (iii) prescribingspecific diets for each individual. Hence, Nutrigenomics was introduced to focus on the effects of thenutrients over the genome, proteome, and metabolome. This new area of science will further improve our fundamental knowledge of the interaction between life processes and our diet.

What is Nutrigenomics?

Nutrigenomics is the integration of genomic science with nutrition. It attempts to study thegenome-wide influences of nutrition with the help ofdietary signals detected by the cellularsensor systems affecting gene and protein expression and, ultimately, metabolite production ('dietary signatures'). Nutrigenomics seeks to examine these dietary signatures inspecific cells, tissues and organisms, and also the effect of nutrition on homeostasis. Itidentifies the genes that influence the risk ofdiet-related diseases on a genome-wide scale.

Experimental Approaches and Technologies used in Studying Nutrigenomics

1. **Transcriptomics: mRNA-Profiling:** The three most frequently used methods for mRNA profiling are cDNA-AFLP (copy DNA - amplified fragment length polymorphism), SAGE (serial analysis of gene expression) and the DNA microarray. For cDNA-AFLP, mRNA is converted into double-stranded cDNA and then digested with two restriction enzymes. After separating the fragments on a polyacrylamide gel, qualitative and quantitative comparison of band patterns before and after changing the triglyceride concentration of the culture medium leads to the detection of genesof which the mRNA production has changed.
2. **Proteomics: Protein Profiling:** Alternative RNA processing and post-translational modificationcauses a gene to produce several proteins differing in physicochemical and functionalcharacteristics. Therefore, it is evident to conclude about the dynamics of gene expression in cellsresponding to a nutrientfrom protein profiling. This is generally examine by 2-D gel-electrophoresis, in which proteins are separated both according to theirelectrical

charge and mass. After staining, proteins appear on the gel as individual spots, of which the staining intensity is used to estimate therelative amount of a protein in the sample. The spot patterns from the cells before and afterexposure are compared using softwares to detect changes in the concentration of individualproteins.

3. **Metabolomics: Metabolite Profiling:** Metabolomics is the large scale analysis of multiple metabolite concentrations under changing nutritional conditions, is also regarded as being part of nutrigenomics. Analysis of the metabolome requires expensive equipment including gas-chromatographs linked to mass spectrometers and nuclear magnetic resonance instruments. Different technologies are used for the profiling of different classes of metabolites like lipids, carbohydrates and amino acids.

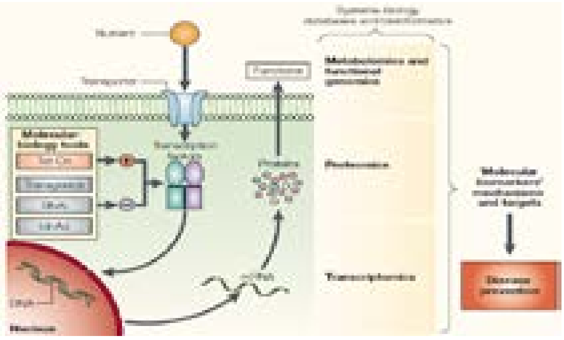

FIGURE 1 : The 'smart' combination of molecular nutrition and nutrigenomics.

Below some of the major deliverables are listed with respect to nutrition-related disorders:

1. **In nutrition-related diseases:** Up and downregulated genes during disease occurrence can be identified by comparing the biopsymaterial between patients and matched controls and can be further used as biomarkers in diagnostic protocols.
2. **In vitamin deficiency control:** Vitamin deficiencies are highly prevalent in socioeconomically challenged populations around the worldtherefore, proponents of nutrigenomics research have cited the population-wide prevention and treatment of vitamin deficiency as a top public health priority.
3. **Biomarkers to monitor the success of nutritional intervention:** Similar comparativestudies before, during and after an intervention will reveal genes and expressionprofiles indicative of the progress and the success of treatment by nutrition.
4. **In nutritionally preventing the DNA damage:** With the increasingly lower pricings for analyzing SNPs in individuals, the population-level potential for dietary optimization based on nutrigenomic approaches seems truly awesome. Even in the absence of information on an individual's genotype, it is practical to use nutrition-sensitive genome damage biomarkers, such as the micronucleus assay, to determine whether dietary and/or supplement choices are causing benefit or harm to a person's genome.

Challenges and Future Research Goals

Identifying the SNP–diet and SNP–nutrient interactions that cause chronic disease is challenging because of the complexities inherent in studying genotypes and in assessing dietary and nutrient intakes. Also, the human intervention studies are costly and difficult to conduct, observational studies (which detect associations, not causal relationships) will likely continue to dominate the epidemiologic approach to nutrigenomics. Diet–gene interactions are highly complex and hard to predict, it may ultimately require a nutrigenomics project on the scale of the Human Genome Project. At the same time, quantifying food intake is challenging because free-living humans simply do not regard daily life as a science experiment where the amount and type of food is accurately recorded thus requires more reliable measurement tools for assessing nutrient intake will be needed in the years ahead.

68. PLANT PATHOLOGY 17427

Diagnostic Kits for Identification of Bacteria

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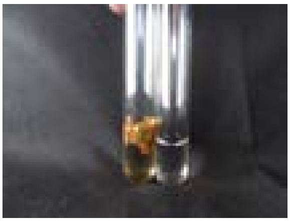
The most important task of bacteriology is to identify the pathogens from the clinical sample so that appropriate treatment can be instituted. There are several methods to identify the different type of bacteria.

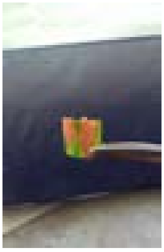
1. Diagnosis of Diseased Leaf Samples

Bacterial symptoms on leaves are sometimes difficult to distinguish from other pathological and physiological leaf drying symptoms in the fields. For rapid and reliable diagnosis, simple tests as described below were followed. All these tests are based on bacterial exudation from the cut ends of the vascular system of the diseased leaves.

1. **Dipping Method:** The freshly collected bacterial infected leaves are cut into small pieces with a scissor across the yellow lesion and place in a test tube filled with clean water. Yellowish white bacterial mass can be seen oozing out from the cut ends of the leaf bits of infected leaves into water within few minutes. After 30-40 minutes, the entire water in the test tube becomes yellowish and turbid.



2. **Guttation Method:** The freshly collected diseased leaves are cut across the yellow lesion and are kept under moist condition in a Petri plate. With a span of 2-3 hours, yellowish turbid droplets of bacterial ooze will be seen on the upper cut end of the Bacterial infected leaves.



3. **Microscopic Method:** In this method, a small section (5 mm x 5 mm) of fresh lesion from a suspected bacterial infected sample will place in a glass slide on a drop of water and then cover with a coverslip. The slide is then observed under low power in a light microscope. Oozing out of cloudy mass of bacteria from the cut end of the leaves is observed in case of bacterial infected samples.

2. Isolation in Pure Form

Studies on the biochemical, antigenic and other characters of bacteria can be done only if the organism available in the pure forms

Technique

a) Plating on solid culture media: clinical sample is streaked onto a solid medium (nutrient agar or blood agar) in such a way so as to ensure isolated discrete colonies.
b) Use of selective growth condition: most important example of this is the growth of anaerobic bacteria which will not take place in an environment having oxygen.

3. Staining Reaction

The age of the culture is important. In older cultures, staining characteristics either vary or are not brought out well. Simple stains bring out the best morphology. Differential and special stains are necessary to bring out characteristics like: gram negative and gram positive bacteria, Acid fast and nonacid fast, spirochetes, capsule and flagella etc.

i) Take a heat fixed bacterial smear.
ii) Flood the smear with Crystal Violet for 1 minute, then wash with water. [Primary Stain]
iii) Flood the smear with Iodine for 1 minute, then wash with water.
iv) Flood the smear with Ethanol-Acetone, quickly, and then wash with water. [Decolorization]
v) Flood the smear with Safranin for 1 minute, then wash with water
vi) Blot the smear, air dry and observe

Examine under Microscope

i) Gram positive bacteria- violet
ii) Gram negative bacteria-pink

Staphylococcus aureus

Escherichia coli

4. Morphology of the Bacterial Colony

i) Shape: circular, irregular, radiate or rhizoid. I
ii) Size: diameter in mm
iii) Elevation: flat, raised, low convex, dome shaped
iv) Margin: Entire, wavy, lobate, filiform
v) Surface: smooth, wavy, rough, granular, papillate, glistening etc.

5. Biochemical Tests

Tests to Know:

1. Indole
2. Methyl Red
3. Citrate Utilization Test

1. Indole Test

Principle: Indole test is performed to determine the ability of the organism to split tryptophan molecule into Indole. Indole is one of the metabolic degradation product of the amino acid tryptophan Bacteria that possess the enzyme tryptophanase are capable of hydrolyzing and deaminating tryptophan with the production of Indole, Pyruvic acid and ammonia.

Property it tests for:
This test is performed to help differentiate species of the family Enterobacteriaceae. Media and Reagents Used: Tryptone broth contains tryptophan. Kovac's reagent—contains hydrochloric acid, dimethyl amino benzaldehyde, and amyl alcohol—yellow in color.

Procedure:

1. Inoculate Tryptone broth with the test organism and incubate for 18 to 24 hrs at 37 c - Add 15 drops of Kovac's reagent down the inner wall of the tube
2. **Interpretation:** Development of bright red color at the interface of the reagent and the broth within seconds after adding the reagent is indicative of the presence of Indole and is a positive test.

2. Methyl Red

Properties its test for: Both tests are used to differentiate species of the family enterobacteria.

Media and Reagents Used

1. Glucose Broth
2. Methyl Red indicator for MR Test.

To test the ability of the organisms to produce and maintain stable acid and products from buffering capacity of the system.

Procedure
Inoculate the MR/vp broth with pure culture of the test organisms and incubate at 35degrees centigrade for 48 to 72 hrs. Add 5 drops of MR reagent to the broth.

Result Interpretation
Positive result is red –indicating pH less than 6

Negative result is yellow indicating no acid production.

3. Citrate Utilization Test

Principle: The test organism is cultured in a medium which contains sodium citrate and ammonium salt the indicator bromoethynol blue. Growth in the medium is shown by turbidity and a change in colour of the indicator from light green to blue due to the alkaline reaction.

Procedure: Inoculum is streaked over the slant of Simmons citrate agar in a tube and incubated for 24 to 48 hrs.

Result and interpretation: Growth on the slant and change in colour to blue of the medium indicate positive result.

69. PLANT PATHOLOGY 17476

Role of Growth Regulators in Plant Disease Development

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Plant growth is regulated by a small number of groups of naturally occurring compounds that act as hormones are called as growth regulators. The most important growth regulators are auxins, gibberellins and cytokinins, but other compounds such as ethylene and other growth inhibitors, play important regulatory roles in the life of the plant (Sequeira, 1963).

Auxins The auxin occurring naturally in plants is indole-3-acetic acid (IAA). Produced continually in growing plant tissues. It is required for cell elongation and differentiation, absorption of IAA to the cell membrane also affects the permeability of the membrane. Increased auxin (IAA) levels occur in many plants infected by fungi, bacteria, viruses, mollicutes and nematodes, although some pathogens seem to lower the auxin level of the host. Thus, the basidiomycete *Exobasidium azalea* causing azalea leaf and flower gall, the protozoon causing clubroot of cabbage (*Plasmodiophora brassicae*), the bacterium *A. tumefaciens* causing crown gall and the one causing leafy gall of sweet pea and other plants, the fungi causing corn smut (*Ustilago maydis*), cedar apple rust (*Gymnosporangium juniperi-virginianae*), banana wilt (*Fusarium oxysporum, f. sp. cubense*), pine western gall rust, the root knot nematode (*Meloidogyne sp.*), and others not only induce increased levels of IAA in their respective hosts, but are themselves capable of producing IAA. How the increased levels of IAA contribute to the development of wilt of plants is not yet clear, but the increased plasticity of cell walls as a result of high IAA levels renders the pectin, cellulose, and protein components of the cell wall more accessible to and may facilitate their degradation by, the respective enzymes secreted by the pathogen. An increase in IAA levels seems to inhibit the lignification of tissues and may thus prolong the period of exposure of the non-lignified tissues to the cell wall degrading enzymes of the pathogen. Increased respiratory rates in the infected tissues may also be due to high IAA levels, and because auxin affects cell permeability, it may be responsible for the increased transpiration of the infected plants.

Gibberellins A century ago, rice farmer in Asia noticed some exceptionally tall seedlings growing in their paddies. Before these rice seedlings could mature and flower, they grew so tall and spindly that they toppled over. In Japan, this aberration in growth pattern became known as bakanae (foolish seedling disease) disease of rice. In 1926, Kurosawa, a Japanese scientist discovered that the disease was caused by a fungal pathogen, *Gibberella fujikuroi*. By the 1930s, Japanese scientists had determined that fungus produced hyper-elongation of rice stems by secreting a chemical, which was given the name gibberellin. Gibberellins are normal constituents of green plants and also produced by several other microorganisms. The best known gibberellin is gibberellic acid. In the past years, scientists have identified more than 80 different gibberellins, many of them occurring naturally in plants. Spraying of diseased plants with gibberellin overcomes some of the symptoms (stunting) caused by several virus- or mollicute-pathogensindicating that gibberellin involves in disease development.

Abscisic acid: Abscisic acid is an isoprenoid compound that regulates developmental processes, such as seed development, desiccation and dormancy. In addition, the function of ABA as a regulator of abiotic stress, ABA has also emerged as a complex modulator of plant defense responses, as a positive or a negative regulator of plant defense depending on the plant–pathogen interaction analysed. ABA-impaired (biosynthesis or signalling) mutants in tomato (sitiens) and Arabidopsis (abi1-1, abi2-1, aba1-6, aba2-12, aao3-2, and pyr1pyl1pyl2pyl4) were shown to overexpressd efensive-signaling pathways, leading to enhanced resistance to different pathogens such as *B. cinerea*, *P. syringae*, *F. oxysporum*, *Plectosphaerell acucumerina* and *Hyaloperonospora parasitica* (Audenaert *et al.*, 2002).

Cytokinins: Cytokinins are potent growth factors necessary for cell growth and differentiation. In addition, they inhibit the breakdown of proteins and nucleic acids, thereby causing the inhibition of senescence and they have the capacity to direct the flow of amino acids and other nutrients through the plant toward the point of high cytokinin concentration. Cytokinins occur in very small concentrations in green plants, in seeds and in the sap stream. The first compound with cytokinin activity to be identified was kinetin, which, however, was isolated from herring sperm DNA and does not occur naturally in plants. Several cytokinins, *e.g.*, zeatin and isopentenyl adenosine (IPA), have since been isolated from plants. Cytokinins act by preventing genes from being turned off and by activating genes that have been previously turned off. The role of cytokinins in plant disease has just begun to be studied. Cytokinin activity increases in clubroot galls, in crown galls, in smut and rust galls, and in rust-infected bean leaves. In the latter, cytokinin activity seems to be related to both the juvenile feature of the green islands around the infection centres and the senescence outside the green island. However, cytokinin activity is lower in the sap and in tissue extracts of cotton plants infected with verticillium wilt and in plants suffering from drought. A cytokinin is partly responsible for several bacterial galls of plants, such as “leafy” gall disease of sweet pea caused by the bacterium Rhodococcus (*Corynebacterium fascians*), and for the witches’ broom diseases caused by fungi and mollicutes.

Ethylene: CH_2-CH_2 Produced naturally by plants, ethylene exerts a variety of effects on plants, including chlorosis, leaf abscission, epinasty, stimulation of adventitious roots, and fruit ripening. Ethylene also causes increased permeability of cell membranes, which is a common effect of infections. However, ethylene production in infected tissues often parallels the formation of phyto alexins and the increased synthesis or activity of several enzymes or signal compounds that may play a role in increasing plant resistance to infection. Never-the-less it has not been shown that ethylene actually provides resistance. Ethylene is produced by several plant pathogenic fungi and bacteria. In the fruit of banana infected with *Ralstonia solanacearum*, the ethylene content increases proportionately with the (premature) yellowing of the fruit, whereas no ethylene can be detected in healthy fruits. Ethylene has also been implicated in the leaf epinasty symptom of the vascular wilt syndromes and in the premature defoliation observed in several types of plant diseases. In Verticillium wilt of tomato, the presence of ethylene at the time of infection inhibits disease development, whereas the presence of ethylene after infection has been established enhances Verticillium wilt development. Polysaccharides Fungi, bacteria, nematodes, and possibly other pathogens constantly release varying amounts of mucilaginous substances that coat their bodies and provide the interface between the outer surface of the microorganism and its environment. Exo-polysaccharides appear to be necessary for several pathogens to cause normal disease symptoms either by being directly responsible for inducing symptoms or by indirectly facilitating pathogenesis by promoting colonization or by enhancing survival of the pathogen. The role of slimy polysaccharides in plant disease appears to be particularly important in wilt diseases caused by pathogens that invade the vascular system of the plant. In vascular wilts, large polysaccharide molecules released by the pathogen in the xylem may be sufficient to cause a mechanical blockage of vascular bundles and thus initiate wilting. Although such an effect by the polysaccharides alone may occur rarely in nature, when it is considered together with the effect caused by the macromolecular substances released in the vessels through the breakdown of host substances by pathogen enzymes, the possibility of polysaccharide involvement in the blockage of vessels during vascular wilts becomes obvious.

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70. PLANT PATHOLOGY 17512

The Importance of Plant Virus Transmission by Insect Vectors

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Most plant viruses depend on insect vectors for their survival, transmission and spread. They transmit plant viruses by two principal modes, circulative (circulating through the insect's haemocoel, CV) and non-circulative (carried on the cuticle lining of mouthparts or foregut, NC). Transmissibility and specificity between NC viruses and their vectors depends on the coat protein (CP) of the virus in addition to virus-encoded helper proteins. Circulative viruses cross the gut, circulate in the haemocoel and cross the salivary glands to render the insect infective. Circulative luteoviruses depend on small CP and the read-through protein (RTD) for transmission. Electrical penetration graphs have provided evidence on insect feeding behaviour and virus transmission. Recently, studies have shown that viruses can modify vector behaviour in a way that transmission is enhanced. Cultural, physical and novel biotechnological tools can provide virus control by interfering with vector landing and the retention of viruses in their vectors.

INTRODUCTION: Insect vectors of plant viruses are found in 7 of the 32 orders of the class Insecta. Hemipterans are by far the most important virus vectors, comprising more than 70% of all known insect-borne viruses. Among these, aphids and whiteflies are the major vectors of plant viruses transmitting more than 500 virus species. Two major classifications of viruses have been proposed: attending to the time the vector remains viruliferous [persistent, semi-persistent (SP) or non-persistent (NP)] or the route of the virus within its vector [non-circulative (NC) or circulative (CV)]. More recently, a third classification was proposed based on the localization of virus–vector retention sites: cuticula-borne or salivary gland-borne. A number of viral and insect proteins have been found to control some virus–vector association, but many remain unknown. Interference with vector landing by manipulation of insect vision together with novel molecules that outcompete viruses from the retention sites in their vectors could help reducing plant virus epidemics.

The Importance of Insect Vectors: Most plant viruses depend on vectors for their survival for two principal reasons:

1. An impermeable cuticle coats the plant epidermis, preventing entry of virus particles (animal viruses enter readily through natural openings). Most vectors are insects (non-insect vectors include mites, nematodes and fungi). Several plant viruses may spread by contact or vegetative reproduction. Many insects such as hemipterans are well adapted to their role as vectors by their capacity to pierce the epidermis and delicately deposit the virus in the cytoplasm without risking the integrity of the plant cell. Recent findings propose that viruses have adapted to their vectors modifying their behaviour to maximise their own spread.
2. Plants are rooted and lack independent mobility. Therefore, many viruses depend on insects for transport among hosts (unlike animals that, by their own mobility, transport the virus to new niches). Insect-borne plant viruses may cause severe or even crippling losses to many annual and perennial crops. On occasion, insects are responsible for transition from a non-spreading form to the epidemic form of diseases. Outbreaks of disease caused by insect vectors are demonstrated in two examples. In perennials, the almost total destruction of the citrus industry in the 1930s in Argentina and Brazil is attributed to the aphid Toxoptera citricida. In annuals, outbreaks of Tomato spotted wilt virus (TSWV) or begomoviruses in recent decades is attributed to the spread of the thrips Frankliniella occidentalis and the whitefly cryptic species complex, Bemisia tabaci, respectively.

Taxonomy: Insect vectors of plant viruses are found in 7 of the 32 orders of the class Insecta. The majority of vectors are found in the two orders of insects with pierce-sucking mouthparts (number of species in parenthesis): Hemiptera (300) and Thysanoptera (6). Other vector species are found in five orders of chewing insects: Coleoptera (30), Orthoptera (10), Lepidoptera (4), Diptera (2) and Dermaptera (1).

Mechanisms of transmission: Progress in the molecular biology of viruses and their vectors has assisted greatly in the localization of virus retention sites in their vectors and in identifying motifs in the viral genome and in viral and vector proteins, thus adding to the understanding of the process of virus transmission by insects.

The Major Transmission Modes: Persistent Versus Non-persistent; Circulative Versus Non-circulative Plant viruses demonstrate a high level of specificity for the group of insects that may transmit them (a virus that is transmitted by one type of vector will not be transmitted by another). CV viruses that propagate in their insect vectors are not considered in this article.

Modes of transmission: In the 1930s, Watson and Roberts proposed modes of virus transmission by insects. The basis for their assigning viruses to these modes was the duration of virus retention in the vector. Originally, they proposed two modes: NP for short retention or 'less than the time the virus survives in leaf extracts'; and persistent for extended retention, often for life. However, several viruses showed an intermediate retention in their vector. This led Sylvester to designate the term SP viruses (Raccah, 1986). In time, a different terminology was proposed for modes of transmission, based on the site at which the virus is retained in the insect. Thus, NP viruses were termed stylet-borne, whereas persistent viruses were termed CV. NP viruses are acquired and inoculated during brief probing times, do not require a latent period in the vector and are transmitted by many aphid species, mostly by those not colonising the crop. SP viruses need longer periods (hours) for acquisition and transmission than do NP viruses. They have a narrower range of vector species. However, they do not require latent period and are lost when the vector moults. In persistent viruses, several hours or even days are needed for efficient acquisition and inoculation. They have a narrow range of vectors, mostly those that colonise the crop, pass through moult and need a latent period. Many thorough biological, microscopical, immunological, molecular techniques and electronic monitoring feeding devices have subsequently been used to elucidate the mechanisms of transmission.

Two Principal Modes of Transmission Emerged

1. CV or internal, where the virus crosses gut barriers and enters the circulatory system of the insect and accumulates inside the salivary glands
2. NC or external, where the virus remains attached to the cuticle of the insect mouthparts or foregut and does not cross gut barriers.

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71. PLANT PATHOLOGY 17550

Choanephora Fruit Rot (*Choanephora cucurbitarum*)

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- Domain: Eukaryota
- Kingdom: Fungi
- Phylum: Zygomycota
- Subphylum: Mucoromycotina
- Order: Mucorales
- Family: Choanephoraceae
- Genus: *Choanephora*
- Species: *Choanephora cucurbitarum*

Distribution: Worldwide in Tropical Regions

SYMPTOMS: *Choanephora cucurbitarum* is a plant pathogenic fungus causing fruit rots, flower rot and leaf blights on a variety of plants including squash, pumpkin, pepper, pea and bean. This fungus is known to attack several other crops which include cereals such as millet, rice and sorghum. The fungus also causes pod blight known as wet rot, blossom blight and whisker rot (Kacharek *et al.*, 2003). This disease is also common on squash and southern pea but occurs on the floral parts of many types of plants (Afolabi, 1994). It causes blossom blight, die back, wet rot and soft rot of stems or side shoots of chilli plants (Maeda *et al.*, 2010). C. cucurbitarum mostly attacks tissues that have been damaged by insects or mechanical means, or crops that are poorly adapted to a hot humid climate.

Choanephora fruit rot in squash

The general appearance of Choanephora blight is similar to that of diseases caused by other Mucorales of the genera Mucor and Rhizopus. Turkensteen (1979) reported that host tissues have a hairy appearance resulting from the tall sporangiophores that produce a cluster of brown sporangiola (often referred to as conidia) at their tips. Garden peas (Pisum sativum) attacked by C. cucurbitarum in Japan developed a dark-greenish rot of leaves, stems and pods with silk-like threads of sporangiophores growing densely on the lesions (Oikawa *et al.*, 1986).

Choanephora fruit rot on common bean

Conditions for Disease Development

Choanephora is favored by warm, wet weather. Both blossoms and fruit are affected and fruit nearest the ground are more likely to become diseased. It is not unusual to find 30–40% of blossoms and/or fruit infected with the fungus. While the disease is destructive, it is also as short-lived as the conditions that promote it. Subsequent fruit sets are usually not affected unless conducive conditions reoccur. The fungus resembles Rhizopus stolonifer, but spore-bearing heads are branched, a feature that can be seen with a 20x hand lens.

Choanephora on pumpkin flower

Control

There are few management techniques available; fungicide sprays may help reduce disease damage.

72. PLANT PATHOLOGY 17676

Ophiocordyceps unilateralis: Fungi that Make Ants Obey

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A new study is shedding light on the mysterious markings of zombie ants, tropical carpenter ants that take their orders from a fungus. The fungal vampire carves its way into an ant's body and compels it to crawl over and devour vegetation until it meets its fate clasped to the underside of a leaf or twig. As the grand finale, toxic spores bloom from the dead ant's head and drift to the ground below, onto more unsuspecting zombies-to-be. It hasn't been clear exactly how the fungus exerts this seeming mind control over the ant, but scientists figured that it made its way directly into the ant's brain. Now, using 3-D computer modeling and artificial intelligence to process samples, the researchers were surprised to discover that the fungus, called *Ophiocordyceps unilateralis sensu lato*, invades an ant's whole body and leaves the brain untouched.

O. unilateralis (Ascomycota: Hypocreales) is a specialized fungal parasite that infects, manipulates and kills formicine ants, predominantly in tropical forest ecosystems. It specifically infects *Camponotus leonardi* of the tribe of campotini. Worker ants are infected during foraging when the fungal spores attach to their cuticles. Germination and then penetration through the cuticle leads to rapid infection inside the host body. Once infected the ants will climb down from their natural habitats on rainforest tree and relocate to 25 cm off the ground under leaves where the temperature is low and humidity is high. Fungal reproduction is only possible after a stalk is grown out of the host's head by propulsion of spores out from its fruiting bodies. Spores of *O. unilateralis* are actively discharged and dispersed over short distances, creating an infectious "killing field" of ~1 m^2 below the dead host

There are three distinct phases of life of the fungus. The first is ascospore formation and germination, where ascospores are deposited on the hopeless ants and a projection called a germ tube goes into the insect. Since it is an entomopathogenic fungus, its metabolism involves cellular processes based on the decomposition of the ant's body.

The exoskeleton remains intact, however the innards of the ant are eventually consumed by the infection of the fungus yeast-like cell phase. *O. unilateralis* have a pan-tropical distribution. They utilize the local carpenter ant species as their hosts, all of which fall within the tribe Camponotini (which include the genera Camponotus, Polyrachis, and Echinopla)

Once the infected ants have died, they collect in giant masses which have been termed "graveyards". These masses of dead ants form patches throughout the forest floor and appear to change in density and location throughout the seasons. When the spores arrive on their target, host-recognition features cause it to form a "drill," utilizing mechanical pressures and enzymes to breach the exoskeleton. Once the exoskeleton is breached the fungus goes into a free-living yeast stage in the ant's hemocoel. It is supposed that once the fungus colonizes the hemocoel, it releases nerve toxins that alter the ant behavior. These nerve toxins also cause the ant to convulse and fall off of the foraging trail into the forest floor below where it can establish itself at the optimum location for growth.

It causes the mandibles of the ant to close upon the leaf vein and begins to atrophy the striated muscle by destroying the sarcomere connections in the muscle fibers, as well as reducing the density of mitochondria and sarcoplasmic reticula. The reduction in mitochondria lowers the amount of energy available to the mandible muscles and eliminates the ability for the muscle fibers to relax and contract, resulting in the permanent closure of the mandibles on the leaf vein (known as the death grip). This action is essential in ensuring that *O. unilateralis* remains at the proper height above the forest floor for the next steps of fungal development and spore release. Within 24 hours of death, hyphae are seen growing from a number of areas on the ant. Hyphae that protrude from the tarsae of the ants function to secure the ant to the leaf.

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73. PLANT PATHOLOGY 17677

A Short History of The CaMV 35S Promoter

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In every organism, almost every gene has its own promoter sequence, which is typified as a DNA stretch that controls how a gene is expressed in a cell. Hence, the activity of a promoter controls in which cell type, during which developmental stage or during what environmental condition a certain gene is expressed. However, the most widely used promoter in plant biotechnology is actually not derived from a plant, but a pathogenic virus. How and why did that happen? Here's a short history of the Cauliflower Mosaic Virus (CaMV) 35S promoter.

The Mosaic Disease (1921 – 1937)

The effects of the CaMV were first noted in 1921 in Chinese cabbage, where it caused mosaic-like necrotic lesions on leaf surfaces. In a 1937 study, using infected cauliflower plants collected in California, Tompkins found that he could transmit the disease from the infected cauliflower plants to 51 different crucifer vegetable varieties.

The Cauliflower Mosaic Virus (1937 – 1978)

One of the first important findings in the following years was that CaMV is a non-circulative (and non-persistent) virus. Through another important finding in the 1960s, the CaMV was identified as the first plant virus containing double-stranded (ds) DNA. This is of particular importance, because this feature is a pre-requisite for the viral DNA to be transcribed in plant cells. Furthermore, this was the first indication that CaMV is a pararetrovirus.

The Cauliflower Mosaic Virus meets Plant Biotechnology (1978 – 1985)

In 1980, the whole genome (8024 ds, circular base pairs (bp)) of the virus was annotated and found to contain six putative open reading frames. At this point, scientists started to focus on deciphering the molecular details of plant infection by the virus. In the early 1980s it was discovered that the six coding regions are transcribed as only two mRNAs, the short, monocistronic 19S RNA, and the whole-genome covering 35S mRNA. While the 19S RNA encodes a single protein, which was later found to be involved in gene silencing suppression in the host cell, the long 35S RNA serves as a template for whole genome replication.

Accordingly, when it became clear that CaMV inserted its DNA into plant cells, and that this DNA was then expressed at high levels, plant biologists immediately recognized the potential use of CaMV as a cloning vector for plant transformation, and for expressing their genes of interest in the plant. This resulted in two paths of research: First, researchers tried to insert a foreign gene into the genome of CaMV to determine whether this will get inserted and expressed in the host cell as well. Secondly, they attempted to identify the exact DNA sequences responsible for the strong expression of the CaMV genes in plant cells. Regarding the first path, researchers quickly progressed, and in the mid-eighties had successfully cloned bacterial and mammalian genes into the CaMV genome, and demonstrated that these genes were then transferred and expressed in plant cells. However, the second research path, the identification of the exact sequences that control gene expression in CaMV-infected cells, turned out to be a much bigger success.

The CaMV 35S Promoter (1985-2000)

In order to define the exact sequences controlling viral gene expression in plants, researchers first created several deletion variants of the roughly 1000 bp promoter region of the 35S gene and fused these variants upstream of the human growth hormone gene. Notably, they used *Agrobacterium tumefaciens* to transform plant cells with their 35S high variants, not the CaMV itself. They found that DNA sequences 46 bp upstream of the 35S gene resulted in minimal expression, while a 343 bp fragment led to strong gene expression across all plant tissues tested. The full 343 bp segment was therefore designated the 'CaMV 35S promoter', while the 46 bp segment was considered as the so-called 'minimal promoter'. Based on these groundbreaking findings, numerous versions of the promoter emerged over the course of the following years; for example, simply placing two CaMV 35S promoters in a tandem led to enhanced strength of the expression system.

In 1986, it was used to promote expression of the 5-enolpyruvylshikimate-3-phosphate synthase (EPSP) gene in transgenic petunia. The EPSP is an essential enzyme in the aromatic amino acid biosynthetic pathway and this enzyme is also the specific target for the herbicide glyphosate. Accordingly, plants that over express the EPSP gene from the 35S promoter acquire an increased tolerance towards glyphosate treatment. This successful engineering of the first transgenic herbicide-tolerant plants combined two major scientific breakthroughs of the early 1980s-the establishment of Agrobacterium-mediated plant transformation and the identification of the CaMV 35S promoter, and together these three milestones, all published within three years, meant a giant leap forward for both the plant science community and the developing field of plant biotechnology

The CaMV 35S Promoter as Target for Anti-GE Activists (1990's)

The creation of genetically engineered crop plants not only gave a boost to plant science, it also activated the anti-GE (Genetic Engineering) movement. And in the 1990s, the 35S promoter became one of their main targets. Interestingly though, there was no biosafety-incident or something comparable, that spawned a reasonable fear of the 35S promoter – it was a combination of insufficient outreach and bad public relations work from the scientific community, and the mere origin of the 35S promoter from a pathogenic virus. There were, 130 however, two incidents that clearly contributed to tarnishing the reputation of the 35S promoter in the public eye: the Petunia field trial in Germany, in 1990, and the Pusztai affair in Great Britain, in 1998.

The CaMV 35S Promoter Today (2000-Today)

To this day the CaMV 35S promoter remains the most commonly used promoter in plant science. Nonetheless, use of the CaMV 35S promoter is slowly decreasing due to several reasons. The number one reason being that today, in contrast to the 1980s, many alternatives to the CaMV 35S promoter are available to researchers. In academia, the Arabidopsis UBIQUITIN10 promoter was identified in the mid-1990s as a strong promoter, active in all tissues of the plant body indeed, the two major selling points of the CaMV 35S promoter and was ready to replace it as a plant derived promoter to use in plants. It was also found that in monocots, such as rice and corn, the CaMV 35S is not as active as it is in dicots, leading researchers to switch to, *e.g.*, the later discovered rice actin 1 or maize Ubi-1 promoters.

In agriculture, over 80% of GE-crops in the field still carry a version of the CaMV 35S promoter; among those the most widely farmed varieties such as the Roundup Ready soybean, Bt corn and cotton, and the 'Sunset' papaya resistant to the papaya ringspot virus. These crops have been found to be safe by all the major scientific institutions, and have been consumed by humans and livestock for decades now, without any negative health effects.

Nonetheless, since its description in 1985 the CaMV 35S promoter has been the standard promoter used in all plant science and plant biotechnology, and has certainly propelled the research field forward like hardly any other discovery.

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74. PLANT PATHOLOGY 17678

Phytophthora infestans a Re-emerging Pathogen

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Introduction: *Phytophthora infestans* has been a named pathogen for well over 150 years and yet it continues to "emerge", is one of the most confounding pathogen and model organism that exhibits high evolutionary potential and rapidly adapts to changing environment. This fungus like organism is responsible for global annual crop loss of US$ 12 billion. Despite potato resistance breeding, fungicide use, and other control measures, it still continues to be a major threat to sustainable potato production worldwide. *P. infestans* population has undergone drastic change during the last two decade. New population has emerged which is more diverse having more pathotypes, carrying the new mating type (A2), haplotype etc (Fry *et al.*, 2015).

Emergence: Goodwin suggested that the Irish famine might have been caused by the US1 clonal lineage of *P. infestans*. Analyses of collected herbarium specimens by using shotgun sequencing indicated that US1 genotype was not present in 1845 to 1896 but instead, populations were dominated by a single genotype named HERB-1. The HERB-1 apparently dominated for 50years but was subsequently replaced by the closely related US1 clone. (Fry *et al.*, 2015).

Migration: Dispersal of *Phytophthora* species can occur due to many different mechanisms. Movement in infected plant parts is probably the most likely avenue for long-distance dispersal, particularly in woody or fleshy parts that do not dry out easily. For example, *P. infestans*, *P. erythroseptica, and P. parasitica* could be dispersed in potato tubers, *P. colocasiae* in taro corms, and *P. cinnamomi* in roots or adhering soil. Oospores are highly resistant to environmental extremes and could be dispersed in soil or dried plant parts. Homothallic species such as *P. phaseoli and P. sojae* may be particularly well adapted for dispersal in host materials; any host tissue could be a suitable substrate for oospore production. Sporangia may be dispersed in water or aerially over long distances under favorable conditions, *e.g.*, during thunderstorms when they would be relatively protected from desiccation and ultraviolet radiation. Zoospores have a much more limited range and probably are adapted for locating suitable host tissue over short distances, not as a means of dispersal.

Re-emergence: In India it was introduced into the Nilgiri hills between 1870 and1880. Soon spread to Darjeeling in Himalayas after introduction of English potato. Severe outbreak of late blight was recorded in India since 2008. A total of 276 isolates of *Phytophthora infestans* 146 isolates from potato and 130 from potato, were collected from major potato and tomato growing regions of India between 2009 and 2014. All the isolates were highly aggressive, A2 mating type and resistant to metalaxyl, that has replaced the US-1 population of *P. infestans* in India. This A2 mating type is almost identical to the 13_A2 clonal lineage reported in Europe. The 13_A2 lineage was responsible for severe late blight outbreaks on potato and tomato in South India. Revised management strategies will be required to combat this destructive 13_A2 clonal lineage and monitoring of the population across other potato- and tomato-growing regions of India. (Chowdappa *et al.*, 2013). The US-1(Ib) lineage increases in frequency in the middle 20th century in the US and globally and then declined. The mefenoxam (metalaxyl) sensitive US-22 is more common on tomato in 2009, has been displaced by US-23 in 2011, which infects both hosts of potato and tomato. The first evidence for probable recombinant genotypes in the field was in British Columbia during 1992 (Goodwin *et al.* 1995a). Other evidence for possible recombinant genotypes has been found in the Columbia Basin of Washington and Oregon *and in* New York (Goodwin *et al.* 1998).

Physiological Specilazation and Origin of New Races

Physiological specilazation and occurrence of new races from *S. demissum & S. tuberosum* And 4 major genes (R1, R2, R3, R4 from *S. demissum*) for resistant, Minor gene resistence was found in *S. tuberosum*. Acc. To international system for classifying races and genes for resistance. Four Rgenes produce 16 combinations of race, 15 are identifies (1953). In India 6 genes produce 64 new races of *P. infestans*. Up to 1958 race 0 and 1 – north western hills, in 1965 Race 0 and 4 in eastern hills, but in 1966 complex races in eatsern hills and shimla. Frequency of race 1 was low on commercial cultivars, but high on seedlings raised under LBRP (1965). In 1969, race 0 was still most common (58%), but frequency of race race 1 (42%) increased over years. Race 3,4 appeared 1st time at Fagu (1973). Nine high spectrum race with 4, 5, 6, and 7 genes were identified in Khasi hills and 13 new race from shimla (1975). Up to 1980s 31 races were recorded in Northern plains and 8 – 9 complex races in hills. In 1986 Absence of race 0 and predominanece of race 3, 4, 7, 8, 10, 11 indicate the shift of virulence of *P. infestans* was complete and in 1991, 7 races identified in Lakhimpur (Assam) in 1993, 11 races on potato and 3 races on tomato in plains of punjab and 6 gene, 7 gene, 8 gene complexes were the most dominated in shimla hills In 1998.

Disease Forecasting and Decision Support System

Various concepts have been developed and utilized over the years for predicting late blight across the globe. They include 'Dutch rules', Beaumont's periods, Irish rules, moving days concept, severity value accumulation, negative prognosis, mathematical models etc. Van Everdingen (1926) was the pioneer in using weather conditions for forecasting potato late blight under Holland conditions. He used dew periods, night temperature, cloudiness and rainfall, known as the "*Dutch rules*", to predict initial appearance of late blight in Holland. Van Everdingen (1926) was the pioneer in using weather conditions for forecasting PLB in Holland. Beaumont modified these rules for UK conditions and these were known as 'Beaumont rules' (Beaumont, 1947). Hyre (1954) proposed 'moving days concept' which takes care of the break in disease congenial conditions over time and the 'severity value' concept based on temperature and relative humidity. Negative prognosis' was developed in Germany and Europe. Cook's moving graph concept (Cook, 1949). BLITECAST is a computer program that combines two late blight forecasting techniques developed by Hyre and Wallin for forecast LB in USA and Europe. ProPhy in Netherlands and recommends first fungicide spray-the crop reaches a height of 15 cm in susceptible varieties and ten days later in moderately resistant varieties. NegFry model was developed in Denmark is based on the negative prognosis (Ullrich and Schrodte 1966) and PROGEB, PhytoPRE, Web-blight: In 1996, Plant-Plus: 1997, PhytoPRE:2000, China-blight, Guntz-Divoux:1997, Bio-PhytoPRE:2005 etc. 1950's when Chaudhury and Pal (1959) utilized the rainfall data and dates of appearance of late blight in Darjeeling hills for 12 years s using Cook's moving graph concept (Cook, 1949) and Hyre's concept (Hyre, 1954) Modified Model for Late Blight Forecasting around Pantnagar: Singh *et al.* (2010) modified JHULSACAST and developed a modified model for late blight forecasting at Pantnagar is as follows: i. 7-days moving > 85% cumulative relative humidity period 85 hours. ii. 7-days moving > 85% cumulative temperature (7.2-26.6^{0}C) period 115 hours. Recently the Institute has developed INDO-BLIGHTCAST- a web based Pan-India model for forecasting potato late blight as an improvement over JHULSACAST. It predicts late blight appearance using daily mean temperature and RH data available with meteorological stations across the country without any calibration. The model is being operationalized throughout the country in collaboration with IMD (Vaibhav *et al.*2013).

Conclusion: We need to be alert to the many factors that influence epidemics and employ all appropriate management tactics. We think that enhanced and more rapid diagnostic and genotyping technologies will contribute to better-informed management strategies, and also to learn more about how *P. infestans* interferes with plant defenses, which could enable the discovery of new approaches to managing this pathogen.

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75. BIOCONTROL 17428

Photorhabdus luminescens: A Potential Biopesticide

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BACKGROUND: Applications of synthetic insecticides are becoming a major threat to environmental sustainability. They are non-biodegradable persist in the environment which leads to bio-accumulation as well as biomagnification. Insecticides also cause pollution of soil and groundwater and have harmful effects on a wide range of non-target organisms which includes beneficial insects, birds, etc. Over a period of time there is a possibility for new resistant strains of insects to emerge which may require increased dosage of insecticidal application.

Due to the serious health hazards linked with the synthetic insecticides, biopesticide product such as BT product offers a good alternative for controlling the pest population. But, there are several studies conducted in the recent past to demonstrate the development of resistance of crop pests towards BT toxin. Since, most of the insects showing resistance to BT toxins even after adapting the resistance management, toxins of *Photorhabdus luminescens* can be used as an alternative to BT toxins as biopesticide.

About *Photorhabdus luminescens*

Photorhabdus luminescens is a gram-negative bacteria. It is entomopathogenic enterobacterium that exists in a state of mutualistic symbiosis *Heterorhabditidae* nematodes. The natural habitat of *Photorhabdus luminescens* is in the intestinal lumen of the entomo-pathogenic nematodes of *Heterorhabditis bacteriophora* and *Heterorhabditis indica*.

Photorhabdus exhibits a complex life cycle, which includes symbiotic stage characterized by colonization of the upper nematode gut, and a pathogenic stage, characterized by release from the nematode into the hemocoel of insect larvae, resulting in rapid insect death caused by bacterial toxins. Upon entering an insect host, the nematodes release the bacteria by regurgitation directly into the insect's hemocoel. Once inside the hemocoel, the bacteria replicate rapidly causing lethal sepsis in the host by producing different high molecular weight toxins that kill the insect within 48–72 hours (Han *et al.*, 2001: 239-247). Bioconversion of the insect cadaver by exoenzymes produced by the bacteria allows the bacteria to multiply and the nematode to reproduce. During this process *P. luminescens* produces antibiotics to prevent invasion of the insect cadaver by other bacterial or fungal competitors. Finally, elimination of competitors allows *P. luminescens* and the nematode to re-associate specifically before leaving the insect cadaver

Photorhabdus species exist in two forms, primary and secondary variants, which differ in morphological and physiological traits. While the primary variants occur in infective stage nematodes, secondary variants occur after sustained growth. Primary variants produce extracellular protease, extracellular lipase, intracellular protein crystals CipA and CipB, antibiotics, and exhibit bioluminescence.

Toxicity of Photorhabdus luminescens

Toxins produced by *Photorhabdus luminescens* are classified into four major groups and these are: (i) Toxin complexes (Tcs); (ii) Photorhabdus insect related (Pir) proteins; (iii) Makes caterpillars floppy (Mcf) toxins and (iv) Photorhabdus Virulence Cassettes (PVC)

Toxin complex a (Tca), a high molecular weight insecticidal protein complex produced by the entomopathogenic bacterium *Photorhabdus luminescens*, has been found to be orally toxic to a wide range of insect larvae. Purified Tca was shown to disrupt the insect midgut epithelium in a manner similar to the dendotoxins from 'Bt', effect of Tca on the midgut are similar to other gut-active toxins such as the -endotoxins.

Tc toxins (1) are a new class of insecticidal toxins that have been shown to demonstrate both oral and injectable activity with results against the Colorado potato beetle, *Leptinotarsa decemlineata* and *Bemisia tabaci* [2], while other toxins like *Mcf* promote apoptosis in a variety of cells including mammalian ones.

Conclusion: *P. luminescens* is a nematode-symbiotic bacterium with a complex life cycle. As such, it needs to coordinate symbiosis and pathogenicity, thus the production of factors that can assist in both is necessary. Various toxins have been found in the genome of the bacterium, with both oral and injectible activities. This states the potential use of the *P. luminescens* toxins as a replacement of the *Bt* toxins (*Bacillus thuringiensis* toxins) in the agriculture of transgenic crops infected by insects resistant to *Bt* toxins [3].

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76. BIOCONTROL 17468

Bioinsecticide and Biopesticide

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Biopesticides

Biopesticides are biochemical pesticides that are naturally occurring substances that control pests by non toxic mechanism. Biopesticides are considered eco-friendly and easy to use. Commonly the biopesticides are bacterial, but there are also examples of control agents based on fungi, viruses and nematodes.

The Basic Requirements of Successful Bio-Control

- A highly effective bio-control strain or other material must be obtained or produced. Such strain should be able to compete and persist in the environment in which it must operate and ideally able to colonize and proliferate on existing and newly formed parts at times well after application.
- Inexpensive production and formulation of bio-control agent or other material in question must be developed. The production process must result in biomass with excellent shelf life even under adverse storage conditions.
- Delivery and application methods that permit the full expression of bio-control agent, delivery system must ensure that bio-control agents will grow well and achieve their purpose.

Botanical Pesticides

Botanical Pesticides are based on naturally occurring substances from plants that control pests by non toxic mechanism. These bio-pesticides are based on neem, karanj, garlic etc. They are not very persistant in soil and crops because the breakdown quickly under influence of high temperature or sunshine. Hence, the application of these biopesticides is safe in view of human health and environmental pollution.

Botanical Insecticides

Botanical insecticides are naturally occurring chemicals extracted from plants. Natural pesticidal products are available as an alternate to synthetic chemical formulation but they are not necessarily less toxic to humans. Some of the most deadly, fast acting toxins and potent carcinogens occur naturally. Botanical insecticides break down readily in soil and are not stored in plant or animal tissue. Often their effects are not as long lasting as those of synthetic pesticides and some of these products may be very difficult to find.

List of Some Botanical Insecticides

1. Nicotine, 2. Pyrethrin, 3. Rotenone, 4. Neem, 5. Sabadilla, 6. Citrus Oil, 7. Chinaberry, 8. Ryania, 9. Quassia, 10. Pongram, 11. Custard Apple, 12. Acorus, 13. Volatile Oil, 14. Manzanilla, 15. Kakawate, 16. Tubli, 17. Atis, 18. *Lobelia excelsa* and 19. *Thevetia neriifolia*

1. Nicotine Sulfate

Nicotine is extracted from tobacco or related *Nicotiana* species and is one of the oldest botanical insecticides in use today. It's also one of the most toxic to warm blooded animals and it's readily absorbed through the skin. It break down quickly, however, so it is leagally acceptable to use on organically grown crops.

Formulation

- **As spray:** 1 part of nicotine sulphate is dissolved in 500 to 1000 parts of water.
- **As fumigants:** Dried tobacco is burnt and the smoke directed amongst the infested plants.

Use Against: Aphids, Thrips, Caterpillar, Scale insect ect.

2. Pyrethrum/Pyrethrins

Pyrethrum is the most widely used botanical insecticides in the United State. The active ingredient, pyrethrin is extracted from a chrysanthemum plant, grow primarily in Kenya, Rwanda, Tanzania, and

Ecuador. Most insects are highly susceptible to pyrethrin at very low concentrations. The compound acts rapidly on insects, causing immediate knock down. Insect mortality is increased by mixing pyrethrins with a synergist, such as piperonyl butoxide (PBO) to create pyrethrum.

Formulation

- **As dust:** By grinding dry flowers and mixing the powder with a non- alkaline carrier.
- **As spray:** By extracting materials in solvents and as aerosols. A synergist is usually added to increase its toxicity.

Use Against: Pickle worms, harlequin bugs, aphids, cabbage worms, leaf hopper, stored grain pest, spiders, mites, etc.

3. Rotenone

Rotenone is a resinous compound produced by roots of two members of the leguminoceae family. It is a white crystalline substance insoluble in water. It is very toxic to fish, pigs and cold blooded. It is both contact and stomach poison. Easily decomposed by light and alkali.

Formulation: It is formulated as dust WDP, EC & aerosols.

Dust is prepared by grinding dried roots and mixing the powder with 3-7 parts of a carrier like talc, clay or gypsum.

Dust are effective in case of ectoparasite.

Use Against: Aphids, chinch bugs, cattle grubs, spider, spittle bugs, carpenter ants, potato beetle ectoparasite, harlequin bugs etc.

Botanical Fungicides

Botanical fungicides are naturally occurring chemicals extracted from plants.

List of some Botanical Fungicides

1. Safe-agro, 2. Mtrine, 3. Vegard, 4. Pipernonaline, 5. Curcumin, 6. *Acores* sp., 7. Groundnut, 8. Neem, 9. Kranj, 10. Dhatura, 11. Castor, 12. *Ocimum* sp., 13. Kakawate, 14. Papaya, 15. Ginger, 16. Mahua, 17. *Mirabilis jalapa* and 18. Organic Alkaloid

1. Safe-agro

- It is a natural botanical fungicide.
- It provides a good control on plant disease of various crops.
- It is a contact fungicide.
- It is derived from cotton seed oil and garlic extracts.

Use Against: Powdery Mildew and Rice yellow dwarf

2. Mtrine

- It is a botanical fungicide.
- It is the product of high efficiency and broad spectrum germicide in China.
- Its main gradient is extracted from botanical plant, light yellow sophora.

Use Against: Downy Mildew of Vegetables & Powdery Mildew of Vegetables.

3. Piperonaline

- It is a botanical fungicide.
- It is obtained from piper longum.
- Pipernonaline was isolated from hexane fraction using chromatographic techniques.

Dosage: 500mg/ml

Use Against: Phytopthora infestans, Rhizoctonia solani, Puccinia recondite.

77. BIOCONTROL 17499

Commercial Biocontrol Agents and their Mechanism of Action in the Management of Plant Pathogens

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INTRODUCTION: Biological control is the total and partial destruction of pathogen populations by other organisms and plays an integral role in the present day organic farming and integrated disease management scenario for increased quality as well as quantity of the yield. Biological control assumes special significance as it is environment friendly and cost-effective. These not only control the disease but also have other mechanisms *viz.*, plant growth promotion, hyper parasitism, and antibiosis and induced systemic resistance. Baker and Cook (1974) defined biological control "as the reduction of inoculums density or disease producing activities of a pathogen or parasite in its active or dormant state, by one or more organisms, accomplished naturally or through manipulation of the environmental, host or antagonist, or by mass introduction of one or more antagonists".

Biocontrol Agents Mechanism of Action in the Management of Plant Pathogens

Plant diseases are the result of interactions among the components of disease triangle *i.e.* host, pathogen and environment. Biological control agents are the organisms that interact with the components of disease triangle to manage the disease. Understanding how the bio control agents work can facilitate optimization of control as well as help to screen for more efficient strains of the agent. Understanding the mechanisms of biological control of plant diseases through the interactions between biocontrol agent and pathogen may allow us to manipulate the soil environment to create conditions conducive for successful biocontrol or to improve biocontrol strategies (Chet, I. 1987.). Mechanism of some bio-control agents are now understood in detail (Zhang *et al.*, 2002). Understanding the mechanism of action of a bio control agent may improve the consistency of control either by improving the mechanism or by using the bio- control agents under conditions where it is predicted to be more successful. Various mechanisms employed by the bio control agents in controlling the plant diseases are broadly classified into: a) Direct antagonisms b) Indirect antagonism

Basic Information of Bio-Agents: *Trichoderma* species, *Pseudomonas florescence*, *Bacillus subtilis*

Trichoderma species

Trichoderma species is the potential antagonistic fungus which prevents the crops from diseases *viz*. Root rots, wilts, brown rot, damping off, charcoal rot and other soil borne diseases in crops. ***Trichoderma species*** is able to suppress more than 60 species of pathogens (Pythium, Botritis, Phoma, Sclerotinia, Fusarium, Ascochyta, Alternaria and others) on different plants like Vegetables, cereals, pulses, oilseeds, Flower crops, spices and various ornamentals etc.,

Trichoderma species secrets cellulose and chitinase enzymes which react with cell wall of the disease causative pathogenic fungi or bacteria and dissolve the same. Trichoderma utilize the protoplasm as a source of food and multiply its spores. By this method the spores of the pathogenic fungi are destroyed. In the process of development Trichoderma synthesizes a variety of antibiotics (gliotoxin, viridine, trichodermin and others). They destroy the cell walls of phytopathogenic fungi and produce biologically active substances, which stimulate plant growth and development. *Trichoderma species* also induce plants to "turn on" their native defense mechanisms offers the likelihood that these strains will control pathogens other than fungi**.** *Trichoderma species* possess innate resistance to most agricultural chemicals, including fungicides.

Mode of Action

- The active components of biopesticides made on the base of this fungus-antagonist are their spores, mycelium and products of metabolism
- The fungus secrets cellulase and chitinase enzymes which react with cell wall of the disease causative pathogenic fungi or bacteria and dissolve the same
- Trichoderma utilize the protoplasm as a source of food and multiply its spores. By this method the spores of the pathogenic fungi are destroyed
- In the process of development Trichoderma synthesizes a variety of antibiotics (gliotoxin, viridine, trichodermin and others). They destroy the cell walls of phytopathogenic fungi and produce biologically active substances, which stimulate plant growth and development

Pseudomonas florescence

Pseudomonas florescence bacteria have a strong oxiding power that helps them break down environmental pollutants and provide useful enzymes and oxygen for plant growth. This bacterium enters the plant system and act as a systemic bio control agent against diseases.

Mode of Action

- By secreting an enzyme, it has the capability to destroy the cell wall of the fungal pathogens and annihilate them
- It secrets hydrogen cyanide and antibiotics such as pycocyanin and phenazine, which inhibit the growth of disease causing pathogens
- It also produces siderospores which chelate with iron in the soil, and make it difficult for the pathogens to proliferate
- Further, it secretes several plant growth substances, and these gibberellins like compounds contribute to vigorous crop growth

Bacillus subtilis

Bacillus subtilis is a non-pathogenic gram+ve bacteria. *B. subtilis* bacteria produce antibiotics, including some called iturins, which help the bacteria compete with other microorganisms either by killing them or reducing their growth rate. When applied directly to seeds, *B. subtilis* bacteria colonize the developing root system, competing with various disease organisms that attack root systems. According to the manufacturers, *B. subtilis* also inhibits plant pathogen spore germination and interferes with the attachment of the pathogen to the plant. When soil or seed-applied, it is claimed that *B. subtilis* feeds off plant root exudates, depriving disease pathogens of a food source.

Mode of Action

- Antibiosis
- *B. subtilis* is reported to induce systemic acquired resistance (SAR) against bacterial pathogens.

Conclusion: Biocontrol agents involve a bewildering array of mechanisms in achieving disease control. However the conclusive evidences for the involvement of a particular factor in biological control is determined by the strict correlation between the appearance of factor and the biological control.

78. ENGINEERING AND TECHNOLOGY 17528

Electro Hydrodynamic (EHD) Drying: A Novel Technique

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INTRODUCTION: Drying is one of the most important and most common unit operations used in food industries to dehydrate food products for preservation and to increase their shelf life. Conventional drying techniques involve the application of heat using conductive, convective, and radiative sources alone or in combination to enhance mass transfer in food products. The use of higher drying temperature produces drastic changes in the physical, chemical, biological and sensory properties of food. Recent changes in consumer demand for products with superior organoleptic and nutritional properties and fresh-like feel has forced food processors to look for alternate drying techniques with lesser cost of production and energy efficiency during the process of drying.

Among the advanced technologies, Electrohydrodynamic (EHD) processing is considered as an energy efficient non-thermal technology, suitable for the treatment of heat-sensitive foods and food ingredients, such as high-value bioactive components of fruits and medicinal plants (oligomeric procyanidins, polyphenols, flavonoids, dietary fiber, etc.), living cells (bacteria, yeasts and viruses), organic substances of biological origin (blood plasma, serum, hormones, antibiotics, prebiotics, nutraceuticals, etc.). EHD phenomenon is based on the high-voltage ionic discharge between electrodes with substantially different radii of curvature, such as sharp pin-plate or thin wire-plate. Corona discharge results when the electric field is strong enough to create a chain reaction: electrons in the air collide with atoms hard enough to ionize them, creating more electrons which ionize more atoms.

Electrohydrodynamic Drying

The typical EHD drying system consists of high voltage converter/regulator system, drying chamber, discharge and collecting electrodes, air heating system with blower (optional), real-time weighing balance and exhaust system. In EHD-drying, electric fields of high intensity and standard industrial/domestic frequency (50 or 60 Hz) are applied so as to generate ionized forms of air-constituents within the foodstuff. The movement of the air ions in a strong electric field generates an ionic wind. Loss of water vapor takes place as the water molecules orient themselves in the direction of an electric field (Fig. 1). During this process, a lowering of entropy occurs, which in turn lowers the temperature of the material being dried. The thermodynamic factors involved in the drop in temperature which occurs under EHD include the rapid rate of evaporation and the exothermic interaction of electric fields with dielectric materials.

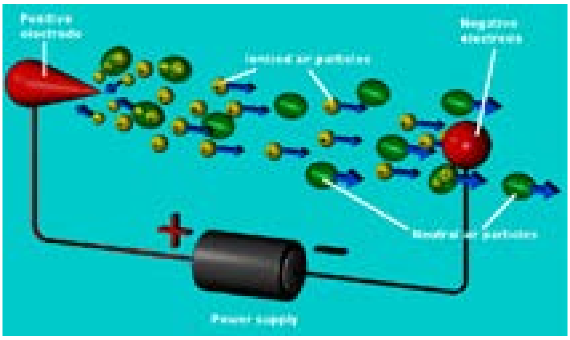

FIG. 1. Principle of EHD Drying

The EHD has wide range of applications in different sectors such as removal of unwanted electric charges from the surface of aircraft in flight and thus avoiding the detrimental effect of uncontrolled electrical discharge pulses on the performance of avionic systems, manufacturing of ozone, sanitization of pool water, electrostatic precipitator, removal of solid pollutants from a waste gas stream, scrubbing of particles from air in air-conditioning systems, photocopying, air ionisers, production of photons for Kirlian photography (to capture phenomenon of corona discharge), nitrogen laser, ionization of a gaseous sample for subsequent analysis in a mass spectrometer or an ion mobility spectrometer, static charge neutralization. Later the application of EHD principle has diverted towards food applications such as drying, refrigeration, freezing, thawing etc.

Though the EHD technique has appreciable remarks in different food applications, but it is still in laboratory scale because of the lacunae in thorough and organized study. Some of the EHD studies related food drying are as follows.

The high voltage electrostatic field (HVEF) treatment was given to dry the tomato slices with different physical parameters. The results of the study indicated that, drying rate of tomato slices was enhanced by the corona discharge electrostatic field (HVEF) with better appearance (lightness and red color) of tomato slices and low energy consumption than air-dried samples.

The novel EHD drying technique was used to dry the grape pomace with different physical parameters such as electrode configuration and discharge voltage. The results of drying process shown that, drying rate was found to be highly significant for electrode configuration and discharge voltage. Similarly significant difference was observed for overall energy consumption as a function of voltage and electrode configuration.

The EHD drying study was conducted to dry the potato slices with different applied voltage and needle gap. The results of the study depicts that, EHD method was significantly accelerated the drying rate of potato chips as a function of voltage and the needle gap. The nutritional loss, color change energy consumption were lesser in EHD dried slices compared to convective drying.

Conclusion: By considering the above facts it was concluded that, EHD drying is still under development stage and has huge potential as an alternative to conventional drying processes with low energy and operational cost. A successful assessment of these attributes demands considerable research in this area because it has immense potential to be used in multidisciplinary fields.

79. ENTOMOLOGY 17404

Integrated Pest Management in Apple Woolly Aphid *Eriosoma lanigerum* (Hausmann) (Homoptera: Pemphigidae): A Review

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INTRODUCTION: Apple (*Malus sylvestris*) family Rosaceae is one of the most widely cultivated tree fruits throughout the world. The apple woolly aphid, is one of the several species of aphids that can infest apple trees in Northern areas. *Eriosoma lanigerum* is native to North America but distributed throughout the temperate regions of the world (**Khan *et al.*, 2015**). Galls formed by feeding on roots can reduce uptake of water and nutrients, tree vigour, and fruit yield and can lead to tree death. The pest is managed by different methods of IPM programme. The natural enemies against this pest are *Aphelinus mali* (Haldeman) (Hymenoptera: Aphelinidae), *Syrphus* sp., *Menochilus sexmaculatus* and *Chrysoperla carnea*. All these are used successfully against *E. lanigerum* in many regions around the world. *E. lanigerum* is chemically controlled by using organophosphates and carbamates active against root colonies. Imidacloprid when applied as a root soil drench provide excellent control of *E. lanigerum* on trees up to 7-years-old (**Alston and Lindstorm 2007**).

Review of Literature

Hetebrügge *et al.*, (2006) tested the release of *A. mali* from artificial rearing for the control of Woolly Apple Aphid (*E. lanigerum*) in field trials. The release of adults proved to be more suitable than the release of cards with parasitized mummies as practised in the first trial. The practical applications of *A. mali* in early spring (after blossom) were not effective because climatic conditions were not suitable enough. The fertility of *A. mali* depends on temperature and light intensity. Application of Micula (rape oil) and T-S forte reduced the aphid population effectively. These substances may be used in a combined strategy to improve the successful subsequent release of *A. mali*. Insecticidal activity of *Rhamnus dispermus* on *E. lanigerum* showed that *Rhamnus spp.* may contain compounds which act as botanicals. All the tested hexane, chloroform, acetone and ethanol extracts of *R. dispermus* showed significant insecticidal activity against this pest. The insecticidal activity of *R. dispermus* extracts increased by increasing the concentration and the exposure time. Extracts of *R. dispermus* could be used as botanical insecticides in the integrated pest management programs (Ateyyat and Darwish 2008**). Berg and Shot (2008)** studied the syrphid fly, *Heringia calcarata* (Loew), a predator of woolly apple aphid in Virginia under field and lab conditions. Phenology and abundance of predator was observed in the field using water pan traps, sticky traps, sentinel trees etc. Sentinel trees with woolly apple aphid colonies were found most effective for phenological studies. From the emergence traps it was revealed that *H. calcarata* adults emerge from the soil beneath apple trees. The efficacy of several products (different mineral oils, lime sulphur, and lime sulphur + mineral oil) was tested in comparison to an untreated control and possible side effects on the population of predatory mites were investigated. The study furthermore aimed at establishing the best timing of the application against the target pest (**Kledere *et al.*, 2008).** Combinations of earwigs and oil applications in order to develop an on-farm control strategy and results showed good efficacies for applying oil preparations by brush against woolly aphid infestation. The efficacy of releasing earwigs depended on the infestation intensity (**Toups *et al.*, 2008**). The important natural enemies of *E. lanigerum* such as hymenoptera parasitoids (namely *A. mali*), syrphids, lady beetles, earwigs and other species are sensitive to many pesticides including those allowed in organic orchards (spinosad, pyrethrum, sulphur). It means that organic system itself does not provide a general solution either and the pesticide choice is important here too. On the other hand, it has been shown that natural enemies themselves are not able to ensure a satisfactory crop protection in the case of emergency. Biological control must be combined with other measures in such situations (**Toups *et al.,* 2010**) including direct and effective insecticide treatments. *A. mali* reared and released into apple orchards in Jordan provided a valuable suppression of WAA during the year of its release but its effectiveness was reduced in the next year due to the routine spraying of non-selective insecticides in neighbouring orchards that led to the movement of aphids to orchards where no insecticides were sprayed (**Ateyyat *et al.,* 2011**). The aphids are also attacked by a diverse community of generalist predators that includes several species of spiders, predatory bugs, syrphid flies, and earwigs (**Gontijo *et al.,* 2012**). This generalist predator guild likely attacks both parasitized and unparasitized aphids and perhaps also *A. mali* adults. *E. lanigerum* due to fluffy white waxy material on the body provide protection during vegetative growth of the crop, so-called wool, secreted by the aphids. Insecticides acting by contact are therefore not effective. Also insecticides with semisystemic activity, such as azadirachtin- or neem oil-based products, have been tested, but their effectiveness was usually insufficient. The reasons for this could be a naturally occurring dilution of the active substances in plant tissues caused by the growth of the plant, and/or differences in the concentration of active substances among the tested products, which are obtained by using different extraction and manufacturing processes (**Caldwell *et al.,* 2013**). The use of *A. mali* and Malathion significantly reduced the *E. lanigerum* population was evaluated in apple orchards at three locations of Skardu-Baltistan during 2009. The results showed that pest density was significantly lower in malathion treatment in apple orchards at Skurdu. Total mean density of the pest was significantly lower in malathion treatment and higher in control (**Khan *et al.,* 2015). Stokwe and Malan 2017** found that the development of resistance of woolly apple aphid against certain insecticides and the inability of parasitoids to manage it successfully early in the season, EPNs offer an alternative biocontrol option and the susceptibility of pest to seven indigenous EPN species was tested in laboratory bioassays in which *Steinernema yirgalemense* and *Heterorhabditis zealandica* were found to be most effective against the subterranean adult females with infection rates of 39% and 28 %, respectively. The effect of *E. lanigerum* size showed that the last instar is most susceptible to infection, whereas none of the crawlers were infected. On evaluating the ability of infective juveniles of these nematodes to tolerate exposure to imidacloprid, both nematode species were found to be compatible at the recommended dosage, with no significant nematode mortality having occurred.

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80. ENTOMOLOGY 17425

Ecofriendly Management of Locusts

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INTRODUCTION: Locusts belong to class orthoptera. There are about 19 species of locusts found in the world, however, there are four species of locust found in India *viz*.

1. Desert locust, *Schistocerca gregaria* (Forskal)
2. Migratory locust, *Locusta migratoria* L.
3. Bombay locust, *Patanga succinct* Joh.
4. Tree locust, *Anacridium rubrispinum* Bei-Benko

Desert locust is most widely distributed affecting sixty one countries and covering nearly 30 million sq. Km. area.

Locust is a polyphagous pest and is found in almost every continent except Antarctica. It is having three phases *viz*. Solitaria, Gregaria and Transiens phase. Low population density produces solitaria while crowded conditions produce gregaria.

According to **Subramanyam *et al.*, 2012**, the current uses of organic pesticides have created a situation of soil and water contamination, resistance development, toxic residues and high cost of application. So to overcome such hazardous situation various ecofriendly management practices of locusts have been developed by various researchers and are as udergiven.

Ryohei Sugahara *et al.*, 2018 identifies corazonin a neuropeptide that controls phase dependent body coloration in locusts. Corazonin was mixed with peanut oil and this mixture was injected into immobilized locusts through incision made between first and second abdominal segments. It was found later in the studies that Crz injection controls expression LOCT, YEL, and ALTO genes which in turn control the colour pattern in locusts.

Xiaoming Zhao *et al.*, 2018, analyzed the function of LmHR3 in the migratory locust. He found that LmHR3 has low expression in early 5th instar while its expression increases after 6th day. When dsRNA LmHR3 was injected into 2nd instar larvae it showed abnormal moulting and died. Both the synthesis of new cuticle and degradation of old cuticle was blocked by LmHR3.

Jin Kyo Jung *et al.*, 2017 identified the regulation mechanism of polyphenism in migratory locusts by miRNA. They identified 175 miRNA clusters from 12 small RNA sequence data and found that sex and phase specific miRNA in locust brain were involved various physiological functions by regulating expression of target mRNA. This important finding may be further used for management of locusts like male and female sterilization technique and preventing transition of locusts from solitary to gregarious phase.

Zhitao Yu *et al.*, 2017, reported the biological roles of ABC transporter LmABCH-9C in the migratory locust. ABC transporters (ATP binding cassette) are proteins that mediate transport of nutrients, lipids and xenobiotics across membrane. LmABCH-9C was expressed continuously during nymphal development with highest expression just after moulting. It was found that suppression of LmABCH-9C transcript levels by RNA interference (RNAi) in nymphs provoked death during or soon after moulting.

Xiaochuang Yao *et al.*, 2017 developed a web based decision support system (DSS) as a part of green prevention and control of locusts. The locust prevention and control and DSS (LPCDSS) helped farmers by providing decision making information. It consist of three layers *viz.*, functional layer, service layer and data layer which provides comprehensive information about locust and is useful in making of integrated management programme for locusts' control.

Sayed *et al.*, 2016 studied the effect of n-hexane and methylene chloride extracted from *Azadirachta indica Citrullus colocynthis*, *Ammi majus Mentha microphylla* in7-14 day old nymph calculating its LC50 and LC 90 values. It was found that after 14 days of feeding *A. majus* was most active followed by *C. colocynthis* and *M. microphylla.* Methylene chloride extracts of *A. indica* formulated with sodium sulfonate as emulsifier raised nymphal duration and exhibited morphogenetic effects. Also this formulation decreased total protein, total lipid and glucose content from hemolymph.

Yan Li *et al.*, 2016 reported the use of CRISPR/Cas9 system to induce targeted mutagenesis. Mixture of Cas9 and Orco gene (encoding the odorant receptor co-receptor) injected into the locust egg showed severely impaired odorant responses in 4th larval stage.

Muhammad Sarwar 2015, studied that protozoan *Nosema locustae* is highly effective against locusts and grasshoppers.

Dulce Santos *et al.*, 2014 studied the effect of RNAi for the control of locusts and found that when used with any biological control its effect is very promising. RNAi management was achieved by knockdown of V-ATPaseH and V-ATPaseD which are involved in basic cellular functions, the delivery of dsRNA led to silencing of desired gene and thus mortality of locusts.

Jornt Spit et el 2014 studied the effect of serine protease transcripts (cDNAs), involved in digestion, might serve as important target for management practices. The study demonstrated that transcription of serine protease reduced after starvation.

Fatma Acheuk *et al.*, 2012, compared the effects of methanolic extract of the plant Haplophyllum tuberculatum and of teflubenzuron on female reproduction in the migratory locust. On studying it was found that both showed almost similar results for ovarian growth, vitellogenesis and ecdysteroid titers. Although TFB completely blocked egg hatch, methanolic extract only had a modest inhibitory effect.

Shereen M. Elbanna *et al.*, 2012, studied the effect of *Metarhizium anisopliae* and nematode (*Steinernema feltiae*) on desert locust (*Schistocerca gregaria*) nymphs. They found that *M. anisopliae* induced high mortality percentage *i.e.* at highest concentration induced faster mortality than the lower concentrations. And Infections with a mixture of both pathogenic agents (fungus and nematode) induced higher and faster percentage of mortality than in single treatment of any of them alone.

V. L. Hunt and A. K. Charnley 2011, studied the effect of fungal toxin destruxin A on behavioural fever in desert locust. It was found that when infected by any pathogen, the locusts show behaviour of fever and seek higher environmental temperature. This behaviour improves the immunity system of locusts by placing the pathogen at sub optimal temperature.

Destruxin A (dtxA) produced by *M. robertsii*, inhibit the immunity system of locust. When dtxA was injected into locusts during early infection with fever causing M. acridium, it inhibited fever thus making locusts more susceptible to *M. acridium*.

Mena-Covarrubias 2009, found that *M. anisopliae acridum* was found to be effective against locusts and grasshoppers.

Thomas 2009, also found that *M. anisopliae acridium* is effective upto 90% against Brown and Red locusts in Africa.

Ravinder Kaur *et al.*, 2008, studied indigenous techniques to manage locust population in three districts of Punjab. It was put forth that locusts can be mass trapped and killed by beating of tin boxes, which moves locusts away from the field and nymphs fell into pits dug, the pits were then covered by sand. In another method ropes were over the field which helps in directing nymphs in desired directions and they are then killed.

J. C. Scanlan *et al.*, 2001 developed a model for Metarhizium application on locust in reference to plant cover. They formulated Metarhizium in oil to form biopesticides and told that for high density crop where locust is not able to receive spores due to high density crop, high doses of biopesticides to be applied. And the similar for moderate and low density crops, moderate and low doses need to be applied respectively.

Thus it can be inferred from the above reviews reported that there are several effective ecofriendly management practices of locusts without causing any harm to the human beings and environment.

81. ENTOMOLOGY 17488

Rearing of *Helicoverpa armigera* on Artificial Diet

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INTRODUCTION: The cotton bollworm, Helicoverpa armigera Hubner (Lepidoptera: Noctuidae) is a major threat to a intensive agriculture (Sigsgaard *et al.*, 2002). Its wide dissemination and pest status has been attributed to its polyphagy, and its ability to undergo both facultative diapause and seasonal migration (Fitt 1989). The species is migratory on all continents, and is a key pest on all of them (Feng *et al.*, 2005). Host plants used by H. armigera have been recorded for India (60 cultivated and 67 wild plants) (Karim 2000), Africa (Pearson 1958), Australia (Zalucki *et al.*, 1986), and New Zealand (Thanee 1987).

Various artificial diets have been developed and proposed for the maintenance, and continuous rearing of economically important insects (Cohen, 2001; Castane and Zapata 2005; Ahmed *et al.*, 1998). Agar is a vital ingredient of insect rearing diet (Ahmed *et al.*, 1998) and is acquired from marine algae such as Gracilaria and Geladiella species (Nene 1996).

Tapioca, prepared from the cassava plant, Manihot esculenta Crantz (Euphorbiales: Euphorbiacea) has been successfully used instead of agar in plant tissue culture media (Nene 1996; Gebre and Sathyanarayana 2001).

The dietary source of Helicoverpa armigera can also be identifying by using carbon isotopes signatures. Biotypes are more commonly distinguished by survival and development on a specific host or by developing feeding preference, oviposition.

1. Rearing the Cotton Bollworm, *Helicoverpa armigera*, on a Tapioca-based Artificial Diet

Ingredient: The wet and dry ingredients of the diet were weighed and kept separately. The agar or tapioca was suspended in 3.5 liter of water and boiled. For the tapioca-based diet a heat-proof mixer from Braun was used while boiling to ensure complete mixing and grinding of the tapioca. The chickpea powder was then added to the boiled mixture and mixed, during this process the temperature of the mixture became nearly 60°C. The remaining dry and wet ingredients were then added to the mixture with thorough mixing. All dry ingredients were added to a flask and sterilized distilled water was gradually added with steady stirring until the entire quantity of powder had been dissolved. Water was then added until the 400 ml volume was obtained. All dry ingredients were added to a flask and sterilized distilled water was gradually added with steady stirring until the entire quantity of powder had been dissolved. Water was then added until the 400 ml volume was obtained.

Results: The results show that tapioca is a suitable alternative for H. armigera continuous rearing up to five generations. By the 5^{th} generation non-significant differences were observed between tapioca and agar-based diets, indicating that they were nutritionally equivalent. The 5^{th} generation also showed a significantly longer average pupal development period on both diets.

The tapioca-based diet developed for rearing H. armigera, maintained this insect for up to eight generations with no loss of vigor or viability. This diet would, therefore, have potential to be used as an artificial diet for rearing several other economically important Lepidoptera.

2. Life Table of *Helicoverpa armigera* on Semi Synthetic Diet

Composition of Diet

Ingredient	Quantity
Commodity*	17.67
Yeast powder	3.07
Sodium ascorbate	0.31
Sorbic acid	0.15
Methyl-P-hydroxybenzoate	0.31
Agar	1.54
Formaldehyde 10% (ml)	0.15
Water (ml)	76.80

Quantity of remaining ingredient in 'g'

Commodity* - Flour of maize/ pea/ pearl millet/ soybean grain (soaked for 24 hrs in water) Four different semi synthetic diets were prepared with four commodities used (one commodity in each diet)

Rearing: Rearing was done at 29±1° C and 80±% relative humidity. 100 newly hatched larva were reared individually in plastic vials (6 cm X 2.5 cm) on each of semi synthetic diets.

Salient Feeding

Soybean (soaked) based diet was highly suitable for mass rearing of this insect followed by diet prepared with flour of maize, pea and pearl millet

3. Development of Semi Synthetic Diets for the Rearing of *H. armigera*

Ingredient	Quantity
Commodity *	17.67
Yeast powder	3.07
Sodium ascorbate	0.31
Methyl-P-hydroxybenzoate	0.31
Sorbic acid	0.15
Agar	1.54
Formaldehyde 10% (ml)	0.15
Water (ml)	76.80

Quantity of Remaining Ingredient in 'g'

Commodities used as basic ingredient in diet were bengal gram, cowpea, finger millet, French bean, green gram, groundnut, lentil, (Veera Reddy C. G. & Bhattacharya A. K. 1990)

Pea, maize, pearl millet, red gram, rice, soybean, sorghum, triticale and winged bean. For compounding the diets the commodities used either as:

- Flour or
- After soaking in water for 24 hrs or
- After boiling for 45 hrs in water ' except maize which is boiled for 75 min.'

Rearing: Rearing was done at 29±1° C and 80±5% relative humidity. Ten newly hatched larvae (0-12 hrs old) were released on each plastic vial (6.0 X 2.5 cm) containing diet.

Salient findings: Growth and success indices show out different diets, pea based diet was the best as it also supported normal adult formation.

82. ENTOMOLOGY 17489

Fuel of Insect: Carbohydrate

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INTRODUCTION: Carbohydrates are the main source of energy in insect body. Carbohydrates are saccharides or sugar which breaks down in the insect bodies to release energy, when insects are physically active. This organic molecule is present in most of the foods. Carbohydrate happens to be the most abundant amongst the important classes of bio-molecules which include lipids, proteins and nucleic acids. When the body is not active, Carbohydrates is stored as fat in the body for later use. Carbohydrates are also used as fuels by a majority of insects. They may be converted to fats and may contribute to production of amino acids. They are therefore, important component of the diets of most insects.

Carbohydrates have nutritive value for an insect depends on three things (Barker *et al.* (1974)

1. The phagostimulant properties of the carbohydrate.
2. The particular monosaccharide and related molecules that can be metabolized for energy production.
3. The component of digestive enzymes available to reduce complex carbohydrates to their constituent monomers.

Nayer *et al.* In 1971, reported that insects may utilize a wide range of carbohydrates like glucose, fructose, mannose, galactose, sucrose, maltose, trehalose, melibiose, mannitol, sorbitol etc. With the study of female Adis spp.,

Role of Carbohydrate

- The most important function of carbohydrates is production of energy.
- Carbohydrates store food in the body in the forms of starch or glycogen and combine with nitrogen when non-essential amino acids are formed.
- Carbohydrates promote health fitness and build up body strength with the generation of energy.
- Carbohydrates in the form of fibre keep the bowel function smooth.

Types of Carbohydrates

Carbohydrates can be classified into the following types:

1. **Monosaccharides:** Monosaccharide means one sugar. *e.g.* galactose, fructose and glucose.
2. **Disaccharides:** Disaccharides which means two sugars. *e.g.* maltose, lactose and sucrose.
3. **Oligosaccharides:** These are simple sugars with 3-10 sugar units. *e.g.* Raffinose etc.
4. **Polysaccharides:** These are simple sugars with over 3000 sugar units. *e.g.* amylose etc.

Digestion of Carbohydrate

The enzymes which are used in the process of carbohydrate digestion are called as carbohydrases. Carbohydrases are mainly two types:

- **Polysaccharases:** Acting on polysaccharides, *e.g.* Starch, cellulose, glycogen.
- **Glycosidases:** Acting on disaccharides and trisaccharides, *e.g.* maltose, trehalose, sucrose, lactose, melibios.

A. Polysaccharases

1. **Amylase**: Act on starch and glycogen'

Starch → maltose (disaccharides)

Glycogen → glucose (monosaccharides

   - ***a) Exoamylase:*** split of maltose residues from the end of the starch molecules. Lead to rapid build up of maltose.
   - ***b) Endoamylase:*** Attack bond well within the starch molecule and release maltose. Lead to slaw build-up of maltose.

2. **Cellulose:** Act on cellulose and convert in to the cellobios. Terra *et al.* (1979) reported, the digestion of carbohydrate like maltose, sucrose, cellobiose and lactose in Rhynchhosciara americana, which are restricted to midgut cells. Where as the digestion carried out by amylase, cellulose and trehalase.

B. Glycosidases: Act on Disaccharides and Trisaccharides

1. α-**glucosidase**: Act a maltose, trehalose, sucrose and melezitose which have □- linkages.
   - a) Maltose is converted in to □- glucose molecules due to **maltase** enzyme.
   - b) Trehalose is coverted in to □- glucose molecules due to **trehalase** enzyme. *e.g* Nettles *et al.* (1971) reported, the effect of sucrose concentration over trehalose, in which if the dietary sucrose concentration is increased so the trehalose content of hemolymph decreased.
   - c) Sucrose is coverted in to glucose + fructose due to **sucrase** enzyme.
   - d) Melezitose is coverted in to glucose + sucrose due to **melezitase** enzyme.
2. α-**galactosidase**: Act on melibiose and

converted in to galactose + glucose due to **melibiase** enzyme.

3. β-**galactosidase**: Act on lactose and converted in to galactose + glucose due to **lactase** enzyme.
4. β-**glucosidase**: Act on cellobiose and converted in to □- glucose molecules due to **lactase** enzyme.
5. α-**fructofaranosidase**: Act on raffinose and sucrose, converted in to glucose and fructose.

Absorption and storage of carbohydrate:

1. Carbohydrates are absorbed mainly as monosaccharide.
2. In cockroach and grasshopper, their absorption takes place in midgut and especially in midgut caecae (Sanford, 1918).
3. Treherne, J. (1958) reported that, mannose is absorbed in midgut caecae and ventriculus and the later sugar being absorbed equally from these two regions in Periplanneta americana.
4. Nettles *et al.* (1971) reported that, absorption of galactose is found to be follow only slowly by conversion to trehalose and glycogen in adults of Anthonomus granddis.
5. Staudenmayer (1938) reported that, Mannose was well absorption by Calliphora and Drosophila.
6. Knowles (1975) reported that, glucose is absorbed in the Malpighian tubules of the blowfiy.
7. Carbohydrate is stored as glycogen which, caterpillar and probably also in other insects, is builed up in the fat body during periods of active feeding.
8. This store becomes depleted during sustained activity or over moult, when the insect is not feeding, or if it is starved.
9. For example, Friedman (1985) reported that, the glycogen content of the fat body of a well fed migratory locust, is about 2 mg per 100 mg fresh weight. After flying for two hours this is reduced to about 0.5 mg per 100 mg.
10. In insect this level is maintained by conversion of glycogen to trehalose in the fat body.
11. This process is regulated by a hyperglycemic hormone. Release of the hormone is offered by a low concentration of glucose in the hemolymph when the glucose is used metabolically.

83. ENTOMOLOGY 17492

Fall Army Worm (Spodoptera Frugiperda): Emerging Threat to Maize in India

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Maize (*Zea mays* L.) is one of the mainly versatile crop having wider adaptability under different agro climatic conditions. Maize is also known as "Queen of cereals" because it has the highest genetic yield potential among the cereals. It is cultivated on nearly 150 m ha in about 160 countries having wider diversity of soil, climate, biodiversity and management practices that contributes 36% (782 m t) of the global grain production. The United States of America is the largest producer of maize followed by China, Brazil, India, Argentina, Ukraine, and Mexico. In India, major maize growing states are Karnataka, Madhya Pradesh, Maharashtra, Rajasthan, Bihar, Uttar Pradesh, Telangana, Gujarat and Tamil Nadu. India produce 21.81 m tons of maize in about 8.69 m ha area with average yield of 2509 kg/ha. Maize is attacked by wide range of insect pests, among which stem borer, pink borer, stem fly, earworm, ear head borer, aphid, leaf hopper etc are commonly observed in our area. Recently, fall armyworm (*Spodoptera frugiperda*), which is native to America, officially reported in Nigeria of West Africa in 2016 and rapidly spread across 44 countries. In India, fall armyworm began being spread from this year (Hodal, 2018). Infestation to maize in India of this pest marks the first report in Asia. Last year Telangana is among the hardest hit affecting more than 17 districts and from this year spotted in Marathwada and Viderbha region of Maharashtra. Though the pest is infesting maize crop but scientists warn that this pest could seen spread and attack other crops like sorghum, sugarcane, cabbage and soybean.

Nature of Damage

In its initial stages, seedlings are fed within the whorl. Full grown larva can cut the base of the plant. Mature plants seems to suffer by this pest during reproductive structures. Maize leaves are partially eaten and the whorl with a mass of holes, tattered edges and larval frass. Young larva skeletonzed the leaf lamina. Early in the season, severe feeding damage to young plants can kill the growing point causing a symptom called 'dead heart'. Maize plants may have the cobs attacked by larvae boring through the kernels. At high densities, large larvae may act as armyworms and disperse in swarms. On tomato, larvae feed on growing points and buds, also fruits may be pierced.

Life Cycle

Egg: Eggs are usually laid in masses of approximately 150-200 in two to four layers deep stuck on the lower surface of the leaf. Spherical in shape and are green at the time of oviposition and become light brown prior to hatching. Incubation period 2-3 days and may vary depending on temperature. The egg mass is usually covered with grey-pink scales (setae) from the female abdomen. Single female can lay about 1,500 eggs (Johnson, 1987). Larva: After hatching larva is green with black lines and spots and as it grows they either remain green or become brownish and have black dorsal and spiracular lines. If crowded by a high population density and food shortage, the final instar can be almost black in its armyworm phase. Full grown larvae are characterized by an inverted Y-shape in yellow on the head, black dorsal pinaculae with long primary setae. Full fed larvae are about 3-4 cm long. There are usually six larval instars and occasionally five. Pupa: Pupae are shiny brown and about 1.3-1.5 cm in males and 1.6-1.7 cm in females. Adult: Female is quite bigger than male, wingspan measures about 3.8 cm and body length measures about 1.7 cm. Whereas, Male wingspan is 3.7 cm while body length is 1.6 cm. The forewing is mottled, dark brown to grey in color. Hind wings are straw color with a dark brown margin.

Management

Fall armyworm being internal feeder on maize, it is extremely difficult to control. In ordere to keep their incidence under check, integrated measures are necessary.

1. Deep ploughing in summer season to expose the pupa in hot scorching sunshine for killing.
2. Hand picking of larva in initial stage or removal of affected shoots along with larvae.
3. Collection and destruction of egg masses.
4. Use of light traps (2/acre) and installation of pheromone trap containing (Z)-9-Tetradecenyl acetate (Z-9-14: OAca) (@ 5 traps/acre) for mating disruption.
5. Sowing of resistant (*Bt*) or less susceptible varieties.
6. Common predators include birds, rodents, beetles and earwigs devour the caterpillar of fall armyworm. It has been shown that direct predation can cause significant population control of caterpillar. However, parasitoid fly and wasp *viz*., *Atanycolus* spp., *Archytas marmoratus*, *Cotesia marginiventris* and *Chelonus texanus* target fall armyworm.
7. Use of transgenic maize containing genes encoding delta-endotoxins from *Bt* kurstaki have been commercialized in the USA and Brazil. Vegetative insecticidal proteins (vip) have been isolated from *Bt* during the vegetative phase of growth which show a wide spectrum of activities against *Spodoptera* spp and other lepidopteran pests (Estruch *et al*., 1996).
8. Recommended insecticides for *Spodoptera* spp., includes emamectin benzoate, fenvalerate, carbaryl, chlorpyrifos, malathion, permethrin, thiamethoxam and lamba-cyhalothrin (Anon., 1997).

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84. ENTOMOLOGY 17501

Lucerne Aphids and their Integrated Pest Management

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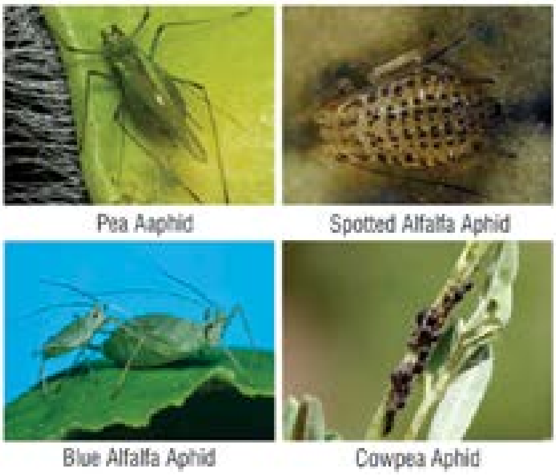
INTRODUCTION: Lucerne (*Medicago sativa* L.), is a most important cosmopolitan forage crop, so it is called “Queen” of forage crops. It is originated in Asia. It was first observed to be cultivated in Iran before 700 BC. The other names of Lucerne are Alfalfa, Luzerne, Snail clover, Purple medick, Medic herb, Burgundy hay or Clover, Chilen clover and Bourgoens Hoy, Lasun ghas, Vilayati ghas, Methighas. It is widely cultivated as green forage crop in Maharashtra, Gujarat, Uttar Pradesh, Haryana, Punjab, Jammu and Kashmir, Madhya Pradesh, Karnataka, Tamil Nadu.

Lucerne belongs to family Leguminaceae of genus *Medicago*. The genus includes 65 species, distributed in Europe, Asia and Africa. Lucerne has the highest feeding value among all commonly grown hay crops. It is consumed by most herbivores and omnivores, including all classes of livestock and big game animals. Hay of lucerne contains approximately 4 times as much protein as sorghum fodder and ample quantity of vitamin ‘A’. Besides, at least 10 other vitamins, lucerne contains 20.2 per cent crude protein, 16.2 per cent digestible crude protein, 30.1

per cent crude fibre, 1.24 per cent calcium, 0.35 per cent phosphorous and 2.17 M cal/kg metabolic energy (Banerjee, 1978).

Due to its herbaceous nature and favourable temperature and humidity, the pests have enormous scope to perpetuate and build up their population on it. Lucerne suffers damage both qualitatively and quantitatively by aphids *Acyrthosiphon pisum* Harris, *A. kondoi* Shinjii, *Aphis craccivora* Koch and *Therioaphis trifolii* F (Martin and Leonard, 1976). An aphid complex of spotted alfalfa aphid (SAA), blue alfalfa aphid (BAA), cowpea aphid (CPA), and pea aphid (PA) are mostly cool season (November through April) pests. (Natwick and Lopez, 2011). The quantitative losses recorded in India are about 37.7 % due to insect pests in lucerne (Shri Ram and Gupta, 1989). Among three Lucerne aphid, Pea aphid was noticed from November to middle of March. Cowpea aphid was found from January to February. Spotted aphid showed peak activity from December to end of February. (Tambe, 2008).



Nature of Damage of Aphids

Pea aphid are found over most of the plant with heavy infestations and can deposit large quantities of honeydew which can fouling of harvesting equipment and supports the growth of sooty molds lowering hay quality. Blue alfalfa aphid may stunt growth and infested plants have smaller leaves, shorter internodes, leaf curling, yellowing, and leaf drop. Spotted alfalfa aphid is capable of stunting susceptible varieties. High aphid densities deposit sticky excrement of sugars and amino acids “honeydew”. Honeydew can foul harvesting equipment and supports the growth of sooty molds reducing marketability of hay. Cowpea aphids are shiny black and immature aphids may be lightly dusted with wax. Colonies start on the growing points of the host plant, but unabated can quickly infest the entire plant (Natwick and M. Lopez, 2011).

Integrated Pest Management

When it is possible, avoid using the pyrethroid insecticides to control alfalfa hay pests. Damaging populations are most commonly encountered under stress conditions. Minimizing crop stress through improved irrigation and proper best management practices. Seed treatment with *Trichoderma viride* (5 g/kg seed) before sowing. Transplanting of marigold seedling 0.5 m apart around and inner border in Lucerne field 1 month after sowing.

Seedling of castor seed 3 m part around and inner border area of lucerne field at the time of sowing. Various predators *i.e.* Coccinellids, *Chrysoperla carnea*, Syrphidfly found effective predator of aphids. Spraying of *Verticillium lecanii* (4 x 105 c.f.u. /ml) for the management of aphids. Spraying of thiamethoxam 0.005 % and imidacloprid 0.004 % for management of aphids. For avoid resedue problems keep pre-harvest intervals for imidacloprid and thiamethoxam were 11 and 15 days, respectively (Tambe, 2008).

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85. ENTOMOLOGY 17510

Role of Insects in Forensic Entomology

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Forensic Entomology is a branch of forensic science that applies the study of arthropods and insects in the investigation of criminal matters. It is the use of the insects, and their arthropod relatives that inhabit decomposing remains to aid legal investigations. It also involves the application of the study of arthropods, including insects, arachnids, centipedes, millipedes, and crustaceans to criminal or legal cases. Forensic entomology is that special associated distinctive discipline of forensic science that deals with the assorted aspects of an insect's or a maggot's life cycle so as to assess the time since death. The forensic entomologist can use a number of different techniques including species succession, larval weight, larval length, and accumulated degree hour. The first instance of forensic entomology can be seen in the Chinese literature. In his book "Hsi yuan chilu", the Chinese lawyer and death investigator Sung Tzu, in the 13th century has mentioned possibly the first case in which insects led to the murder culprit. In that case there was a stabbing near a rice field. A day after the incidence, the investigator made all the labourers to lay down their sickles. The presence of invisible bloodstains led insects (possibly blow flies) to one of the sickles. Thus the culprit was apprehended and he confessed to the crime. Pierre Megnin can be regarded as the first person who undertook a scientific research on forensic entomology. He worked on the subject for almost a couple of decades and compiled his findings in the form of a book titled La faune des Cadavres in 1894. He also described the morphological features of various classes of insects that helped in their identification. His contribution in popularizing the subject remains unparalleled. The late 1970s saw the emergence of entomotoxicology as a new branch of forensic entomology. In this the presence of toxins in the invertebrate decomposers was detected and was used as a method of finding the cause of death. Forensic determine the post mortem interval or "time since death" in homicide investigations. The forensic entomologist estimates a portion of the post mortem interval based on the age of the insect present. This entomological based estimation is most commonly called the "Time Since Colonization".

TABLE 1: Major insect families found on or near carrion

Family and Example	Description
Dipterans Insect	
Calliphoridiae Blowfly (blue and green bottle flies)	Colonizes the carrion during early stages of decomposition. Often the most abundant larvae on carrion. Possess specific preference for light intensity and temperature being a poikilothermic.
Sarcophagidae Flesh Flies	Large in size. Lays live larvae. Larvae parasitizes blowfly maggot and may also be present shortly after death.
Muscidae House Fly	Usually found during the last stages of decomposition.
Piophilidae Cheese skippers	Associated with late stage of decomposition.
Coleopterans Insect	
Staphylinidae Rove beetles	Can be present within hours of death as well as months later. Adult and larvae feed on eggs and larvae of other species.
Silphidae Carrion/burying/sexton beetle	Found during early stages of decomposition. Adult and larvae feed on maggots as well as carrion.
Histeridae Clown/hister beetle	Present from early on to the start of the dry stage of decomposition. Adult and larvae feed on maggots and pupae on larvae of *Dermestes* beetles.
Dermestidae Skin beetle	Feed on dried skin and tissues during the later stage of decomposition.
Scarabidae Hide beetle	Some of the last arrivals at a corpse (dry decay stage).
Cleridae Ham/checkered beetle	These are predators of flies and other beetles.
Tenebrionidae Darkling beetle	Larvae and adults are predatory.
Carabidae Ground beetle	Larvae and adults are predatory. Found during all stages of decomposition.

Uses of Insect in Forensic Entomology

- Estimation of Time Since Death/Post Mortem Interval (PMI): The primary application of insects answering questions in death investigation is to estimate when the victim died. This possibility exists due to the insects being the very first organisms to colonize dead animals.

- Estimation of Location or Point of Death: Another application of entomology is using the ranges of a specific insect species' geographic distribution (where it lives) to establish from where a body originated.
- Identification of Area of Trauma in Extensively Decomposed Body: Carrion insects (primarily blowflies) can be used to identify areas of trauma on badly decomposed remains when major changes have taken place in the appearance of the soft tissues on the body
- **Entomotoxicology:** The maggots may be used to determine the presence or absence of drugs when human body tissues are too badly decomposed to do toxicology on the tissue remains.
- **Identification of Suspect/Criminal:** Techniques for analyzing molecular DNA structures of insects for species identification and the human DNA in insects that feed on humans have recently been developed. Maggots feeding on decomposing humans have been tested for human DNA and found to retain testable levels used for identification of rapist.

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86. ENTOMOLOGY 17536

Tuta absoluta: An Invasive Pests of India

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INTRODUCTION: Tomato leaf miner, *Tuta absoluta* (Meyrick), (Lepidoptera: Gelechiidae) is also known as tomato pin worm, tomato borer, American tomato moth. It is recently noticed as invasive pest from most part of the world's tomato growing regions. Invasive species also called introduced species, alien species, or exotic species, any non-native species that significantly modifies or disrupts the ecosystem it colonizes. It is native to South America. It is a devastating pest of tomato, also attack on pepper, eggplant, tobacco, potato, and black nightshade. The pest has been reported for the first time from Spain in 2006, from where it spread to other European, African, Asian and Middle East countries. In India, it was first reported from Pune, Maharastra in 2014, later it was detected from Andhra Pradesh, Tamil Nadu, Karnataka, and Gujarat. Present day, the pest is found so devastating in many countries that pest has been responsible for losses of 80-100 per cent in tomato plantations in both protected and open field cultivation.

Marks of Identification

Eggs: Cream- coloured and small, Oval-cylindrical.

Larvae: Early instars are white or cream with a black head. As larvae grew older, they turn greenish to pink with a brown head.

Pupae: Newly formed pupae are greenish and turn dark brown as they mature.

Adult: They are small, brown or silver with black spots on the narrow wings. Antennae are filiform. Legs and palps are ringed with black and brown, labial palpi prominent head vertex covered with appressed scales; hind wings with outer margin concave posterior of apex.

Life Cycle

Egg: A female can lay on an average 260 eggs singly on the under surface of the leaves, stems and calyx of young fruits (Incubation period- 5-7 days).

***Larva*:** The larvae pass through four instars (20 days).

***Pupa*:** It pupates in the soil (1-2 cm deep) and in the last the larvae builds a cocoon and pupates on the leaf surface or inside mines. (Female- 10-11 days and males- 11-13 days).

***Adult*:** Adult are nocturnal and usually hide during the day between leaves (30-40 days).

Factors responsible for the spread of the pest: Aggressive nature of the pest, Multivoltine character, Short generation time, High biotic potential, Resistant to insecticides.

Host range: Tomato, brinjal, potato, wild solanaceae, such as pepper, eggplant, tobacco, potato, and black nightshade, *Solanum nigrum* have been recorded as hosts.

Nature of damage: In tomato infestation found on apical buds, leaves, and stems, flowers and fruits, on which the black frass is visible. The larvae mine the leaves producing large galleries and burrow into the fruit, causing a substantial loss of tomato production in protected and open filed cultivations. Damage can reach up to 100%. The larvae are very unlikely to enter diapause as long as food source is available. It can overwinter as eggs, pupae and adults.

Management

Cultural Control: Ploughing, manuring, irrigation, crop rotation, solarisation, and the elimination of symptomatic leaves and destruction of infested tomato plants.

Biological Control: CABI (2016) The most common predators are the mirid bugs *Nesidiocoris tenuis* and *Macrolophus pygmaeus*. *Bacillus thuringiensis* (Bt)-based insecticide formulations have been used.

Host-Plant Resistance: Host-plant resistance was explored by developing tomato accessions with high zingiberene and/or acylsugar contents resulting on low ovipostion rates and larval feeding of *T. absoluta*.

Monitoring and Mass Trapping: EPPO (2014) Pheromone trap based on Qlure-TUA gives early warning of infestation and also exhibits the density of the insect accurately in low population to medium level infestation. Qlure -TUA give high capture rate is ideal for mass trapping

Chemical control: IRAC (2016) Frequent intense application of insecticide leads to develop insecticide resistance. Resistance to Pyrethroid and Methamidophos, Cartap has been reported in Brazil, Chile and Argentina. However, there are active ingredients, Emamectin benzoate, Indoxacarb and spinosad have found to be effective against larval infestations.

Conclusion: *T. absoluta* is considerably spreading very fast across the continent and getting status of globally invasive pest in tomato growing regions of world including India. Mostly, it entered in various regions by invading tomato plant and later it has expanded its host range. The pest can be effectively managed with insecticides *i.e.* Spinosad 24 SC, Indoxacarb15 EC, and Emamectin benzoate 0.5EC. The use of alternate strategies *i.e.* host plant resistant, cultural, behavioral, biological control are more effective to manage it.

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87. ENGINEERING AND TECHNOLOGY 17441

Traction Aids in Agricultural Tractor

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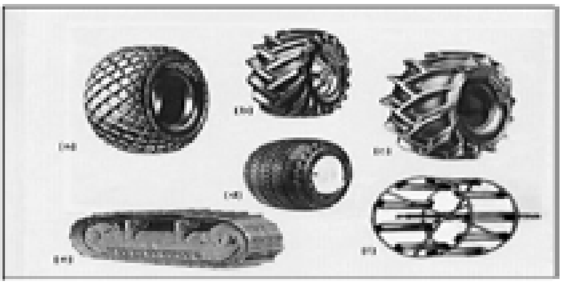
INTRODUCTION: Mechanization of agricultural processes is now commonplace and brings with it a variety of new technologies and constructional innovations in terms of the appliances which has contributed significantly for improving crop productivity improvements as well as a reduction in energetic demands, reduction of the fuel consumption and undesirable emission. For many years, the trend in agriculture has been for increasing tractor size and weight, which increases the risk of severe soil compaction. The increasing engine size of the tractors also increases the demands on transferring power from engine to draught force, *i.e.* using tire equipment or tracks that can increases engine power (Arvidsson *et al.*, 2011).

Traction is a term applied to the driving force applied by a wheel, track or other traction devices. The main reasons for fitting traction aids to tractors are to increase the grip between wheels and the ground surface and to spread load weight. If traction aids have a greater area in contact with the ground than wheels alone the footprint size increases and ground pressure exerted by the machine is reduced. The footprint area of a tractor is influenced by the number of wheels, tyre pressure, tyre dimensions, tyre tread pattern and the use of traction aids that increase the area through which the weight of the machine is transferred to the ground. Traction aids can also increase machine stability, improves flotation and protect tyres.

The changeable soil composition and hardness have important influence on the traction performance parameters such as tractor's slippage, motion resistance ratio, drawbar power and fuel consumption (Elwaleed *et al.*, 2006). The tractor slippage is changing widely in the field works and in the same field it depends on the soil features. The slippage of driving wheels is inherently connected with traction force. The dependencies of the slippage of tractors having different mass on traction force in the same soil are different and depend on the vertical load (G) of driving wheels (Arthur *et al.*, 2014).



	Surface	Tread form
(a)	Hard surfaces such as roads	Large area, shallow tread with 'high' pressure
(b)	Normal agricultural work, dry soil	Heavy, intermediate depth tread
(c)	Soft, wet agricultural soils	Depp tread
(d)	Lawns, low sinkage is required	Wide, low pressure
(e)	Dry soil, heavy loads as in earthmoving	Tracks, as on a "crawler" tractor
(f)	Saturated, puddled siols	Metal cage, with angled lugs, alone or as extensions to normal tyres

Traction Aids

The following of aids can be used for enhancing the traction development.

- Rubber tires with extensions (strakes)
- Inflation pressure
- Tire tread pattern and design
- Tire chains
- Solid or Liquid Ballasting

Why Traction Aids ??

Traction aids are used to increase drawbar pull, reduce rolling resistance, reduce slip, give stability and to increase tractive performance of a tractor

Tractors usually are designed to pull the implements in fields. The resistance force of the implement is proportional to the wheel adhesion with soil and depends on the soil conditions, where tractor wheels interact on soft, loose soil surfaces. According to soil conditions it is possible to control their vertical load forces by the tractor's drive-wheels load (ballasting), to select the tire caring area by reducing the tire inflation pressure or using double wheels. Variations in the soil structure and surface roughness affect the variations in the implement resistance and drawbar (Way *et al.*, 2006). The appropriate choice of the tractor configuration, with view to optimizing the drive wheels configurations on soft soils, thereby reducing the fuel consumption in field operations (Suresh and Varshney 2006).

Advantages of Traction Aids

1. Increased traction
2. Increased tractor life
3. Increased tire life
4. Greater fuel economy
5. Reduced slippage

Limitations

- Skilled operator required
- Additional costs required

Conclusions: Several types of traction aids are used on farm tractors to increase their tractive ability. Tracks gives best traction results in loose or wet sticky soils as compared to pneumatic and steel wheels. Pneumatic wheels provide good ride comfort and steering ability in both on road and off-road condition. Ballasting at heavy pulling work reduces drive wheel slippage. Optimum ballasting is required for minimum power lost during a tillage operation.

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88. FOOD TECHNOLOGY 17354

High Pressure Processing: A Novel Non Thermal Technology for Preservation of Foods

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INTRODUCTION: Consumers have a growing preference for convenient, fresh-like, healthy, minimal-processed food products with natural flavour and taste and extended shelf-life. High pressure processing (HPP) is a promising "non-thermal" technique for food preservation that efficiently inactivates the vegetative microorganisms, most commonly related to food-borne diseases allowing most foods to be preserved with minimal effect on taste, texture or nutritional characteristics. Microbial inactivation is one of the main goals for the application of high pressure technology. The inactivation effect of high pressure processing results in extended shelflife and improved microbial safety of food products.

High Pressure Processing (HPP)

It is also known as ultra-high pressure (UHP) or high hydrostatic pressure (HHP) is a non-thermal food processing technology applied when the food is subjected to high hydrostatic pressure commonly at or above 100 MPa. This technology has been established to inactivate microorganisms and denature several enzymes, without flavour and nutrient degradation related to usual thermal processing treatments and other processing methods. HPP has now been increasingly applied in the food production industry to produce high-quality food. HPP is the application of uniform and even ultra-high pressures to the product from all sides within a few minutes. This method causes no damage or distorts to the foods as long as the treated product is not hollow or having an empty space inside. During the pressurizing time, a major reduction of microorganisms and a denaturation of proteins could occur without influencing molecular bonds. This process can inactivate the inappropriate bacteria, extend the shelf life of the product and provide an improvement to the criteria of the product. In addition, chemical reactions that cause the destruction of vitamins or produce off-flavours can be reduced under High-pressure conditions.

Basic high pressure processing principles: High-Pressure technology has been cited as one of the best innovations in food processing from the last 50 years. Some physical and chemical changes result from application of pressure. Physical compression during pressure treatment results in a volume reduction and an increase in temperature and energy. The basic principles that determine the behaviour of foods under pressure are:

PHOTO 1: High pressure processing equipment

Le-Chatelier's principle: Any reaction, conformational change, phase transition, accompanied by a decrease in volume is enhanced by pressure.

Principle of microscopic ordering: At constant temperature, an increase in pressure increases the degrees of ordering of molecules of a given substance. Therefore pressure and temperature exert antagonistic forces on molecular structure and chemical reactions

Isostatic principle: The food products are compressed by uniform pressure from every direction and then returned to their original shape when the pressure is released. The products are compressed independently of the product size and geometry because transmission of pressure to the core is not mass/time dependant thus the process is minimized If a food product contains sufficient moisture, pressure will not damage the product at the macroscopic levels as long as the pressure is applied uniformly in all directions.

FIG 1: Processing of food products in HPP unit

FIG 2: Effect of application of high pressure on microorganisms

Aspects of Applications of High Pressure Processing of Foods

The main advantage of high pressure processing compared to thermal sterilization and pasteurization is maintenance of sensory and nutritional characteristic of treated food products. HPP provides a means for retaining food quality while avoiding the need for excessive thermal treatments or chemical preservation. High-pressure processing provides a unique opportunity for food processors to develop a new generation of value added food products having superior quality and shelf-life to those produced conventionally. High pressure treatment could be accepted as a food safety intervention for eliminating *Listeria monocytogenes* in processed meat products and cheese. Hydrostatic pressure treatment is also effective in inactivating other hazardous microorganisms such as *E. coli*, *Salmonella*, and *Vibrio*, as well as many yeasts, molds, and bacteria responsible for food spoilage. The microbiological shelf-life and food quality can be substantially extended by the use of HPP. HPP has potential as a phyto sanitary treatment to control quarantine insect pests in fresh or minimal processed fruits and vegetables to extend their shelf-life. Pressure inactivation of yeast and moulds has been reported in citrus juices. Juices pressurized at 400 MPa for 10 min at 40 °C do not spoil during 2-3 months of storage. The high pressure treatment effectively reduced the bacterial flora of fresh goat milk cheese after 60 days of storage (2-4 °C) in inoculation studies after treatments at 400-500 MPa for 5-10 min. High-pressure technology could improve the microbiological safety and quality of foods, including meat, milk and dairy products.

Conclusions: High pressure technology proposes a great potential to develop new minimally" treated foods with high nutritional and sensory quality, novel texture and with an increased shelf-life. The novelty of HPP technology and high equipment costs are barriers to its commercialization but increased consumer's demand for fresher-tasting foods containing fewer preservatives drive an increase in this segment. HPP can preserve food products without heat treatment or chemical preservatives, and its ability to ensure safety and significantly extended refrigerated shelf-life has opened new market opportunities particularly in the area of "natural" preservative free food products.

89. FOOD TECHNOLOGY 17670

The Uncharted Journey of Food Dryers from Labs to Industries: What went Wrong?

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In the past few years, there have been many innovations in drying equipment's including many incremental innovations such as incorporation of certain non-conventional features to pre-existing dryers, to a few radical innovations, such as a new type of dryer or drying technique altogether. Most of these dryers remain at the research and development phase of which a selected few go on to the pilot scale and a handful of fortunate ones become commercialized at the industry level. Such is the condition observed in the world and especially in India today. There could be several reasons for this situation which includes financial backwardness, manufacturing lags or lack of industry oriented research, to name a few. But in spite of these considerations, there are few innovative dryers and even drying techniques which need to be promoted to the industrial scale mostly due to their potential or rather capability to generate export grade quality food products with lower energy consumption. Superheated steam drying, heat pump assisted drying, impinging steam drying, variable pressure drop drying, pulse combustion drying and many other hybrid drying technologies are still in the developing stage and some are developed but not under industrial utilization. Table 1 shows the availability of some of these dryers across the world.

TABLE 1: Availability of drying equipment of recent origin across the world

Equipment	Manufacturers	Country
Super heated steam dryer	Fraunhofer IGB	Germany
	Swedish Exergy	Sweden
	Okawara MFG. Co.	Japan
Heat pump assisted dryer	Not found	-

Equipment	Manufacturers	Country
Impinging steam dryer	Glenro Inc.	USA
	Radiant Energy systems Inc.	USA
Pulse combustion dryer	Pulse combustion systems	Australia

Another perspective to look at the situation is the primary concern of energy preservation that has cropped up which led the industrialists, food engineers and scientists to realize an important agenda that "*drying is an energy intensive process*". In the past few years, many works have started pouring in with intense energy efficient solutions but unfortunately lack any pilot plant studies and hence are confined within the boundaries of the laboratory. In light of the "energy efficiency revelation", drying technologies based on renewable energy started gaining popularity and are still highly encouraged! In India, where grains are produced and consumed on a large scale, a large portion of energy is consumed in grain drying. A report by Goyal *et al.*, 2012 says that the total energy required per tonne for milling of raw and parboiled paddy was 31.17 kWh and 36.78 kWh, respectively with mechanical energy varying from 18-55 kW/t for different rice mills. The lowest energy consumption has been seen for super heated steam drying as compared to other drying methods and hence was recommended for industries all over the world to use. Use of energy efficient processes and equipment, co-generation, recovery and recycling of thermal energy, proper insulation, etc. are some other steps that have been reported through extensive research to reduce the gross energy consumption. Although, the work done so far allows an industry to move closer to energy self-sufficiency, there is still a lot of work to do and a lot of lacunas to fix.

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90. FOOD PROCESSING AND PRESERVATION 17272

Women Entrepreneurship through Food Processing

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Agriculture being an important occupation for the rural poor in Kashmir region has potential for micro entrepreneurship development through food processing units. The state grows a variety of food crops like rice, maize, wheat pulses, oilseeds and has a monopoly of growing temperate fruits like apple, pear, peach, plum, apricot, cherry, walnut, almond and quince.

Agro-based industry is regarded as the sunrise sector of the Indian economy in view of its large potential for growth and likely socio-economic impact specifically on employment and income generation. Globally, women represent 49.6% of the total population but only 40.85 of the total workforce in the formal sector. In almost all societies women have less power than men, have less control over resources and receive lesser wages and remain as invisible work force. Micro-entrepreneurship development and income generating activities are a feasible option for empowering women in agriculture.

Benefits of micro-entrepreneurship for women in food processing are:

- Raw materials are easily available on farm
- Primary processing like cleaning, grading, custom milling of cereals, pulses oilseeds, spices, paste, powders at small scale
- Most technologies are available, accessible and affordable for farm women
- Locally demand and market of the product is high after value addition
- Processing adds value to raw fruits and vegetables (often in surplus)
- Minimal processing of fruits and vegetables has low environmental impact

Entrepreneurship among women is a recent phenomenon and a large percentage of micro entrepreneurship in developing countries is undertaken by women. Agro processing industry has paved the way for economic independence of rural women. Besides this processed product require less space as compared to raw produce, add value to the products and improves livelihood. Increasing income is always accompanied change into food basket. Thus processed products have recently become more important because of consumer preferences.

91. FOOD AND NUTRITION 17439

Mulberry (*Morus alba* L.) Fruit: Health Benefits

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INTRODUCTION: Mulberry (*Morus alba* L.) belongs to the Morus genus of the Moraceae family. It is globally distributed under varied climatic conditions ranging from tropical to temperate. This plant contains 24 species and one subspecies and *Morus alba* L. is a dominant species among them. Mulberry is a species native to China and has been widely cultivated in many regions including Asia, Africa, America, Europe and India. Mulberry is a traditional Chinese edible fruit that can be eaten fresh. In most mulberry-growing countries, mulberry fruit is commonly eaten fresh, dried, or processed into wine, fruit juice, and jam for its delicious taste, pleasing color, low calorie content, and high nutrient content. They contain considerable amounts of biologically active ingredients that might be associated with some potential pharmacological activities that are beneficial for health.

Nutrients

Morus alba L. fruit contains abundant protein, lipid, carbohydrate, fiber, minerals and vitamins but low calories, which can be a healthy food choice for consumers. 100 g of the fresh mulberry fruit can give 1.44 g of protein. Total of 18 amino acids including all nine essential amino acids required by humans are found in mulberry fruit. Fatty acids in mulberry fruit are polyunsaturated fatty acids (PUFA), monounsaturated fatty acids (MUFA), saturated fatty acids (SFA). PUFA were the major fraction of fatty acids, representing around 75 per cent. Linoleic acid, palmitic acid and oleic acid were the major fatty acids in mulberry fruit. The predominant fatty acid was linoleic acid which is necessary for health promotion and disease prevention.

The principal sugars found in mulberry fruits are glucose and fructose. It is also good source of minerals, particularly potassium, calcium and phosphorus. The ascorbic acid found to be higher in the fresh fruit, at 36.4 mg/100 g. In addition, mulberry fruit also provides other vitamins, such as thiamin, riboflavin, niacin, folate, vitamin A, vitamin B6, vitamin E and vitamin K. These reported nutrients in the mulberry fruit are beneficial for human health.

Health Benefits

Mulberry fruits had rich content of bioactive polyphenols, which possess wide scopes of bioactivities, such as free-radical scavenging, antidiabetic, neuroprotective, antifatigue, antiatherosclerosis, anti-thrombotic, immune-modulating and others. They are rich in anthocyanins which have attracted attention of researchers and consumers because of their potential pharmacological activities on health.

1. **Hypolipidemic Effect:** Atherosclerosis, a chronic inflammatory disease characterized by the accumulation of lipids in the arterial intima, is widely accepted as a main cause of cardiovascular disease. Oxidative low-density lipoprotein (oxLDL) is an important atherogenic factor. Consumption of a diet rich in natural antioxidants is associated with attenuation of the development of atherosclerosis. Mulberry fruits are rich in anthocyanin which is an effective anti oxidant. That can prevent lipid oxidation and accumulation of lipids the arterial intima. In addition, the mulberry fruits might have a hypolipidemic effect because mulberry fruits have high content of dietary fiber and linoleic acid. Therefore, the consumption of mulberry fruits might reduce the risk of atherosclerosis because mulberry fruits possess hypolipidemic and anti-oxidative abilities to prevent the oxidation of LDL.
2. **Hypoglycemic effect:** Diabetes is a chronic metabolic disorder characterized by hyperglycemia which results from the defects of secretion of insulin. It is associated with a series of health complications including CVD and failure of various organs. Mulberry anthocyanin not only prevented the progressive declining of insulin secretion through protecting -cell, but also enhanced hepatic/peripheral tissue glucose uptake and therefore, lowered the blood glucose levels in the body.
3. **Anti-tumour activity:** The effects of mulberry fruit polyphenols on cellular differentiation, proliferation, and apoptosis are studied in several cancer cell lines or animal tumor models. Hydroxycinnamic acid derivatives of mulberry fruits had capacity to increase reactive oxygen species production by acting as pro-oxidants and hence killing the cancer cells.
4. **Anti-obesity effect:** The elevated levels of triglycerides and low-density lipoprotein are risk factors of obesity and obesity related chronic diseases. Many studies have demonstrated the hypolipidemic properties of mulberry extracts. Mulberry fruit extract reduce the levels of triglyceride, cholesterol, and low-density lipoprotein cholesterol in the serum. Therefore

the mulberry fruits helps to manage the obesity.

5. **Hepatoprotective effect:** The prevention of liver fibrosis is an important issue. Mulberry fruit extracts have the capacity to decrease the lipid peroxidation and increase the protective and curative effects of liver damage and fibrosis. Mulberry anthocyanins reduces the enzyme released from the oxidative stress of liver such as Aspartate aminotransferase (AST), Alanine aminotransferase (ALT), and Alkaline phosphatase (ALP). They also help to decrease the hepatic lipids, thus protecting livers from impairment. Mulberry flavonoids, especially quercetin-3-O-glucoside had strong anti-inflammatory activity.

Conclusions: Mulberry fruit contains huge number of nutrients and bioactive compounds, and it possesses various pharmacological properties, indicating that it is a potential disease-preventing food for the treatment of chronic diseases. These beneficial properties of mulberry fruits recommend for the development of novel functional foods or potential drugs as consumers' consciousness and demand for healthy food rise.

92. FOOD AND NUTRITION 17494

Types of Headaches and Relieving Foods

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Headaches are one of the most common medical complaints; most people experience them at some point in their life. They can affect anyone regardless of age, race, and gender.

A headache can be a sign of stress or emotional distress, or it can result from a medical disorder, such as migraine or high blood pressure, anxiety, or depression. It can lead to other problems. The headaches can be divided into primary and secondary headaches. Primary headaches usually occur by the over activity of, or problems with, structures in the head that are pain-sensitive. This includes the blood vessels, muscles, and nerves of the head and neck. Common primary headaches include migraines, cluster headaches, and tension headaches. Secondary headaches are symptoms that happen when another condition stimulates the pain-sensitive nerves of the head. In other words, the headache symptoms can be attributed to another cause.

Different range of headache include:
Aalcohol-induced hangover, brain tumor, blood clots, bleeding in or around the brain, brain freeze, or ice-cream headaches, carbon monoxide poisoning, concussion, dehydration, glaucoma, teeth-grinding at night, influenza, overuse of pain medication, known as rebound headaches, panic attacks, stroke

It is important to seek medical advice if they become more severe, regular, or persistent. For example, if a headache is more painful and disruptive than previous headaches, worsens, or fails to improve with medication or is accompanied by other symptoms such as confusion, fever, sensory changes, and stiffness in the neck, a doctor should be contacted immediately.

There are Different Types of Headache

1. **Tension headaches:** Tension headaches are the most common form of primary headache. Such headaches normally begin slowly and gradually in the middle of the day. A constant, dull ache on both sides, pain spread to or from the neck can be experienced. Chronic headaches occur for 15 or more days a month for a period of at least 3 months.
2. **Migraines:** The aching may be accompanied by blurred vision, light-headedness, nausea, sensory disturbances known as auras.
   According to the WHO, migraine is the sixth highest cause of days lost due to disability worldwide. A migraine can last from a few hours to between 2 and 3 days.
3. **Rebound headaches:** Rebound or medication-overuse headaches are the most common cause of secondary headaches. They may improve with pain medication, but worsen when its effects wear off. Rebound headaches can cause a range of symptoms, and the pain can be different each day.
4. **Cluster headaches:** Cluster headaches usually last between 15 minutes and 3 hours, and they occur suddenly once per day up to eight times per day for a period of weeks to months. The pain caused by cluster headaches is, one-sided, severe, often described as sharp or burning, typically located in or around one eye. The affected area may become red and swollen, and the nasal passage on the affected side may become stuffy and runny.
5. **Thunderclap headaches:** A thunderclap headache is often secondary to life-threatening conditions, such as intracerebral hemorhage, cerebral venous thrombosis, ruptured or unruptured aneurysms, reversible cerebral vasoconstriction syndrome (RVS), meningitis, and pituitary apoplexy. People who experience these sudden, severe headaches should seek medical evaluation immediately.

Foods that Relieve Headaches

1. **Coffee:** One cup of coffee may be helpful for decreasing hangover-related headaches, but

drinking coffee throughout the day would not be the best choice for curing a headache.

2. **Water melon:** Dehydration is a major cause of headaches. The natural water contained in both fruits and vegetables contains essential minerals, like magnesium, that are key in headache prevention.
3. **Baked Potatoes:** Eating potassium-rich foods can help to alleviate hangover-related headaches." Surprisingly, a baked potato (with the skin) is one of the most impressive sources of potassium, containing a whopping 721 mg.
4. **Almonds**: Magnesium, found in almonds, may protect your body from the brunt of a headache by relaxing blood vessels. Migraine sufferers may also experience relief by following a diet rich in magnesium, some experts believe. "To increase your magnesium intake, try consuming magnesium-rich foods such as bananas, dried apricots, avocados, almonds, cashews, brown rice, legumes and seeds.

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93. FOOD AND NUTRITION 17654

Facts about Clarified Butter (Pure Ghee)

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Clarified butter is actually the Indian pure Ghee which is made from melting segregated cream from the milk. It is pure fat. It can be acquired from buffalo's or cow's milk. Rich in taste and adds flavour to any dish. It is very much relished by Indian population and used in many Indian cuisines.

Healthiness of ghee has always been a question of confusion. Doctors often restrict the consumption of ghee to the diabetics, obese people, cardiovascular patients and hypertensive etc. Now this particular matter of concern needs a quick fix.

Let us understand first that excess of everything is bad and if quantification is done when it comes to food the results will always incur in positive direction. If we talk about fat consumption, in general 40 gm of total visible fat can be suggested to normal healthy human being. 40 gm inculcate the total visible oil, ghee and butter etc that is used to prepare the food or to garnish further. Now the problem point rises when we consume 20 gm of visible fat in daal and vegetables, 20 gm while consuming roti, 30 gm in confectionaries, 30 gm in fried food items and much more in a single day. We need to understand that total amount of visible fat consumption should be 40 gm. This above said consumption does include the trans fat too. Wise choice should be made and quantification should be done.

Ghee constitutes saturated fat but the type of short chain fatty acid present makes it absolutely safe for consumption. But then, again quantity should be determined. The short chain fatty acids present in ghee is termed as Butyric acid and considered effective for gastrointestinal health.

Ghee is a rich source of Vit A, D and E which regulates hormones, metabolism, and repairs skin and improves vision.

Recent studies show that those who consume ghee by replacing any every kind of other fat have good heart health; lesser risk of cardiovascular diseases even is beneficial in reducing cholesterol levels.

It is absolutely safe to consume ghee in recommended quantity but the underlying cause should get treated. Even an obese person can consume ghee but then he/ she need to remove those harmful refined oils, trans- fat or other kind of visible fats from diet.

At last we can say that ghee has countless number of health benefits and is extremely good for health. We need to learn quantification of nutrients well.

94. HOME SCIENCE 17579

Single Parenthood: It's Effect on Children

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A single mother who demonstrates strength, resilience and determination provides a role model that will last for life. Children can develop positive attributes like independence and confidence by learning from the challenges and responsibilities that their mothers face and overcome.

Raising happy and healthy children depends on the quality of the care, affection and love a child receives, not on the number of parents in the home. Along with the constant routines that one creates will have the biggest and more positive impact on the children. When problems arise, the close bond between mother and the children can act as a buffer and support of others may help in facing the problem.

Quality and Positive Relationship

Having a good quality and positive relationship with the children provides the strongest basis for their development and learning.

As a single mothers have less time and need special attention in this relationship with the child. Children who grow up with strong and loving relationships with a parent tend to feel fine about themselves. They are more likely to grow up to be caring adults who can develop positive relationships with their children. The added stresses of a single mother can put pressure on their parenting, making it harder for a single mother to show the warmth and encouragement of the children need. It might be harder to put aside time and space to actively build the parent child relationship. With the advantages the greater self-confidence – for both single parent and their children. Making it against odds not only gives the children a better foundation for the future in respect to working hard and winning out, it adds tremendously to their self-confidence and sense of independence. They may work harder because they have faced hardships in life from an early age and learn how to deal with life on its own terms.

Amongst the disadvantages are that children tend to grow up more one sided in their knowledge of family relationships, one may feel stressed out and alone more often than not and everything from social acceptability to financial security may be a greater struggle for your family unit. Being a single parent is twice the work, twice the stress and twice the tears. Hence here are some suggestions to strengthen the bonging with children.

Strengthens the Bonging with Children

- **Make the most of happening moments:** Quality time with the children can happen anywhere and anytime: talking on the way to child to school, talking over dinner instead of watching TV, sharing the feelings and information of school, friends and other between the mother and child.
- **Be interested in the child:** Focus on the children's interests by talking about their favorite things, whether that is about their sport, books, music, or how things work. Encourage the child to talk freely with answering questions is also about listening. Acknowledging the children's feelings, without expressing ones own opinion, will encourage them to talk.
- **One-to-one attention:** When you can, put aside some regular time to spend with each child. It could be smile, laugh and hug the children as often as it can, making lots of eye contact or a special outing to the park with the child.
- **Keep it simple:** Long and tricky explanations can confuse children, and expose them to little more than they need to know so be clear and simple.

95. HUMAN HEALTH 17446

Causes and Prevention of Disabilities

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Disability is the consequence of an impairment that may be physical, cognitive, mental, sensory, emotional, developmental, or some combination of these that result in restrictions on an individual's ability to participate in what is considered "normal" in their everyday society. A disability may be present from birth, or occur during a person's lifetime.

Conditions causing disability are classified by the medical community as:

1. Inherited (genetically transmitted) or Congenital: caused by a mother's infection or other disease during pregnancy, embryonic or fetal developmental irregularities, or by injury during or soon after birth;
2. Acquired, such as conditions caused by illness or injury; of unknown origin.

Prevention of disability: Prevention of disability is two fold

- First attempts to eliminate the causes of disabilities
- Secondly attempts to reduce the severity of those already in existence

Types of Prevention

1. Primary prevention
2. Secondary prevention
3. Tertiary prevention

Primary Prevention

It reduces the incidence of disabilities by preventing risk factors which cause impairment. If primary prevention efforts succeed, they completely eliminate any possibility that disability will occur. It aims at the general population rather than at an identified "high risk" group. Eg. Giving knowledge to the pregnant women regarding danger of smoking, drugs and alcohol

Tips

- Do not drink, smoke or take drugs during pregnancy
- Take folic acid, iron tablets, vitamins and supplements as prescribed by the doctor
- Go for regular antenatal check-up
- Get regular immunization at appropriate time during pregnancy eg. Tetanus toxide
- Avoid self medication
- Maintain proper diet/ nutritional status
- Follow the immunization schedules for your child
- Fit stair gates for young children
- Don't leave your baby unattended on a bed, sofa or changing table, even for a second.
- Do not keep medicines, sharp objects within the child's reach

Secondary Prevention

It targets at existing risk factor and removes or reduces it. When it is successful the disability will not occur. Efforts in the category of secondary prevention are aimed at an identified group of people who either show symptoms of a disabling condition or are considered to be "high risk" for the development of such conditionEg. Screening newborn for Phenylketonuria.

Tips

- Go for prenatal and neonatal screening to identify chromosomal abnormality and metabolic error
- Provide intensive care facilities to the babies who are at high risk of developing mental retardation (birth asphyxia, low birth weight, premature babies, etc.)
- Early stimulation intervention programme
- Use child safety car seats, bicycle helmets, smoke alarms
- Provide suitably modified work or activities to the children according to their ability

Tertiary Prevention

- It is implemented when a pathological/ condition exists.
- It "promotes adjustment to irremediable conditions and minimizes further complications or loss of function"
- When tertiary prevention is successful progression along the continuum from pathology to disability is slowed, halted, or even reversed
- Tertiary prevention is focused on a limited population who have a specific condition

Tips

- Provide Special education programme
- Provide Rehabilitation programme
- Give Vocational training to the differently abled children
- Make correct diagnosis of disability to give right type of intervention or rehabilitation
- Adjust your schedule in the interest of receiving service for your children with disability
- Follow instruction of the professionals about home management
- Collect as much correct information about your child's disability

96. HUMAN HEALTH 17456

Menopause: Myths, Facts and Impacting Factors

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INTRODUCTION: A woman has gone for 12 consecutive months without having a period, she's officially reached menopause. For some women, menopause signifies an end to their childbearing years and the realization that they are getting older. For others, menopause means they no longer have to deal with the discomfort and inconvenience of a monthly period. It brings an end to the worry about unwanted pregnancy, and it's a new age of freedom. Early puberty usually means late menopause, and vice versa. Loss of the childbearing function is not an overnight phenomenon, any more than the development of this function at puberty. It takes several years for the reproductive apparatus to cease its normal functioning, the rate depending on the rate of decline of ovarian functioning. During the period when the endocrine interactional system is becoming adjusted to lessened ovarian functioning, certain physical system normally occur. These are the result of the estrogen deprivation which comes from the decline in the functioning of the ovaries. In addition, other symptoms are due partly to estrogen deprivation but are mainly the result of environmental stress and thus are psychological characteristics of the menopausal syndrome.

Menopausal symptoms divided into somatic, psychological and urogenital symptoms which are commonly associated with menopause Shakila (2014). Most reported menopausal symptoms were joint and muscular pains, physical and mental exhaustion, lack of concentration, sleeping problems, hot flushes and night sweating, irritability, itching in private part, anxiety and depressive mood. For the effective management of menopausal symptoms, the women should aware of these symptoms. The knowledge regarding menopausal symptoms and care and management of these symptoms affected their reproductive life. It has been suggested that not only general characteristics but also living areas should be considered in developing interventions to manage the climacteric symptoms of middle aged women. Perhaps the biggest myth about menopause is that it's the beginning of the end. That may have been true in the sixth century, when the average age of menopause coincided with or often surpassed life expectancy, but today women are living longer and healthier lives than ever before. The average woman can now expect to live about one-third of her adult life after menopause, which typically begins around age 51. And for many women, those years are a time of growth and opportunity. Menopause is the end of your monthly period, but it's not the end of your life — nor is it the miserable experience it's often made out to be. Here's the truth behind some common menopause myths.

Myth: Most Women going through Menopause Experience Depression

FACT: Women are already twice as likely as men to experience depression, and a few studies have suggested a possible link between hormone changes and major depressive episodes. But other research shows no link at all. According to the American College of Obstetricians and Gynecologists, menopause in and of itself does not cause depression. Hormone changes may be responsible for some symptoms, including mood swings, but those are different from true psychological distress.

Myth: All Women Experience Unpleasant Symptoms during Menopause

FACT: Although many women do have symptoms including hot flashes, night sweats, and mood swings, menopause affects every woman differently. For many women, menopausal symptoms are mild, and for some, the only obvious symptom is the absence of a period.

Myth: Most Women need to take Hormone Replacement Therapy after Menopause

FACT: The number of women taking hormone replacement therapy (HRT) rose in the 1960s when it was thought that HRT was a cure-all for menopausal symptoms. By the 1990s the estrogen replacement drug Premarin was the most widely prescribed drug in America. Since then, however, evidence has surfaced that HRT can increase the risk of heart disease, stroke, breast cancer, and blood clots for some women. Today doctors are very cautious about prescribing hormone replacement therapy for women because of its potential side effects. When it is used, the U.S. Food and Drug Administration recommends taking the smallest dose possible for the shortest amount of time. HRT can increase the risk of certain health conditions. If you already have risk factors for these conditions, talk to your doctor about alternatives to relieve menopause symptoms like hot flashes and vaginal dryness.

Myth: Women Gain a Lot of Weight after Menopause

FACT: Many women gain weight between the ages of 35 and 55. Although some studies confirm that middle-aged women gain more weight during perimenopause and menopause, others have shown that even those women who remain pre-menopausal during this age range have a tendency to gain weight. Some studies point to a change in body composition after menopause, including increases in body fat percentages and decreases in lean body mass. If you watch your diet and follow a good exercise routine, you can prevent weight gain during your middle years.

Myth: You can still get Pregnant after Menopause

FACT: During the beginning stages of menopause — when you're still having an occasional period and are technically considered to be in the perimenopause phase — you can get pregnant. Talk to your ob-gyn about the right birth control for you during this time. Once you've reached 12 consecutive months without a menstrual period, you have officially passed through menopause and don't need to worry about getting pregnant anymore.

Myth: Women stop having Sex after Menopause

FACT: Sex can actually be better and more fulfilling after menopause since you no longer have to worry about getting pregnant. Some women also gain a better mental outlook and greater level of self-confidence that comes with maturity. So before you blame it on menopause, ask your doctor if a lack of interest or lessened enjoyment in sex is due to any chronic illnesses or to a medication you may be taking. If vaginal dryness is keeping you from enjoying sex, investigate lubrication aids that can make intimate contact more comfortable.

Perhaps the biggest myth about menopause is that it is a time when you slow down and watch your health start to go downhill. The truth is that women are living healthier, more active lives than ever before and often use this time to further develop their careers, travel, volunteer, and spend more time with loved ones. Women who take good care of their bodies and minds can continue to enjoy life long after menopause.

97. EXTENSION EDUCATION AND RURAL DEVELOPMENT 17392

Integrated Pest Management: A Solution for Doubling Farmers' Income

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Integrated Pest Management at its own is self-sufficient, sustainable intensification for tropical small- holder farmers. Global pesticide use has grown because of rapid enhancement in its demand and flourishing industry over the past 20 years to production of 3.5 billion kg/year, amounting to a global market worth $45 billion. It is estimated that approximately 25 percent of the global crop output is decreased due to attacks by pests, weeds and diseases and in such circumstances agrochemicals have an increasing role to play in enhancing crop productivity. Crop protection chemicals also play a crucial role in India's exports of products which generate of more than 2 Billion Dollar.

Farmers in low income countries like India are excessively dependent on synthetic pesticides to manage crop pests and diseases. Across the world Integrated Pest Management is getting propagated among crop growers as it is 50% cheaper than chemical fertilizer, guarantees higher productivity by 10-15 percent and leaves very less harmful residue. Moreover, shifting to integrated pest management can get at least 10-15 percent higher selling price for farmers if agricultural yields grownup through it is certified as such. The over- use of chemical herbicides and pesticides affect the environment and its residues enter in to food chain. The challenge is to protect the environment, in this purview IPM is a best solution. Increasingly adopted for long-term, sustainable agriculture it achieves adequate, safe and quality food production, improves farmer livelihoods and preserves non-renewable energy. Benefits of IPM could be improved crop profitability due to better pest control measures & appropriate selection of crop protection solutions; it also ensures stable, reliable and good quality crop yields. Fall in intensity and severances of pest infestations leading to reduced potential for problems of pest resistance or resurgence are other potential benefits.

In IPM, several crop management features are planned to avert outbreak of insects, diseases or weeds. Numerous strategies can be combined and augmented for an IPM program. The goal is to check pest populations from crossing the economically damaging levels. Location of crops, selection of crop variety, crop planting and rotation, soil management and water management are such areas to be considered for integrated pest management. In IPM, various tools like pheromone traps, diagnostics and forecasting systems can be helpful to assist with monitoring in a timely and accurate way. IPM often necessitates collaborative decisions within a explicit geography to provide actual control of pest population. Under IPM, reducing economically damaging pests' population to acceptable levels may need cultural, physical, biological and chemical control measures individually or in combination as whole to act synergistically. Costs, benefits, timing, labour force and equipment as well as economic, environmental and social impacts all must be taken into consideration for this sustainable and eco- friendly practice of pest management. Cultural practice such as weed control by tractor cultivation and reduction of incidence of disease by eradicating infected plant debris should be considered for their impact on plant roots and yields. Those strategies for biological control can be lure and kill strategies, mating disruption, and use of predatory mites against spider mites. Biotechnology focus on mass production of micro-organisms that cause disease in insect pests and compete with plant disease-causing organisms. In chemical control reduced drift nozzles and spot spraying, help farmers protect untreated retreats and natural habitats for wildlife as well as pest enemies. The timing of treatment as well as the types of active ingredient products used is also critical factors.

Doubling Farmers Income Committee tables the "growth targets" for doubling farmer's real income while improving the ratio between farm and non-farm income from 60:40 as of now, to 70:30 by 2022, which includes the Improved and optimised input delivery mechanism and overall input efficiency [Integrated Pest Management (IPM), Integrated Nutrient Management (INM), farm extension services etc.]. Digital photography allows for near-instant spectrographic analysis of soil and plant health. In short duration of time, patterns are not visible to the eye, when compared with a large database to diagnose the INM and IPM needs on a farm. This committee calls for a inclusive policy on products sold as 'organics', 'bio stimulants' as these are currently sold without any proper regulatory mechanism. "These are not recommended by any scientific body for usage in pest management; active ingredients in these products are not disclosed, keeping both the user and the experts in dark.

Department of Agriculture, Co-Operation & Farmers Welfare (DAC&FW) emphasizes Integrated Pest Management (IPM) which encourages biological, cultural and mechanical methods of pest control and promotes need based, judicious use of pesticides. DAC&FW started a new scheme "Strengthening and Modernization of Pest Management Approach in India" to endorse Integrated Pest Management (IPM) as an environment friendly and broad ecological approach for controlling pest problems. It incorporates pest control techniques such as cultural, mechanical and biological which aims for minimum dependence on chemical pesticides. A key imperative for government includes crop protection from chemicals to avoid harmful effects on crop by reducing their residual content. Educating farmers to discriminate between certified and false crop protection chemicals available in the market. The four principles of IPM are grow a healthy crop, observe the field weekly, conserve natural enemies, farmers become IPM experts and trainers, above four principle support the low economic cost and thus are an aid to doubling the farmer's income. IPM has positive effect on human assets and social assets and increased social and human assets would also affect the situation of the financial asset for many households in positive aspects. Farmers can choose to adopt modifications to the IPM methods that better come across their needs of resource-poor growers. This would give the chance other institutions working with IPM, to get a constant feedback on the practical outcomes of the technologies.

98. EXTENSION EDUCATION AND RURAL DEVELOPMENT 17480

Information and Communication Technology (ICT) in Agriculture

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INTRODUCTION: Information means data in paper or electronic format.

- Communication is the sharing or transmission of data or information from one device to another.
- Information technology (IT) includes software, hardware and electronics.
- Communication technology includes protocols, software and hardware that are used to process and communicate information.

Therefore, ICT stands for "Information and Communication Technology." which refers to technologies that provide access to information through telecommunications. It includes communication device or application, encompassing: radio, television, cellular phones, computer and network, hardware and software, satellite systems and so on, as well as the various services and applications associated with them, such as videoconferencing and distance learning. ICTs are often spoken of in a particular context, such as ICTs in education, health care, or libraries. (Margaret Rouse 2005).

ICT is the digital processing and utilization of information by the use of electronic computers which comprises of the storage, retrieval, conversion and transmission of information. (Ifueko Omoigui Okauru, 2011).

A branch of engineering dealing with the use of computers and telecommunications equipment to store, retrieve, transmit and manipulate data. (Daintith, John, ed. (2009))

Role of ICT in Agriculture

As we know that India is a country with majority of rural population and agriculture is main occupation practiced in the country which has direct influence on Indian economy. But there are some factors which make farming more difficult for farmers. Such factors are climate change, flood, drought, increased input costs, inefficient supply chains, and lack of education facilities, lack of scientific knowledge. Agriculture is knowledge-intensive sector and hence there is a need to provide right information to farmers so that they can improve their farming practices thereby increasing agricultural productivity.

ICTs have been a significant contributor to growth and socio-economic development in business sectors, countries and regions where they are well adopted and integrated. The large adoption and integration of ICTs have improved service delivery, created new jobs (while making some older ones less relevant), generated new revenue streams and saved money. The rapid growth of mobile phone ownership globally provides new avenues to share and access information. About half of the world's population owns a mobile phone and this figure is much higher when children are not counted.

The rapid growth of broadband (especially mobile broadband) and its increasing affordability provides a great opportunity for e-agriculture. Many ICT interventions have been developed and tested around the world, with varied degrees of success, to help agriculturists improve their livelihoods through increased agricultural productivity and incomes, and reduction in risks. E-agriculture has been one of the main action lines of The World Summit on the Information Society (WSIS) implementation process. IT supports new methods for precision agriculture like computerized farm machinery that applies for fertilizers and pesticides. Farm animals are fed and monitored by electronic sensors and identification systems. Selling or buying online began to become popular in the world. However, it's most important role remains communication, and the Internet has provided us with an ideal opportunity to do so. ICT supports new methods for precision agriculture like computerized farm machinery that applies for fertilizers and pesticides. Farm animals are fed and monitored by electronic sensors and identification systems. Selling or buying online began to become popular in the world. However, it's most important role remains communication, and the Internet has provided us with an ideal opportunity to do so.

Benefits of ICT to farmers ICT has gained a special position in agricultural sector, giving an effective and positive result. Here are some of the benefits of using information and communication technologies in agriculture:

1. **Improved decision making:** By having the required information, farmers can make better and more informed decision concerning their agricultural activities. May it be about whom to get their grains from or perhaps who to sell it to, the communication channels that information technology brings makes production up to distribution easier for the farmers. The exchange of knowledge from various countries and organization also helps farmers be more aware of factors to consider before making their decisions.
2. **Better planning:** Various types of farming software such as software for tracking of crops, predict yields, when to best plant and what to plant, to intercrop or focus on just one product, or determine the current need of the crops—just about everything needed to improve production and income, farmers can better plan for farming, thereby reducing input costs.
3. **Development of new farming methodology:** By adjusting to the modern farming methodologies, farmers can have better control of their crops. Gaining information from their farm is essential in sustaining its success and fuelling further growth.
4. **Community involvement:** There are several programs which are made possible by ICT applications, and community involvement in agriculture can be increased as well. When a community adopts modern methods for agriculture, the production of local goods can be increased.
5. **Agricultural breakthroughs:** IT makes the spread of information concerning the latest agricultural breakthroughs more possible. When scientists develop new and improved grains or find techniques to help winter crops become stronger against the cold, farmers from all over the world may benefit from the same breakthroughs simply by being connected to the rest of the agricultural world. Sharing information to help everyone progress is made much easier through resources made available and accessible by ICT.
6. **Agriculture for everyone:** Farmers have in-depth knowledge when it comes to their trade. However, interested individuals who may be called backyard farmers may also benefit from how modern technology has changed how agriculture is seen. Growing your own sustainable garden of herbs, fruit trees, and other agricultural produce can be possible in a smaller scale. Planting is beneficial in more ways than one, and having your own produce even helps assure the freshness and quality of the food your family eats.

99. EXTENSION EDUCATION AND RURAL DEVELOPMENT 17502

Expert System: A Perspective of Agriculture Development

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INTRODUCTION: Agriculture production involves many parameters and many complicated steps. The overall production management activities are: land preparation, variety selection, pest control, water and fertilizer requirement etc. The identification of crop diseases is also a difficult task. If the crop diseases are identified timely, the control measures can be applied efffictively in conventional extension system there is lack of enough experienced experts to support the farmers in diseases identification and other agricultural production management problems.

Since the early eighties knowledge based expert systems technology has been applied to a variety of agricultural problems. For example, the use of digital technology can produce high quality digital images including photos and clips of healthy and infected plants easily that can play important role in diseases identification. Digital images can be seen and shared easily among the experts. Image can be examined on camera screen literally and they are captured and download to a computer for a closer inspectio0n within a minute. This technology in expert system. This makes the choice of expert system approach for solution of any type of agricultural problem.

Expert System Concept and Defintion

An Expert System is defined as " a computer program designed to model the problem solving ability of a human expert " (Durkin, 1994).

According to prassad and babu (2008) expert system defined as a tool for information generation from knowledge. It is a computer programme designed to stimulate the problem-solving behaviour of an expert in a narrow domain or discipline.

An expert system is a computer application that solves complicated problems that would otherwise require extensive human expertise. To do so, it simulates the human reasoning process by applying specific knowledge and interfaces. Expert systems also use human knowledge to solve problems that normally would require human intelligence. These expert systems represent the expertise knowledge as data or rules within the computer. These rules and data can be called upon when needed to solve problems. Books and manual guides have a tremendous amount of knowledge but a human has to read and interpret the knowledge for it to be used.

Some Important of agricultural And Horticultural Expert Systems In Indian and World

1. Expert Systems Innovations in India

A. Exowhem

1. Developed by Indian Agricultural Statistics Research institute (IASRI)
2. Developed for the wheat growing farmers of India.
3. it provides the complete information about the Wheat Crop Management in the country. It advises wheat varieties on the basis of area, cultural and climatic conditions and other characteristics of farmer's interest.
4. It also suggests the appropriate cultural practices like field preparation, fertilizer application, schedule of irrigation etc. It guides them in protecting the crop from insects/diseases/weeds etc.

B. Rice-Crop-Doctor

1. National institute of agricultural extension management (MANAGE) has developed an expert system to diagnose pest and diseases for rice crop and suggest preventive/curative measures.
2. The rice crop doctor illustrates the use of expert systems specifically in the area of rice production taking into consideration of a few major pest and diseases and some deficiency problems limiting the rice yield.

C. Grape Cultivation

Indian institute of horticultural Research, Bangalore developed an expert system for the grape cultivators

D. Agrex

Centre for informatics research and advancement, Kerala has prepared an expert system is called AGREX to help agricultural field personnel give timely and correct advice to the farmers relating to fertilizer application, crop protection, irrigation scheduling, diagnosis of diseases in paddy and post harvest technology of fruits and vegetables.

2. Expert System Innovations World Wide

A. Soybean Crop

The expert system applied to the problems of diagnosing soybean diseases in illions, USA is one of the earliest expert systems developed in Agriculture (Michalski *et al.*, 1983).

B. Pomme

This expert system developed for apple orchid management (Roach *et al*) it advises growers about specific pest management, when and what spray on apples to avoid infestations.

C. Comax

COMAX is a expert system for cotton. The system is integrated with a computer model, Gosssym that stimulates the growth of the cotton plant (Lemmon, 1986)

D. Cuptex

An expert system for cucumber disorders was designed to identify the cause and severity of observed disorders and then propose the appropriate remedies. Over 45 known cucumber disorders are included in this system's expertise.

E. pommi

In Italy, an expert system for integrated pest management of apple orchards (Gerevini *et al.*)

F. Calex

It is an integrated expert decision support system for agricultural management developed at University of California.

G. Ley Expert System

It is computer controlled, automated, remote, real time weather data acquisition and reporting system in Washington State. Real time weather data are also used in applications such as irrigation scheduling, crop protection and pest management.

Conclusion: The expert systems in agriculture help a lot in increasing the crop production and reducing the yield losses. The successfully developed expert systems should be demonstrated to farmers for the benefit of them. The research institutes take care about the expert systems reach to farmer field level and conduct training on expert systems.

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100. ECONOMICS 17435

Green Marketing: Some Economic Implications

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According to the American Marketing Association, green marketing is the marketing of products that are presumed to be environmentally safe. Thus green marketing incorporates a broad range of activities, including product modification, changes to the production process, packaging changes, as well as modifying advertising. Other similar terms used are Environmental Marketing and Ecological Marketing. In India, around 25% (Mishra and Sharma) of the consumers prefer environmental-friendly products, and around 28% (Mishra and Sharma) may be considered health conscious. Therefore, green marketers have diverse and fairly sizeable segments to cater to.16% penetration in the food and beverage industry and 18% in the clothing and footwear industry. Green marketing helps in effective outcomes like cost-cutting, employee satisfaction, waste minimisation, social welfare for the companies as well for society also. The only thing required is the determination and commitment from all the stakeholders of the companies. It is the right time to adopt the concept of sustainable development in the marketing mix of the companies and integrate them to save the planet from the upcoming risk.

The Four Ps of Green Marketing

Product: That can be reused or reused. Proficient items, which spare water, vitality or fuel, spare cash and lessen the ecological effect. Products with naturally capable bundling. McDonald's, for instance, changed their bundling from polystyrene clamshells to paper. Products with green names, the length of the offer substantiation.

Price: Estimating is a basic component of the promoting blend. Most clients are set up to pay a premium if there is a view of extra item esteem. This quality might be enhanced execution, capacity, outline, visual bid or taste. Natural advantages are normally a special reward, however, will frequently be the integral element between results of equivalent worth and quality.

Place: The decision of where and when to make an item accessible significantly affects the clients being pulled in. Not very many clients make a special effort to purchase green items simply for it. Advertisers looking to effectively present new green items ought to, as a rule, position them extensively in the commercial centre so they are not simply engaging a little green speciality market.

Promotion: Elevating items and administrations to target markets incorporates paid publicizing, advertising, deals advancements, direct showcasing and on location advancements. Keen green advertisers will have the capacity to fortify natural believability by utilizing reasonable showcasing and specialized apparatuses and practices.

Green Products in India

Wipro Infotech (Green It) was India's first organization to dispatch environment benevolent PC peripherals. Samsung was the first to dispatch eco benevolent versatile handsets (made of renewable materials) – W510 and F268-in India. Oil and Natural Gas Corporation Ltd. (ONGC), India's biggest oil organization, has presented vitality proficient Mokshada Green Crematorium, which spares 60% to 70% of wood and a fourth of the blazing time per incineration. Reva, India's own special Bangalore based organization was the first on the planet to financially discharge an electric auto. Honda India presented its Civic Hybrid auto. ITC has presented Paper Kraft, a premium scope of the ecoaccommodating business paper. Indusland Bank introduced the nation's first sun based fueled ATM and in this manner realized an eco-savvy change in the Indian saving money segment. Suzlon Energy produces and markets wind turbines, which give an option wellspring of vitality in light of wind force. This green activity taken by the organization is critical for decreasing the carbon impression

Ways to Go Green

1. Unplug when not being used.
2. Use less water, each drop tallies.
3. Switch to conservative glaring lights.
4. Choose items with less bundling.
5. Buy natural and neighbourhood sustenance.
6. Drive less that spares fuel.
7. Walk more.
8. Recycle more.
9. Switch to green force, use non-ordinary vitality like sun based force and so on.
10. Spread the world about green, live green, stay green.

Green Marketing-Challenges

In spite of the fact that an extensive number of firms are honing green promoting, it is not a simple employment as there are various issues which should be tended to while executing Green showcasing. The real difficulties which Green showcasing must be confronted are:

1. **New Concept**: The new green developments need to achieve the masses and that will take a great deal of time and exertion.
2. **Cost Factor:** Green showcasing includes advertising of green items/administrations, green innovation, green influence/vitality for which a ton of cash must be spent on R&D programs for their advancement and resulting special projects which at last may prompt expanded expenses.
3. **Sustainability:** Initially the benefits are low since renewable and recyclable items and green advances are more costly. Green showcasing will be fruitful just in long run.
4. **Non-Cooperation:** The organizations honing Green showcasing need to endeavour hard in persuading the partners and numerous times it might neglect to persuade them about the long haul advantages of Green advertising when contrasted with fleeting costs.

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101. ECONOMICS 17469

GST: One Nation, One Tax, One Market

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Goods and Services Tax (GST) is an indirect tax introduced in India on 1st July 2017 governed by a GST Council and its Chairman is the Finance Minister of India. It is introduced by the replacement of multiple cascading taxes levied by the central and state governments and made tax structure simple, hassle free and export oriented. Presently, there are around 160 countries that have implemented GST in some form or other. GST is comprised of 3 components like CGST, SGST and IGST. The rates for CGST and SGST, which are applicable to all the intra-sate transaction of goods and services except the exempted goods and services, would be determined by taking into account the revenue consideration. A PAN linked tax payer identification number is allocated with total 13-15 digits. Input tax credit would be available for discharging the tax liabilities on all the transactions. Interstate transaction of goods and services would be subjected to IGST. Rates of CGST, IGST and SGST are expected to be equal to revenue neutral rate (RNR). It is a destination based consumption taxation emphasized on supply of goods and services. Import of goods is subjected to IGST in addition to applicable custom duties and that of services on reverse charge basis. CGST, IGST, SGST/UTGST is levied at the rates mutually agreed upon by the centre and the states under the aegis of GST council. There are 4 tax slabs -5, 12, 18 and 28% for all goods and services. Precious metals would be subjected to tax @ 3% where as rough precious stones attract tax @ 0.25%. It covers entire gamut of goods and services except alcohol for human consumption. Besides 5 petroleum products (crude, petrol, diesel, ATF and natural gas) are out of GST. A common threshold exemption of Rs, 20 lakhs for both CGST and SGST/UTGST has been provided for and 10 lakhs for north-eastern states. Besides an option to pay tax under composition scheme is available to small taxpayers having an annual turnover of 75 lakhs. The exports and supplies to SEZ are zero-rated. GST will definitely boost the economic growth. Due to this overall tax burden will be less on the consumers as far as agricultural sector is concerned. Initially it will have an inflationary pressure on processed food articles. It may hurt the farming community as they will have to pay higher tax on the inputs which in turn would reduce their income. But it has created encouragement between international and domestic trade. As it is a destination based tax, inter-state trade of goods and services needs a robust settlement mechanism amongst the centre and the states which can be possible only when there is a strong IT infrastructure and service backbone that enables capture processing and exchange of information among different stakeholders including tax payers, state and central governments, accounting officers, banks and RBI. Implementation of GST would improve the GDP of the country by providing the government revenue and continuously ensure the liquidity of the treasury.

GST in Global Scenario

Presently, there are around 160 countries that have implemented GST/VAT in some form or the other. 7 Asean Countries, 19 Asian Countries, 53 European Countries, 70 Ceania, 44 African Countries, 11 South American Countries, 19 Caribbean, Central and North American Countries have implemented it. In some countries VAT is the substitute for GST but conceptually it is a destination based tax levied on the consumption of goods and commodities. France was the first country to introduce GST. Only Canada has a dual GST model. Rates of GST ranges between 15-20% generally.

Features of Goods and Services Tax

The components OF GST are CGST, SGST and IGST. The rates for CGST and SGST would be determined by taking into account the revenue consideration. CGST and SGST would be applicable to all the intra-sate transaction of goods and services except the exempted goods and services. Payment of CGST and SGST would be separate. Allocation of PAN linked tax payer identification no. with total of 13-15 digits. Input tax credit would be available for discharging the tax liabilities on all the transactions. Interstate transaction of goods and services would be subjected to IGST. The rates of CGST, IGST and SGST are expected to be equal to revenue neutral rate (RNR). Here compensation is given to states. Emphasis is given on supply of goods and services. It is majorly based on destination based consumption taxation. Import of goods is subjected to IGST in addition to applicable custom duties. Import of services is subjected to IGST on reverse charge basis. CGST, IGST, SGST/UTGST is levied at the rates mutually agreed upon by the centre and the states under the aegis of GST council. There are 4 tax slabs -5, 12, 18 and 28% for all goods and services. Precious metals would be subjected to tax @3% where as rough precious stones attract tax @0.25%. It covers entire gamut of goods and services except alcohol for human consumption. Besides 5 petroleum products (crude, petrol, diesel, ATF and natural gas) are out of GST. A common threshold exemption of Rs, 20 lakhs for both CGST and SGST/UTGST has been provided for and 10 lakhs for north-eastern states. Besides an option to pay tax under composition scheme is available to small taxpayers having an annual turn over of 75 lakhs. Exports and supplies to SEZ are zero-rated. System of self-assessment of taxes payable by the registered person has been provided for.

Benefits of GST

Cascading effect has been removed. The trade and industry will benefit because of –uniform single indirect tax throughout the country seamless flow of input tax credit. Tax related barriers at inter-state borders have been removed. Logistics costs are removed. End-end IT system has been enabled. Minimal interface with tax authorities. Manufacturers can take more rational decisions. The exports will become more competitive. The central and state government will witness tax buoyancy and tax collection costs will reduce significantly. It is previously tax arbitrage but now this will be removed because of SMART governance- S-smart, M-moral, A-accountable, R-responsive, T-Transparent (GST REGIME).

GSTN-Goods and Services Network

GSTN is a special purpose vehicle as non-government, not- for profit company incorporated under section 25 of the companies act, 1956 where centre and the state holds 49% and the remaining 51% shares are held by private financial institutions in the following ratio- HDFC -10%, HDFC home loan major -10%, LIC housing finance -11%, ICICI bank -10% and NSE strategic corporation owns 10%. This company will provide IT support to all stakeholders for smooth implementation of new taxation regime across the country. GSTN will mobilise working capital by levying a user fee on state govt. for its services. GST envisages credit of ITC of 80 lakhs taxpayers to be processed within 10 days after filing of monthly returns which is expected to contain 2.6 to 3 billion business to business invoice data. The IT backbone of GST has come up in the form of GST portal and IT platform. GST portal is a common interface for all tax payers from any part of the country. To develop the application software GSTN has partnered Infosys at its Managed service provider for next 5 years.

GST Council

As per Article 279A of the constitution, GST Council is the joint forum of centre and states. It includes Union Finance Minister as the Chairperson. The Vice-chairperson is choosen from the ministers of the state. Union minister of the state is in-charge of Revenue of Finance (member). The Minister in charge of taxation or finance or any other minister nominated by each state government. The quorum consists of 50% of the total members. States are given 2/3 rd weightage and that of centre 1/3rd weightage. Decision is taken by 75% majority. There is a council to make recommendations on everything related to GST.

Summary and Conclusion: GST will boost the economic growth. Overall tax burden will be less on the consumers as far as agricultural sector is concerned. Initially it will have a inflationary pressure on processed food articles. It may hurt the farming community as they will have to pay higher tax on the inputs which in turn would reduce their income. But it has encouraged International and domestic trade. GST being a destination based tax, inter-state trade of goods and services needs a robust settlement mechanism amongst the centre and the states. This can be possible only when there is a strong IT infrastructure and service backbone which enables capture processing and exchange of information among different stakeholders including tax payers, state and central governments, accounting officers, banks and RBI.

102. ECONOMICS 17486

Problems of Agricultural Marketing in India

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CONCEPT: Agricultural marketing system is an efficient way by which the farmers can dispose their surplus produce at a fair and reasonable price. Improvement in the condition of farmers and their agriculture depends to a large extent on the elaborate arrangements of agricultural marketing.

The term agricultural marketing include all those activities which are mostly related to the procurement, grading, storing, transporting and selling of the agricultural produce. Thus Prof. Faruque has rightly observed: “Agricultural marketing comprises all operations involved in the movement of farm produce from the producer to the ultimate consumer. Thus, agricultural marketing includes the operations like collecting, grading, processing, preserving, transportation and financing.”

Defects/Problems of Agricultural Marketing in India

1. **Lack of Storage Facility:** There is no proper storage or warehousing facilities for farmers in the villages where they can store their agriculture produce. Every year 15 to 30 per cent of the agricultural produce are damaged either by rats or rains due to the absence of proper storage facilities. Thus, the farmers are forced to sell their surplus produce just after harvests at a very low and un-remunerative price.
2. **Distress Sale:** Most of the Indian farmers are very poor and thus have no capacity to wait for better price of his produce in the absence of proper credit facilities. Farmers often have to go for even distress sale of their output to the village moneylenders-cum-traders at a very poor price.
3. **Lack of Transportation:** In the absence of proper road transportation facilities in the rural areas, Indian farmers cannot reach nearby mandis to sell their produce at a fair price. Thus, they prefer to sell their produce at the village markets itself.
4. **Unfavorable Mandis:** The conditions of the mandis are also not at all favorable to the farmers. In the mandis, the farmers have to wait for disposing their produce for which there is no storage facilities. Thus, the farmers will have to lake help of the middleman or dalal who lake away a major share of the profit, and finalizes the deal either in his favour or in favour of arhatiya or wholesalers.
5. **Intermediaries:** A large number of intermediaries exist between the cultivator and the consumer. All these middlemen and dalals claim a good amount of margin and thus reduce the returns of the cultivators.
6. **Unregulated Market’s:** There are huge number of unregulated markets which adopt various malpractices. Prevalence of false weights and measures and lack of grading and standardization of products in village markets in India are always going against the interest of ignorant, small and poor farmers.
7. **Lack of Market Intelligence:** There is absence of market intelligence or information system in India. Indian farmers are not aware of the ruling prices of their produce prevailing in big markets. Thus, they have to accept any un-remunerative price for their produce as offered by traders or middlemen.
8. **Lack of Organization:** There is lack of collective organization on the part of Indian farmers. A very small amount of marketable surplus is being brought to the markets by a huge number of small farmers leading to a high transportation cost. Accordingly, the Royal Commission on Agriculture has rightly observed,

"So long as the farmer does not learn the system of marketing himself or in cooperation with others, he can never bargain better with the buyers of his produce who are very shrewd and well informed."

9. **Lack of Grading:** Indian farmers do not give importance to grading of their produce. They hesitate to separate the qualitatively good crops from bad crops. Therefore, they fail to fetch a good price of their quality product.
10. **Lack of Institutional Finance:** In the absence of adequate institutional finance, Indian farmers have to come under the clutches of traders and moneylenders for taking loan. After harvest they have to sell their produce to those moneylenders at unfavorable terms.
11. **Unfavorable Conditions:** Farmers are marketing their product under advice circumstances. A huge number of small and marginal farmers are forced by the rich farmers, traders and moneylenders to fall into their trap to go for distress sale of their produce by involving them into a vicious circle of indebtedness. All these worsen the income distribution pattern of the village economy of the country.

Remedial Measures for Improvement of Agricultural Marketing

The following are some of the measures to be followed for improving the existing system of agricultural marketing in the country:

- Establishment of regulated markets.
- Establishment of co-operative marketing societies.
- Extension and construction of additional storage and warehousing facilities for agricultural produce of the farmers.
- Expansion of market yards and other allied facilities for the new and existing markets.
- Provision is made for extending adequate amount of credit facilities to the farmers.
- Timely supply of marketing information's to the farmers.
- Improvement and extension of road and transportation facilities for connecting the villages with mandis.
- Provision for standardization and grading of the produce for ensuring good quality to the consumers and better prices for the farmers.
- Formulating suitable agricultural price policy by the Government for making a provision for remunerative prices of agricultural produce of the country.

103. ECONOMICS 17589

Doubling Farmers Income by Pradhan Mantri Annadata Aay SanraksHan Abhiyan

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Realizing the vision of doubling farmers' income by 2022 government initiated many steps to achieve farmers' income double. The emphasis is on enhancing productivity, reducing cost of cultivation and strengthening post-harvesting management, including market structure. Several market reforms have been initiated. These include Model Agricultural Produce and Livestock Marketing Act, 2017 and Model Contract Farming and Services Act, 2018. Efforts are on for new market architecture, so as to ensure that farmers get remunerative prices on their produce. These include setting up of Gramin Agricultural Markets (GrAMs) so as to promote 22,000 numbers of retail markets in close proximity of farm gate and competitive and transparent wholesale trade at APMC through e-NAM and a robust and pro-farmer export policy. Besides, several other pro-farmers' initiatives such as implementation of Pradhan Mantri Fasal Bima Yojana (PMFBY), Pradhan Mantri Krishi Sinchai Yojana (PMKSY), Paramparagat Krishi Vikas Yojana (PKVY) and distribution of Soil Health Cards have been undertaken. The commitment for farmer welfare is also reflected by unprecedented decision of announcing minimum support price based on the formula of 1.5 times the cost of cultivation.

Government recently announced Umbrella scheme to ensure remunerative princess to farmers it comprised of all three components which are;

1. Price Support Scheme (PSS),
2. Price Deficiency Payment Scheme (PDPS)
3. Pilot of Private Procurement & Stockist Scheme (PPPS).

Price Support Scheme (PSS)

Under the scheme, the physical procurement of pulses, oilseeds, and copra (kernel of coconut) will be done by Central Nodal Agencies with the proactive role of the state governments. Further, in addition to NAFED, the Food Cooperation of India (FCI) will take up PSS operations in states and districts. The procurement expenditure and losses due to procurement will be borne by the Union Government as per norms.

Price Deficiency Payment Scheme (PDPS) or Bhavantar Bhugtan Yojana

PDPS is proposed to cover all oilseeds for which minimum support price (MSP) is notified. In this, direct payment of the difference between the MSP and the selling/modal price will be made to pre-registered farmers selling their produce in the notified market yard through a transparent auction process. All payments will be done directly into the registered bank account of the farmer. The support to the farmers for PDPS will be given as per norms.

Pilot of Private Procurement and Stockiest Scheme (PPPS)

The cabinet also decided that the participation of private sector in procurement operation needs to be piloted on the basis of the learnings the ambit of private participation in procurement operations. Therefore, it was decided that for oilseeds, the states will have an option to roll out Private Procurement Stockist Scheme (PPSS) on pilot basis in selected districts and Agricultural Produce Market Committee's (APMC) of district involving the participation of private stockiest.

The pilot district and selected APMC(s) will cover one or more crop of oilseeds for which MSP is notified.

The Centre's age-old procurement and MSP system needs a relook because of its many shortcomings in those practices. Research by NITI Aayog and other research outfits has shown that the reach of the current MSP procurement system is very poor both in terms of geography and the crops covered. Despite thousands of crores of public money being spent in MSP operations every year, the farm crisis continues. If implemented well, the new system may help revive the rural economy by assuring better income to farmers. Unlike the current system where farmers repeatedly go for the few crops, such as paddy, wheat and sugarcane, where MSP is effective, the new scheme may ensure crop diversification and reduce the stress on soil and water. If this umbrella scheme implemented effectively yields better results to the farmers by securing remunerative price, avoid hold private traders' in oil seeds and avoid malpractices price deficiency payment scheme (PDPS) by transparent marketing practices. This Pradhan Mantri Annadata Aay SanraksHan Abhiyan (PM-AASHA) scheme will results better if it implements and monitor properly by government by this way helpful in doubling farmers income and asure providing remunerative price.

104. STATISTICS AND BIOMETRY 17706

Transformation of Data: An Important Tool for Statistical Analysis

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INTRODUCTION: Many biological variables do not meet the assumptions of parametric statistical tests: they are not normally distributed, the standard deviations are not homogeneous, or both. Using a parametric statistical test (such as an ANOVA or linear regression) on such data may give a misleading result. In some cases, transforming the data will make it fit the assumptions better. To transform data, perform a mathematical operation on each observation, then use these transformed numbers in statistical test.

Choosing the right transformation: Data transformations are an important tool for the proper statistical analysis of biological data. There are an infinite number of transformations you could use, but it is better to use a transformation that other researchers commonly use in your field, such as the square-root transformation for count data or the log transformation for size data.

The interpretation of data based on analysis of variance is valid only when the following assumptions are satisfied:

1. **Additive Effects:** Treatment effects and blocks (environmental) effects are additive.
2. **Independence of errors:** Experimental errors are independent.
3. **Homogeneity of Variances:** Observations have common variance.
4. **Normal Distribution:** Character under study follows a normal distribution.

Also the statistical tests t, F, z, etc. is valid under the assumption of independence of errors and normality of character under study.

The departures from these assumptions make the interpretation based on these statistical techniques invalid. Therefore, it is necessary to detect the deviations and apply the appropriate remedial measures.

The above detection can also be done with the help of a scatter diagram of mean and variances (or range).

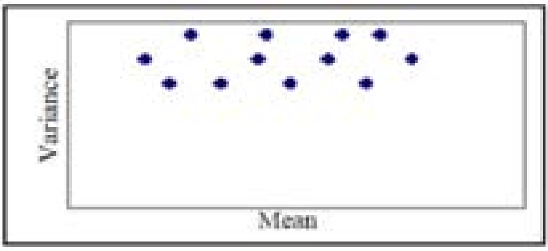

Fig. 1: Homogeneous variance

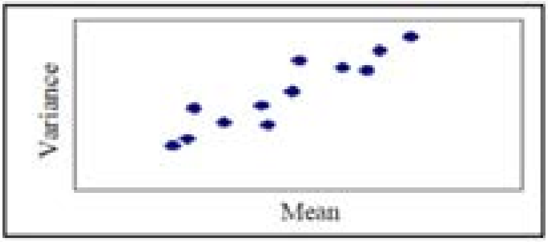

Fig. 2: Heterogeneous variance where variance is proportional to mean

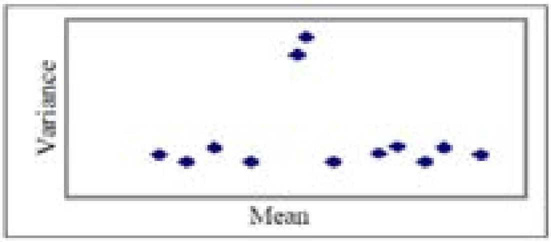

Fig. 3: Heterogeneous variance without any functional relationship between variance and mean

- The first of variance heterogeneity is usually associated with the data whose distribution is non-normal *viz.*, negative binomial, poisson, binomial, etc. Data transformation is the most appropriate remedial measure, in such situations. With this technique, the original data are converted to a new scale resulting into a new data set that is expected to satisfy the homogeneity of variances. Because a common transformation scale is applied to all observations, the comparative values between treatments are not altered and comparison between them remains valid.
- The second kind of variance heterogeneity usually occurs in experiments, where, due to the nature of treatments tested some treatments have errors that are substantially higher (lower) than others.

Here, we shall concentrate on those situations where character under study is non-normal and variances are heterogeneous and some function of means. Depending upon the functional relationship between variances and means, suitable transformation is adopted. The transformed variate should satisfy the following:

1. The variances of the transformed variate should be unaffected by changes in the means. This is also called the variance stabilizing transformation.
2. It should be normally distributed.
3. It should be one for which real effects are linear and additive.
4. The transformed scale should be done for which an arithmetic average from the sample is an efficient estimate of true mean.

The following are the three transformations, which are being used most commonly, in biological research:

a. Logarithmic Transformation:

This transformation is suitable for the data where the variance is proportional to square of the mean or the coefficient of variation is constant or where effects are multiplicative. These conditions are generally found in the data that are whole numbers and cover a wide range of values. This is usually the case when analyzing growth measurements such as trunk girth, length of extension growth, weight of tree or number of insects per plot, number of egg-mass per plant or per unit area etc.

For such situations, it is appropriate to analyze *logX* instead of actual data, *X*. When data set involves small values or zeros, *log(X+1)*, *log(2X+1)* or *log(X+3/8)* should be used instead of *logX*.

This transformation would make errors normal, when observations follow negative binomial distribution like in the case of insect counts.

b. Square-Root Transformation:

This transformation is appropriate for the data sets where the variance is proportional to the mean. Here, the data consists of small whole numbers, for example, data obtained in counting rare events, such as the number of infested plants in a plot, the number of insects caught in traps, number of weeds per plot, parthenocarpy in some varieties of mango etc. This data set generally follows the Poisson distribution and square root transformation approximates Poisson to normal distribution.

For these situations, it is better to analyze *X* than that of *X*, the actual data. If X is confirmed to small whole number then, $\sqrt{X+\frac{1}{2}}\sqrt{X+\frac{1}{2}}$ or $\sqrt{X+\frac{3}{8}}$ $\sqrt{X+\frac{3}{8}}$ should be used instead of $\sqrt{X}$-$\sqrt{X}$.

This transformation is also appropriate for the percentage data, where, the range is between 0 to 30% or between 70 to 100%.

c. Arc Sine Transformation:

This transformation is appropriate for the data on proportions, *i.e.*, data obtained from a count and the data expressed as decimal fractions and percentages. The distribution of percentages is binomial and this transformation makes the distribution normal. Since the role of this transformation is not properly understood, there is a tendency to transform any percentage using arc sine transformation. But only that percentage data that are derived from count data, such as % barren tillers (which is derived from the ratio of the number of non-bearing tillers to the total number of tillers) should be transformed and not the percentage data such as % protein or % carbohydrates, %N, etc. which are not derived from count data. The value of 0% should be substituted by $\left(\frac{1}{4n}\right)\left(\frac{1}{4n}\right)$ and the value of 100% by $\left(100-\frac{1}{4n}\right)$ $\left(100-\frac{1}{4n}\right)$, where n is the number of units upon which the percentage data is based.

It is interesting to note here that not all percentage data need to be transformed and even if they do, arc sine transformation is not the only transformation possible. The following rules may be useful in choosing the proper transformation scale for percentage data derived from count data.

- **Rule 1:** The percentage data lying within the range 30 to 70% is homogeneous and no transformation is needed.
- **Rule 2:** For percentage data lying within the range of either 0 to 30% or 70 to 100%, but not both, the square root transformation should be used.
- **Rule 3:** For percentage that does not follow the ranges specified in Rule 1 or Rule 2, the Arc Sine transformation should be used.

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105. STATISTICS AND BIOMETRY 17707

Time Series Analysis and its Applications

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INTRODUCTION: Time series (TS) data may be considered as a sequence of measurements of some variables, taken periodically through time. There are different types of time series data which depends on the collection of the data. For example univariate time series data, multivariate time series data, discrete time series data, continuous time series data *etc.*

A basic assumption in any time series analysis or modeling is that some aspects of the past pattern will continue to remain in the future. In agriculture time series analysis is mostly used for forecasting purposes because historical sequences of observations upon study variables are readily available from published secondary sources.

Examples:

- In Agriculture, area, production and productivity of agricultural crops for the past years
- In Meteorology, forecasting of weather parameters
- In Economics, daily closing stock prices, weekly interest rates, monthly price indices and yearly earnings
- In Social Sciences, annual birth rates, mortality rates, accident rates and various crime rates

Objectives of Time Series Analysis

- It helps in predicting the future behavior like demand, production, prices, weather condition *etc.*
- To describe past behavior of time data
- To analysis the pattern of behavior of time series data
- To understand the variability of the time series data
- To exhibit and measure the changes which occur in the series during a period of time

Requirements for proper Analysis of Time Series Data

- Long period data
- As far as possible value should have equal interval
- Definite time period
- Homogeneous

Components of Time Series

1. **Trend component:** The trend component is the tendency of the data to increase or decrease during a long period of time.
2. **Seasonal component:** Short term fluctuation observed in a time series data, particularly in specified period usually within a year. The important factors causing seasonal variations are: climate and weather conditions, customs, traditional habits, *etc.*
3. **Cyclical component:** Any regular pattern of sequences of values above and below the trend line lasting more than one year can be attributed to the cyclical component. Most of the economic and financial time series show some kind of cyclical variation.
4. **Irregular component:** Irregular fluctuations (random or residual) are the movements or fluctuations which cannot be traced to the steady influence of trend. An irregular component is

caused by short-term, unanticipated and non-recurring factors that affect the values of the time series. Beyond the human control and it's unpredictable.

Methods for Estimation of Components of Time Series

- Least Square Method
- Semi Average Method
- Moving Average Methods
- Exponential Smoothing Methods

Assumption for Regression Model

- Randomness of error
- Zero mean of error
- Homoscedasticity
- Normality
- Non- Autocorrelation
- No perfect Multicollinearity

There are different models for analysis or forecasting of time series data. These models are applied in agriculture for the forecasting of the agricultural products.

- ARIMA (Box-Jenkins)
- SARIMA Model
- ARCH (Engle)/GARCH (Bollerslev)
- Goodness for fit of the model
- Co-efficient of determination (R^2)
- Root Mean Square Error (RMSE)
- Mean Absolute Error (MAE)
- Mean Absolute Percentage Error (MAPE)
- Akaike Information Criterion (AIC)
- Schward Information Criterion (SIC)

Note: Low values of RMSE, MAE, AIC and SIC are preferred for a good model.

Conclusion: No single form of model is considered as universally superior. The triple exponential smoothing is used when the data exhibits both trend and seasonality. ARIMA model gives reasonable and acceptable forecasts. But, it did not perform very well when there exist volatility in the data series. ARCH-GARCH model should be used when there is heteroscedasticity in time series data. Price forecasting model is better to update every day or every week or every month for higher accuracy.

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106. POULTRY SCIENCE 17558

Marek's Disease in Poultry

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Chickens are the most important natural host for Marek's disease virus, a highly cell-associated but readily transmitted alphaherpesvirus with lymphotropic properties of gammaherpesviruses. Marek's disease is one of the most ubiquitous avian infections; it is identified in chicken flocks worldwide. Every flock, except for those maintained under strict pathogen-free conditions, is presumed to be infected. Although clinical disease is not always apparent in infected flocks, a subclinical decrease in growth rate and egg production may be economically important.

The disease has various manifestations:

a) **Neurological:** Acute infiltration of the CNS and nerves resulting in 'floppy broiler syndrome' and transient paralysis, as well as more long-standing paralysis of legs or wings and eye lesions;

b) **Visceral:** Tumours in heart, ovary, tests, muscles, lungs;

c) **Cutaneous:** Tumours of feather follicles.

Morbidity is 10-50% and mortality up to 100%. Mortality in an affected flock typically continues at a moderate or high rate for quite a few weeks. In 'late' Marek's the mortality can extend to 40 weeks of age. Affected birds are more susceptible to other diseases, both parasitic and bacterial.

Etiology

Three serotypes of Marek's disease virus. Gallid herpesvirus 2 (MDV-1) represents all virulent Marek's disease virus strains and is further divided into pathotypes, designated as mild (m), virulent (v), very virulent (vv), and very virulent plus (vv+).

Transmission

- The disease is highly contagious and readily transmitted among chickens.
- The virus matures into a fully infective, enveloped form in the epithelium of the feather follicle, from which it is released into the environment. It may survive for months in poultry house litter or dust. Dust or dander from infected chickens is particularly effective in transmission.
- Once the virus is introduced into a chicken flock, regardless of vaccination status, infection spreads quickly from bird to bird.
- Infected chickens continue to be carriers for long periods and act as sources of infectious virus. Shedding of infectious virus can be reduced, but not prevented, by prior vaccination.

Clinical Findings

- Paralysis of legs, wings and neck.
- Loss of weight.
- Grey iris or irregular pupil.
- Vision impairment.
- Skin around feather follicles raised and roughened

Marek's disease, leg paresis, chicken

Diagnosis

- For the diagnosis of Marek's disease, diagnosis is based on enlarged nerves and lymphoid tumors in various viscera. The absence of bursal tumors helps distinguish this disease from lymphoid leukosis the presence of bursal tumors does not exclude Marek's disease.
- Marek's disease can develop in chickens as young as 3 wk old.

Vaccination

- Mareks disease vaccine inject 0.2ml subcutaneously in the back of the neck of day old chick.

Control

- Attempt should be made to rear the chick in strictly isolated manner.
- Farm should be disinfected with formalin and house should be kept vacant for about a month following outbreak.
- Insecticide should be used to prevent insect load in the farm since virus may be transmmited through insect and insect may act as reservoirs.
- Vaccination is the central strategy for the prevention and control of Marek's disease.
- Vaccination is given to the day old chicks.

Latest Information: In 2018, Aviagen published their comprehensive brief "Marek's disease control in broilers birds" on The Poultry Site. It includes details of transmission, diagnosis, vaccinations, vaccine administration and causes of the disease.

107. VETERINARY MEDICINE 17505

Application of DCAD Theory to Reduce Periparturient Hypocalcemia

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INTRODUCTION: In theory, all the cations and anions in a diet are capable of exerting an influence on the electrical charge of the blood. The major cations present in feeds and the charge they carry are Sodium (Na), Potassium (K), Calcium (Ca) and magnesium (Mg). The major anions and their charges found in feeds are Chloride (Cl) and Sulphate (SO_4), and PO_4. Cations or anions present in the diet will only alter the electrical charge of the blood if they are absorbed into the blood. Trace elements present in diets are absorbed in such small amounts that they are of negligible consequence to the acid-base status. Organic acids such as the volatile fatty acids are generally absorbed in the undissociated, neutral form so they carry no net charge into the blood. They are also rapidly metabolized within the liver, so when they do dissociate they have only a small effect on blood pH under most circumstances. An exception is during rumen lactic acidosis, whereby the lactate anion builds up to unusually high levels in the blood.

Desired Mineral Profile of Prepartum Diet

The difference between the number of cation and anion particles absorbed from the diet determines the pH of the blood. The cation-anion difference of a diet is commonly described in terms of milliequivalent per kilogram (some researchers prefer to use mEq/100-g diet) of just Na, K, Cl, and SO_4 (traditionally calculated on the basis of S% reported when diet is analyzed by wet chemistry) as follows:

$$\text{DCAD} = (\text{mEq } Na^{+} + \text{mEq } K^{+}) - (\text{mEq } Cl^{-} + \text{mEq } SO_4^{2}).$$

This equation is useful, although it must be kept in mind that Ca, Mg, and PO_4 absorbed from the diet will also influence blood pH. Evaluation of the relative acidifying activity of dietary Cl versus SO_4 demonstrates that SO_4 is only about 60% as acidifying as Cl. The DCAD of a diet and its acidifying activity is more accurately described by the following equation: $(Na+K)-(Cl+0.6S^{2-})$. A more complex DCAD equation would include Ca, Mg, and P. It should probably also include ammonium, as this cation seems to also contribute to the cation content of the blood.

Unfortunately, experimental data are lacking that would allow assignment of a coefficient of absorption to each of these dietary ions when fed to the dry cow. Although DCAD equations provide a theoretical basis for dietary manipulation of the acid-base status, they are not necessary for formulation of mineral content of prepartum dairy cow rations because (with the exception of K and Cl) the rate of inclusion of the other macrominerals can be set at fixed rates.

Monitoring Urine pH

Urine pH of the cow provides a cheap and fairly accurate assessment of blood pH and can be a good gauge of the appropriate level of anion supplementation. Urine pH on high-cation diets is generally more than 8.2. Limiting dietary cations will reduce urine pH only a small amount (down to 7.5–7.8). For optimal control of subclinical hypocalcemia, the average pH of the urine of Holstein cows should be between 6.2 and 6.8 during the last week of gestation, which essentially requires the addition of anions to the ration. In Jersey cows, the average urine pH of the close-up cows has to be reduced to between 5.8 and 6.3 for effective control of hypocalcemia.

Urine pH should be checked 72 or more hours after a ration change. Urine samples should be free of feces and made on midstream collections to avoid alkalinity contributed by vaginal secretions. The best estimate of acid-base status seems to be from samples obtained 6 to 9 hours after fresh feed is offered. The timing of urine collection is less critical than adopting the habit of regularly checking urine pH of cows in the last week of gestation. Anion-supplemented diets are generally fed for the last 3 to 4 weeks before calving. If anions are fed the entire dry period, be aware that after 3 weeks on anion diets, urine pH will begin to move toward neutral as the bone buffers the acidity.

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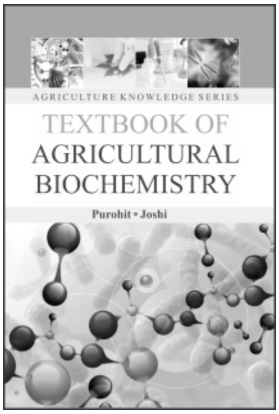

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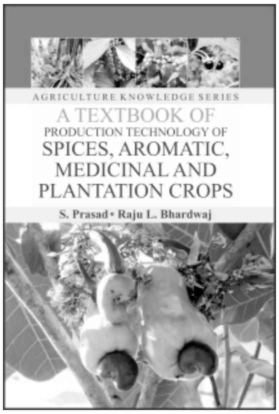

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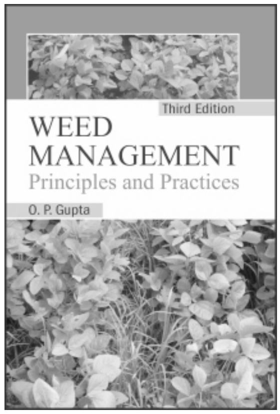

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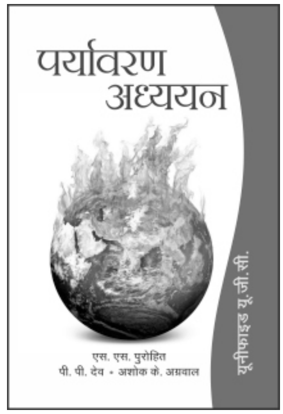

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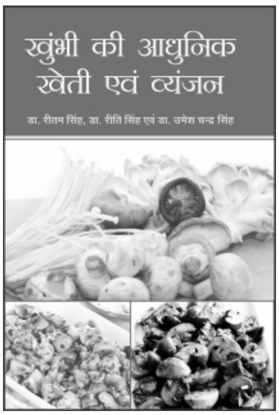

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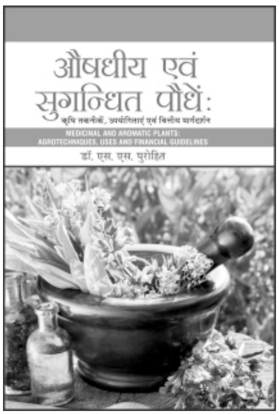

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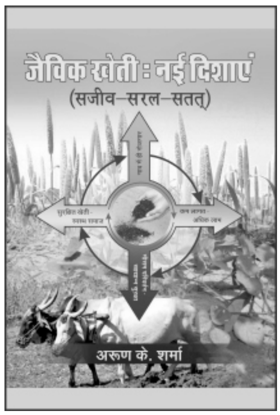

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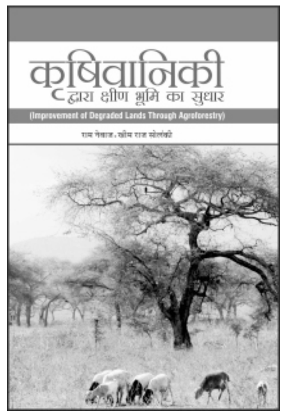

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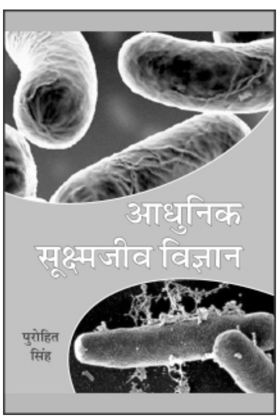

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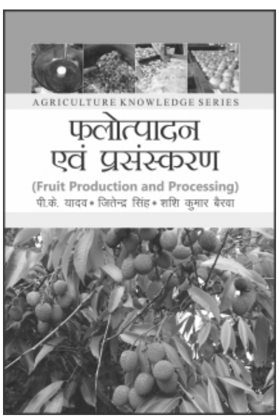

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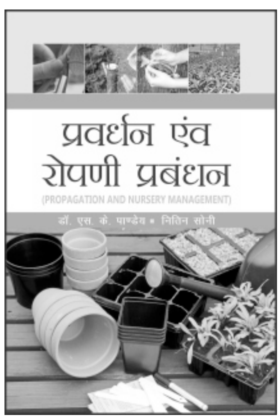

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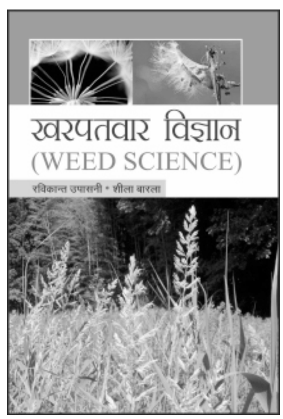

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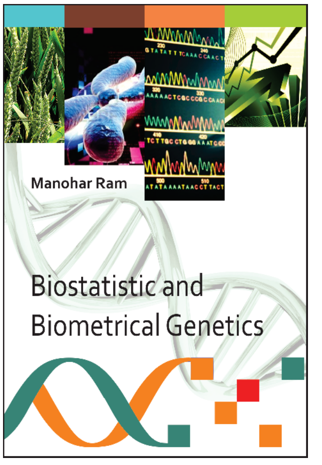
NEW RELEASE 2017

Biostatistic and Biometrical Genetics

Manohar Ram



ABOUT THE BOOK

The book is prepared to serve as a text book for senior undergraduate and post graduate students. The book is written in simple language and even complex terms have been reduced for easy understanding. Biostatistic and Biometrical Genetics provides up-to-date information about almost all basic principles, basic techniques, biometrical Genetic methods and analysis available in the literature. Due importance has been given to both the theoretical and practical aspects of the subject. The book will serve as an in-depth guide to the students of genetics and plant breeding interested in identifying most biomaterial techniques and knowing their role in crop improvement programmes. The book will also be helpful for the statisticians who are working in collaboration with the geneticists and plant breeders.

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