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Objective

The procedures/guidelines for conducting All India Coordinated Trials in a uniform way in Self-pollinated, Cross-pollinated, Often cross-pollinated and Vegetatively propagated crops.

Stages of testing

A three tier system of multiplication evaluation spread over a minimum period of three years*, involving following stages is a must for release of a variety or a hybrid.

- First year: Initial Varietal/Hybrid Trial (IVT/IHT)
- Second year: Advanced Varietal/Hybrid Trial I (AVT-I/AHT-I)
• Third year: Advanced Varietal/Hybrid Trial II (AVT-II/AHT-II)

Mode of Induction of Test Entries

Test entries shall be included in the coordinated trials on the basis of the data generated in pre-coordinated testing such as station and other trials. These trials must be conducted by sponsoring breeder/institution/organisation/company. Yield and other important agronomic attributes, reaction to insect pests and diseases and relevant quality parameters are to be made available to the coordinator in support of inclusion of test entries in the coordinated trials. The entries shall possess some distinct diagnostic features, making them different/identifiable from the varieties of common knowledge or use. Acceptance of entries for coordinated testing shall be subjected to same system, irrespective of the method followed in the development of lines/strains.

Induction of entries from private organizations with established R & D units would require:

1. Discussion and approved by the annual workshop/group meeting of the respective crop, chaired by the DDG concerned or his nominee.
2. Strict compliance with the national laws, especially those concerning bio-safety and other regulations, if any.
3. Charge of a minimum fee, as specified by the ICAR from time to time

Evaluation of Test Entries

a. Initial Varietal/Hybrid Trial (IVT/IHT)

1. Constitution of trials: These trials would be constituted with the new entries sponsored by cooperating breeders/institutions along with the specified number of checks, including latest identified/released varieties/hybrids.
2. Number of entries: The number of entries (including checks) shall be limited to an extent where adaptation of appropriate experimental design becomes otherwise difficult.
3. Checks: A minimum of three checks, like National check, Zonal check, Local check, shall be used. The national (wherever available), zonal and local checks remain the same for a period of three years to enable comparison with the same test entries. Any new check added in between should be in addition to the national, zonal and local checks in the trials with the same test genotypes with which conducted in the previous years, IVT/IHT or AVT-I/AHT-I.
4. Plot size, number of replications and field layout
   a) The experimental design, plot size and the number of replications shall be decided in the workshop on the basis of the experience gained from the past trials over years, to reduce experimental error to bare minimum and enabling detection of minimum yield difference of 5-10% as significant at 5% level.
   b) Plot size and number of the replications shall be same uniformly at all the test locations/zone/ecology.
5. Management of the crop: Cultural practices shall be clearly defined at the time of constitution of the trials, and be specified as decided by the workshop.
6. Test locations: Same set of IVT/IHT for each specified cultural situation shall be conducted across all zones (wherever applicable) of the country in different regions, where the crop is predominantly grown. The test centre shall be identified in the workshop.
7. Monitoring of the trials: All the trials shall be monitored by a team of scientists to be deputed by the PD/PC. The monitoring team shall have the following minimum composition.

<table>
<thead>
<tr>
<th>PD/PC/ZC/PI/ Senior most member of the team</th>
<th>Team Leader</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plant breeder</td>
<td>Member</td>
</tr>
<tr>
<td>Agronomist</td>
<td>Member</td>
</tr>
<tr>
<td>Pathologist/Entomologist</td>
<td>Member</td>
</tr>
<tr>
<td>Scientist of any other specified discipline</td>
<td>Member</td>
</tr>
</tbody>
</table>

The monitoring team shall also indicate an overall estimate of the yield of the trial on the basis of its observations, and give a clear-cut recommendation whether the trial data should be accepted or rejected. Recommendations of the monitoring team shall be the major deciding factor in acceptance or rejected of the trials.

1. Data to be generated: In addition to the
data on the produce of economic importance, observations should be recorded on the agronomic features like days to flowering and maturity, plant height, lodging, threshability, reaction to important diseases and insect-pest, easily measurable grain quality attributed such as grain colour, grain weight, grain appearance etc. The characters on which data shall be recorded need to be specified by the workshop.

2. Data processing
   a) The trial data may be considered for discarding or acceptance for further processing on the basis of the following.
      i) Recommendation of the monitoring team
      ii) Suggestions by the ZC/concerned breeder
      iii) Deviation from the specified range of sowing date, specified crop management practices for the trials such as fertilizer doses, irrigation levels etc.

   b) All the trials considered acceptance on the basis of the above may be statistically analyzed and examined for the following before pooling of the results.

   General yield levels: In case of trials under restrictive environment such as rainfed, salt-affected, waterlogged conditions etc., all trials where the check entries have produced reasonable yields should be considered for analysis, irrespective of the poor overall trial average yield/extremely poor performance of any test entry.

   C V levels: In case of trials under restrictive/rainfed environments, all those showing significant genotypic differences and reasonable yield level of the checks should be considered. Trials with extremely low/negligible CV should be considered cautiously.

   Overall performance of checks: Trials, where performance of the checks is low and unrepresentative of the general trial performance, may be considered cautiously.

   Norms for promotion of entries in the First year, second year: The promotion of entries from IVT/IHT to AVT/AHT would be strictly based on the overall performance/merit of the test entries.

   b. Advanced Varietal/Hybrid Trial-I and Advanced Varietal/Hybrid Trial-II

   These trials conducted with entries which promoted from first year and second year testing respectively and remaining stage same as IVT/IHT.

   The following criteria would be followed in Pearl millet.

   • Grain yield equal or higher than best check or 10% higher over relevant check in early and medium group and 5% over relevant check in Late group. Days to 50% flowering in IHT (Early) and AHPT (Early) equal to or less than 45 Days, in IHT (Medium) and AHT (Medium) equal to or less than 50 Days. A grace of one day in days to 50% flowering may be given to hybrids yielding grains 15% higher over HHB 67 Improved in early group hybrids and yielding grains 15% higher over relevant check in medium group hybrids.

   • The total promoted entries should not be more than 33% of total test entries in medium and late maturity hybrid trials. Iron content ≥42 ppm and Zinc content ≥32 ppm in all the trials. Downy mildew (60 DAS) under sick plot equal to or less than 5%, Blast (Score) equal to or less than 3 (by using 0-9 scale), Ergot (% severity) under artificial inoculation conditions equal or less than 20%, Smut (% severity) under artificial inoculation conditions equal or less than 20% and Rust (% leaf area) equal to or less than 20% in hybrids and populations, across all Zones.

   In addition to the generation of data recorded in the previous trials and nurseries, more elaborate data need to be generated, like Response to the agronomic variables such as different date of sowing, population densities in terms of spacing, levels of fertilization and irrigation etc., as recorded from the exclusive trials conducted at selected centres by the agronomists only in third year testing of particular entry.

D. Variety Identification Procedure

Superior eligible test entries shall be identified in third year of testing based on the performance for specific crop zones (s) in the workshop/group meeting for presentation to the
Central Sub-Committee on Crop Standards, Notification and Release of Crop Varieties. This shall be done by a committee called "Variety Identification Committee", constituted in advance of annual workshop/group meeting with the approval of the Deputy Director General (Crop Science).

Reference
1. http://seednet.gov.in
2. www.aicmip.res.in
* Testing of Near Isogenics may be included at AVT-I/AHT-I so it can test for two year under multi-location testing.

2. AGROFORESTRY

Implementation of Government and Industrial Policies or Programmes in the Development of Agroforestry in India

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Agroforestry is an age old practice and can be defined as “a collective name for land use system and technologies where woody perennials (tree, shrubs, palms, bamboos etc.) are deliberately used on the same land management unit as agriculture crops and/or animals, either on the same form of spatial arrangement or on temporal sequence (Lundgrean and Raintree, 1983). Agroforestry leads to greater prosperity at the farm level, also helps to increase tree cover and is the only option to meet the target of 33% forest area as per National Forest Policy 1988. Hence in this connection there is a vital need for government and private policies/programmes to enhance the adoption of agroforestry. A policy is defined according to New Oxford Dictionary as: “a course or principle of action adopted or proposed by a government, party, business or individual”. Policies are very much required for any organized management of any sphere. In this regard, there are many government policies/programmes such as Farm Forestry programme (1970s), The National Forest Policy (1988), JFM (1990), National Agriculture Policy (2000), National Bamboo Mission (2002), Green India Mission (2010-2020), Agroforestry Policy (2014) etc. have promoted agroforestry through exempting agroforestry tree species from transit regulation.

There are also many forest based industries like WIMCO Ltd., ITC Ltd., Star Paper Mills Ltd, etc. that needs wood as a raw material and have promoted agroforestry through plantation by making direct relationship with the farmers. Both the government and private sectors run extensive programs and provide incentives, technical as well as financial assistance, which encouraged farmers to plant trees. The policies had a positive influence throughout the country. In Haryana the area under trees on farm grew up to 53% between 1975 to 1984 (NCAER, 1987). Under JFM Programme, Andhra Pradesh Forest Department has reported an increase in dense and open forest cover by 18% and 22% between 1996 and 1999 respectively (Chavan, 2013). In NBM it was planned to bring around 36,000 ha area under improved bamboo stock but an area of 51,925 ha has been covered throughout country which is 44% more than the targeted (Agricultural Finance Corporation, 2014). WIMCO’s endeavors in promoting trees on farmland has made U.P. a leading state in poplar culture and the state has planted approximately 1.2 crore saplings covering an area of over 24,000 ha in 2011-12 (Dhiman, 2012). Income generation of farmers has increased from Rs. 66,147/ha to 1,02,247/ha due to the technical input and distribution of high quality saplings through ITC’s Social, Farm Forestry and Agroforestry Scheme (Anon., 2013).

Farmers become free to plant trees and get revenue because of the exemption of agroforestry species from harvesting and transit mentioned in Government policies. And because of this, industries become independent to produce raw material through contract farming with the farmers with buy back guarantee. Both the government and private sectors run extension programs and provide incentives, technical as well as financial assistance, which
encouraged farmers to plant trees.

It is worth to mention that implemented government and industrial policies/programmes had helped in strengthening the agroforestry and markets for the agroforestry produces which enhance the development of agroforestry, which is having a significant role in terms of carbon sequestration, livelihood improvement, biodiversity conservation, soil fertility enhancement and poverty reduction.

References:

NCAER (1987) Haryana wood balance study, National council of applied economic research, New Delhi.64p

3. AGRI BUSINESS MANAGEMENT

Yog for Management
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“You might be managing big businesses. Yoga teaches you to manage your own self.”

Abstract—Now a day, with increasing competition around the globe, stresses become normal among the employees in various companies. Various organizations are adopting yog techniques and results are seen as increasing the productivity within the organization. Adoption of yog has shown positive results in various organizations. So in today’s world for becoming competitive, the organizations need to adopt yog in their routine life. Yog is nearly 5000 years old concept, which was developed by Indian sage Maharishi Patanjali. Management has become a challenging task in today’s world. World is becoming a large global village. Today’s manager has to keep pace not only with the changing environment but also to be in touch with expanding horizons of knowledge in his respective managerial area. This is a demanding task. He has to accomplish so many things in target time and to deal with so many people within and outside the organization. This creates stress and tension which sometimes becomes difficult to manage and expresses itself into various kinds of diseases. Therefore due to yoga blood flow increase in the body and also oxygen supply increase in the body due to that every part of the body gets more energy and as a result work capacity of human being increase and reduces stress and physical and mental health problems.

Index Terms— yog, competitive, targets, stress and tension, diseases, energy, mental health

Introduction:
Root of yog is India which was introduced by maharishi Patanjali before 5000 years ago. The concept was developed for main aim of self-realization at that time but with the passage of time and era its aim changes to mental peace as well as physical benefits. Yog is nearly 5000 years old concept, which was developed by Indian sage Maharishi Patanjali. The yog given by Patanjali has eight parts viz; Yama (external moral/ethical discipline), Niyama(internal moral/ethical strength), Asana(yogic postures), Pranayama(proper breathing for vital energy), Pratyahara(sense withdrawal), Dharana(focus/concentration),
Dhyana (meditation) and Samadhi (total absorption). Due to yoga blood flow increase in the body and also oxygen supply increase in the body due to that every part of the body gets more energy and as a result work capacity of human being increase (Anon., 2011a).

Management in Present Era:
It has become a challenging task in today’s world. World is becoming a large global village. Electronics and telecommunication revolution has changed the whole scenario. As we have entered into 21st century, we are involved in the most crucial and most difficult of all the transitions so far, the transition to the global society. Moreover, new concepts, theories and new techniques are emerging every day all over the world. Environment is also changing very rapidly in its all dimensions-political, economic, business, finance, social etc. Today’s manager has to keep pace not only with the changing environment but also to be in touch with expanding horizons of knowledge in his respective managerial area. He has to accomplish so many things in target time and to deal with so many people within and outside the organization. This creates stress and tension which sometimes becomes difficult to manage and expresses itself into various kinds of diseases (Anon.2011b).

Various Yog& Meditation Systems
a) Art of Living
b) PatanjaliYogpith
c) Chinmaya Mission l
d) GurutatvaYogSahaj Yog
e) Siddha Samadhi Yog (SSY)
f) Vipassana
g) Osho Rajnees
h) Silva Mind Control
i) Sahaj Marg; Shree Ramchandra Mission

3.1 Yog is a science
Yoga is a science, and not a vague, dreamy drifting or imagining. It is an applied science, a systematized collection of laws applied to bring about a definite end. It takes up the laws of psychology. Applicable to the unfolding of the whole consciousness of man on every plane, in every world (Bhayani, 2005).

Yoga Myths
a) Yoga Sessions require lot of space and time.-It is not necessary to keep the Yoga session long, it can be customized as per requirement. Even a 15 minutes rapid session can yield good results. There need not be dedicated separate session, Yoga can be done while sitting on the chair or standing in the desk space area.

b) Yoga is passive and yield slow results.-Yoga comprises of different simple asana (poses) and breathing techniques, which if practiced properly can yield wonderful and fast results.

c) It is burden on management in terms of money and time.- Companies that invest time and resources in a company-based wellness culture, with the focus on ‘maintenance’ rather than ‘repair’, can expect major returns on investment. Upbeat, energetic employees result in a healthy, relaxed environment with less absenteeism. De-stressed, Healthy, happy, focused and alert employees have a higher productivity then those which are stressed out, fighting fatigue and have body pain.

Why corporate wellness?
Welcome to the 21st century where it is common to see people suffering from heart disease, spondylitis & diabetes, even at the young age of 30. We all know that the Corporate World is all about Performance, but performance at the cost of what Stress? Health hazards? Mental & Emotional breakdown?? In this rat race, the body and mind reach a state of “burn-out” which is often recognized only when a medical condition manifests, resulting in Absenteeism and Attrition (Anon., 2011c).

How Yoga Helps to Management?
The powerful techniques of Yoga will guide the employees to correct wrong postural habits. Yoga also lower the adverse effects caused by work environment i.e. constant use of computers, etc.,

Thereby reducing physical ailments. Further, yogic methods for relaxation and stress management help to reduce physical and emotional stress, thus transforming them into more healthy, emotionally balanced and energetic individuals.

a) Benefits of Yoga for managers
i) Benefits of Yoga for the Employee
ii) Improvement of the general disposition towards working.
iii) Improvement of attention, concentration, work efficiency and decision power.
iv) Maintenance of mental and physical health.
v) Improve inter-relationship between the employee as well as a team work.
b) Benefits of Yoga for the Company
   i) Less sick leaves & lower health care cost.
   ii) High quality output & increased productivity.
   iii) Increase employee retention.
   iv) Good rapport & company’s image.
   v) Boost company’s morale (Anon., 2011d).

Yoga in Indian Corporate

Transcendental Meditation is widely practiced by the industrial and governmental leaders of India. Recently Maharishi Corporate Development Programme has been introduced to the multinational giants of India, Tata Tea Ltd. and Tata Chemicals. 20,000 managers and employees of Tata Tea and 6,000 of Tata Chemicals have taken part in the programme. Other renowned companies enjoying the benefits of this unique programme include: Associated Cement, Indian Aluminum, Reckitt & Colman, Oriental Bank of Commerce, SRF, Eveready, Tata Unisys, BHEL, Jindal Polyester, Indian Petro Chemicals Ltd., Anand Group, DCM Shriram, Finolex, Hewlett Packard India, DCM Financial Services, Indian Sugar and General Engineering Corporation, SWIL, Williamson Magor and Co., and Kribhco.

Conclusion

Now a day, with increasing competition around the globe, stresses become normal among the employees in various companies. Various organizations are adopting yoga techniques and results are seen as increasing the productivity within the organization. Adoption of yoga has shown positive results in various organizations. So in today’s world for becoming competitive, the organizations need to adopt yoga in their routine life.

References


4. ENTOMOLOGY

Human Health Issues Related to Occupational Pesticide Exposures

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Keywords: Respiratory, Poison, Ill effects, Precaution, Safety

Introduction

Pesticides are designed to control pests, but they can also be toxic to desirable plants and animals, including humans. Pesticides, including herbicides, insecticides, fungicides, bactericides and rodenticides, are commonly used to control pests and pest-induced diseases (Damalas and Eleftherohorinos, 2011). Worldwide, approximately five billion pounds of pesticide are consumed annually (Pesticide Market Estimates, 2006–2007), among which
organophosphate (OP) and carbamate insecticides (34%), dithiocarbamate fungicides (18%) and phenoxy herbicides (12%) are most commonly used (FAO, 2013). Occupational exposures to pesticides occur during the production, transportation, preparation and application of pesticides in the workplace as it is quite common for agricultural workers and their family members (Bradman et al., 2009). Accidental spills of pesticides, leakages, incorrect uses of equipment and non-compliance with safety guidelines, are the leading causes of occupational pesticide exposures (Jaga and Dharmani, 2003). Epidemiological data proved that occupational exposure of pesticides plays a major role in cancer development for both adults and children (Bassil et al., 2007; Mink et al., 2008).

Respiratory problems, such as cough, wheezing and airway inflammation, are commonly observed among people exposed to pesticides (Malley, 1997). Epidemiological studies have attempted to investigate the association between occupational pesticide exposures and chronic respiratory diseases, such asthma, chronic obstructive pulmonary disease (COPD) and lung cancer (Sanborn et al., 2002; Hoppin et al., 2009).

**Routes of Poisoning into the Human system:**

There are many ways through which pesticide can enter the body. The three main routes are dermal route, oral route and inhalation route. In the dermal route wet, dry, or gaseous forms of pesticides can be absorbed through the skin. The pesticide may enter into the body by improper handling of pesticides, usage of contaminated clothing etc. The eyes, ear drums, scalp and groin area absorbs pesticides more quickly than other areas on the body.

Dusts, spray mist, or fumes, pesticides can be drawn into your lungs via inhalation route as you breathe. Inhalation of pesticides can occur during the mixing of wettable powders, dusts, or granules and also while fumigating or spraying. Smaller particles are able to be inhaled directly into the lungs. The number of particles needed to poison by inhalation depends upon the concentration of the chemical in the particles. Even inhalation of dilute pesticides can result in poisoning.

Pesticides can enter the body through the mouth (also called ingestion). This can occur when hands are not properly washed before eating or smoking. They may be swallowed by mistake, if they are improperly stored in food containers. Ingested materials can be absorbed anywhere along the gastrointestinal tract; small intestine being the major absorption site.

Once the pesticide is absorbed, they eventually enter the blood stream by one of several means, and circulate throughout the body.

**Ill effects of the Pesticides in Human System:**

“The benefits of crop protection products have to be balanced against the risks to farmers and other agricultural workers handling and applying them”. – Litchfield, 2005. The long term effects of the pesticide poisoning are numerous to the individual who is occupationally exposed to the pesticides. The human outcomes related to the pesticides are precocious puberty (Krstevska et al., 2001), altered lactation (Rogan and Ragan, 2007), breast cancer (Diamanti et al., 2009), female fertility (Caserta et al., 1998), decreased semen quality (Kamijima et al., 2004; Lifeng et al., 2006), male urogenital tract malformations, antiandrogens, reproductive neuroendocrine systems (Diamanti et al., 2009), prostate cancer and prostatic hyperplasia (Prins, 2008), thyroid function (Goldner et al., 2010), asthma (Moretto, 1991) etc.

Studies on the farm workers in the Agricultural Health Study revealed the symptoms such as headache, fatigue, insomnia, tension, irritability, dizziness, depression and numbness in the hands and feet [in adults] were related to the duration of exposure to pesticides. A body of research associates chronic effects of pesticide exposure with ADHD (Attention Deficit and Hyperactivity Disorder) and ASD (autism spectrum disorder) in the school age children. Evidence of neurodevelopmental toxicity arising from chronic, low-level exposure in gestational or early postnatal life is building up.

Pesticides have contaminated even mother’s milk. Researchers from Rajasthan University have found an alarming presence of organochlorine pesticides in the blood and milk samples collected from lactating women in Anupgarh, a town in Rajasthan known for its
extensive use of pesticides in farming (Singh, 2009).

**Conclusion**

One of the most important and major weaknesses of many epidemiological studies is adequacy and reliability of exposure assessment. Data relating human endocrine disruption has become progressively stronger in supporting a role of pesticides. Extensive research continues in this area of investigation.

Respiratory symptoms, including wheezing, airway irritation, dry/sore throat, cough, breathlessness and chest tightness, and respiratory diseases such as asthma and COPD, were associated with occupational pesticide exposures. Impaired lung function was also often observed among people occupationally exposed to pesticides. There is little evidence suggesting that occupational pesticide exposure is associated with respiratory tract infection, although an association has been described for organochlorine insecticide exposures in young children (Dallaire et al., 2004; Sunyer et al., 2010). The author of the book “Silent spring” Rachel Carlson and her scientific colleagues have alarmed the widespread use of DDT and other long-lasting poisons in so-called agricultural control programs.

To conclude the crisis, all the peoples (especially the farmers) can be trained in educational programs in safety and precaution, proper use of personal protection equipment, pesticide management and regulations and these are some of the effective approaches to control the acute and chronic effects of pesticides due to occupational exposure.

**Selected References**


———. 2010. The author of the book “Silent spring” Rachel Carlson and her scientific colleagues have alarmed the widespread use of DDT and other long-lasting poisons in so-called agricultural control programs.

## 5. **AGRONOMY**

### Methane Emission in Rice

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Methane has been recognized as one of the most important greenhouse gas which is second only to CO₂. The first evidence that the atmospheric CH₄ concentration is increasing was presented in the early 1980's. The enhanced greenhouse effect of CH₄ varies between 15-20% (IPCC, 1990). Methane is also an isochemically active in the atmosphere thus influencing atmospheric concentrations of several important species, e.g., hydroxyl radicals, ozone and carbon monoxide.

Methane is produced by strict anaerobic bacteria (methanogens), ex: aquatic sediments, natural wetlands, and wetland rice.

Anaerobic decomposition of organic material in flooded rice fields produces methane (CH₄), which escapes to the atmosphere primarily by diffusive transport through the rice plants during the growing season.

**Pathway**

The important pathway for methane production in flooded soil is due to the reduction of of CO₂ with H₂, with fatty acids or alcohols as hydrogen donor, and the transmethylation of acetic acid or methanol by methane-producing bacteria (Takai, 1970; Conrad 1989).

**Factors affecting methane production:**

There are several factors which help in play an important role in methane production, here some of the important factors are discussed as follows:

1. **Redox potential:** It is one of the important factor as it has been found that the redox potential of a soil must be below approximately -150 mV in order to have CH₄ production (Patrick, 1981).

2. **Soil temperature:** It has been found that
CH₄ formation is maximum at 35⁰ C in waterlogged alluvial soils and very small below 20⁰ C which clearly suggest that temperature plays a very important role in methane production.

3. **pH**: It is generally recognized that CH₄ formed at an optimum quantity within a narrow pH range around neutrality (pH from 6.4 to 7.8) and above and below reduces methane formation considerably.

4. **Continuous submergence/anaerobic condition**: Continuous submergence or anaerobic condition is the prime requirement for growth of methanogenic bacteria.

5. There are three processes of CH₄ release into the atmosphere from rice fields.

6. **Diffusion**: Loss of CH₄ across the water surface is the least important process.

7. **Ebullition**: During land initial crop growth stages, it is the most important mechanism.

8. **Transport through rice plants**: It is the most important mechanism which contributes around 90% of emission.

### Measures to reduce methane emission:

There are some measures we can adopt to curb down the methane emission.

1. Breeding rice cultivars with low CH₄ emission
2. Alternate wetting and drying
3. Use of sulfate containing fertilizers
4. Change in pattern of fertilizer
5. Use of methanotrophic bacteria
6. Controlling soil PH
7. Adoption SRI and aerobic method
8. Use of phosphatic fertilizer

### Conclusion

Reduction of methane emission is a difficult task and most of the rice growers are marginal and small farmers. So the technology should be in such a way that in addition to reducing methane emission, it also make improvements in terms of any one of the factors like higher yields, lower water use, lower fertilizer use/costs, less labour intensive or offer an alternative and more profitable. So these mitigation should be incorporated in the package of practices to curb down the emission as well as improving the economic condition of the grower.

### References:


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**6. AGRICULTURE ECONOMICS**

**Agribusiness Opportunities in India**

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### Agribusiness

Agribusiness denotes the collective business activities that are performed from farm to fork. It covers the supply of agricultural inputs, the production and transformation of agricultural products and their distribution to final consumers.

### Scope for Agribusiness in India

1. India is endowed with varied ago-climate, which facilitates production of temperate, sub-tropical and tropical agricultural commodities.
2. There is growing demand for agricultural inputs like feed and fodder, inorganic fertilizers, bio-fertilizers.
3. Biotechnology applications in agriculture
have vast scope in production of seed, bio-control agents, industrial harnessing of microbes for bakery products.

4. At present processing is done at primary level only and the rising standard of living expands opportunities for secondary and tertiary processing of agricultural commodities.

5. The vast coastal line and internal water courses provides enormous opportunity for production of marine and inland fish.

6. The livestock wealth gives enormous scope for production of meat, milk and milk products, poultry products etc.

7. Beekeeping and apiary can be taken up on large scale in India.

8. Mushroom production for domestic consumption and export can be enhanced with improvement in the state of art of their production.

9. Production of vegetables and flowers under green house conditions can be taken up to harness the export market.

10. The enhanced Agri business opportunities for employment in marketing, transport, cold storage and warehousing facilities, credit, insurance and logistic support services.

7. **SOIL SCIENCE**

Environmental Impacts of Over Use of Fertilizers

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Intensive agriculture and advent of modern agro-techniques has promoted fertilizer use. However; over use of fertilizer often poses severe environmental threats. Such environmental threats should be taken into consideration while recommending fertilizer dose and application methods.

There are many environmental constrains. Some of them are listed below (Reddy, 2012)

- Loss of N retention capacity of soil
- Global warming because of increased emission of nitrous oxide
- Depletion of ozone by nitrous oxide
- Acid deposition by nitrogen oxide
- Methemoglobinemia in infants because of increased nitrate ion in water and food
- Eutrophication because of high nitrogen in aquatic ecosystem
- Loss of biodiversity, especially loss of those plants adapted to efficient use of N
- Loss of soil nutrients such as calcium and potassium
- High concentration of nitrate in drinking water have carcinogenic effect
- Acid rain may occur due to reaction of ammonia with water

However; the negative impacts of excessive fertilizer can be minimized by:
8. SOIL SCIENCE

Role of Antioxidants in Plant Disease Management

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Introduction: Antioxidant is a substance that delays, prevents or removes oxidative damage to a target molecule. Antioxidants are group of substances, when present at low levels, in relation to oxidisable substrates, considerably suppress or delay oxidative process, while often being oxidized themselves. Any substance that directly scavenges reactive oxygen species (ROS) or indirectly acts to up-regulate antioxidant defenses or inhibit ROS production. Any molecule that inhibits the oxidation of another molecule (Halliwell and Gutteridge, 1995).

Classification of antioxidants

Endogenous antioxidants: Endogenous antioxidants can be categorized into primary antioxidants and secondary antioxidants. Primary antioxidants inactivate the ROS into their intermediates. SOD, catalase, and glutathione peroxidase are the primary antioxidant enzymes. Secondary antioxidant enzymes act directly to detoxify ROS. They maintain their proper functioning by decreasing the peroxides level and continuously supplying NADPH (nicotinamide adenine dinucleotide phosphate) and glutathione for primary antioxidant enzymes. Glutathione reductase, glucose-6-phosphate dehydrogenase, glutathione-S-transferase, and ubiquinone are the secondary antioxidants.

Exogenous antioxidants: Many foods and various dietary components exhibit antioxidant activities. Several herbs, spices, vitamins, foods, vegetables, etc., are reported to be sources of exogenous antioxidants. Many polyphenolic compounds such as flavonoids, isoflavones, flavones, anthocyanins, coumarins, lignans, catechins, isocatechins, epicatechins, and phenolic acids such as hydrocinnamic acid, hydrobenzoic acid, gallic acid, ellagic acid, etc., have gained importance as antioxidant phytochemicals. GSH (Glutathione) and uric acid act as the direct scavengers of reactive metabolites (Halliwell and Gutteridge, 1995).

Reactive oxygen species (ROS): ROS are a group of free radicals, reactive molecules, and ions that are derived from O₂. They have unpaired electrons and are extremely reactive and are capable of initiating chain reactions that destabilize other molecules. ROS create a homeostatic imbalance that generates oxidative stress and causes cell death and tissue injury. It has been estimated that about 1% of O₂ consumed by plants is diverted to produce ROS in various subcellular loci such as chloroplasts, mitochondria, peroxisomes.

Sites of production of ROS in plants: ROS are always formed by the inevitable leakage of electrons onto O₂ from the electron transport activities of chloroplasts, mitochondria, and plasma membranes or as a byproduct of various metabolic pathways localized in different cellular compartments.

One of the earliest cellular responses following successful pathogen recognition is oxidative burst involving production of ROS. Recognition of a variety of pathogens leads to generation of O₂•−, or its dismutation product H₂O₂ in apoplast. Differential regulation of antioxidant enzymes, in part mediated by SA (Salicylic acid), also contribute to increases in ROS production. Under biotic stress conditions, the production of reactive oxygen species (ROS) increases in the plants, resulting in induction of oxidative stress.

Reference
In response to increased oxidative stress, plants augment the production and accumulation of several low molecular weight antioxidants (e.g: vitamin C, vitamin E, phenolic acids, etc.) and high molecular antioxidant secondary metabolites such as tannins, which confer antioxidants to most plants by functioning as free radical scavengers, reducing agents, and metal chelators. The genetic make-up of plants imparts them with an innate ability to synthesize a wide variety of phytochemicals to perform their normal physiological functions and protect themselves from microbial pathogens and animal herbivores (Sharma et al., 2005).

**Conclusion:** Antioxidants inhibit a number of enzymes by dissolving the membrane lipids and interfere with membrane functions, including transport of nutrients also interfere with the synthesis of protein, RNA and DNA, destroy the membrane potential, inhibit the activity of enzymes involved in the biosynthesis of melanin of pathogen. This stimulatory effect of the antioxidants which protect the chloroplasts from the production of toxic free radicals, thereby prevent degradation of pigments and inhibit the photo oxidation of pigments that arise under stressful conditions.

**References**


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**9. LIVE STOCK PRODUCTION AND MANAGEMENT**

**Present Status of Livestock and Poultry in Indian Economy**

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**Introduction**

Livestock means group of all domesticated animals reared for economical benefits of farmers. Livestock sector includes cattle, buffalo, sheep goat, pig, poultry, and dairy and fisheries sector. India has vast resource of livestock and poultry birds which is important role in improving socio-economic condition of rural peoples.

In India most of the people (20.5 million) based on livestock for their livelihood. 16 % of income of small farmer contributed by livestock as compare to 14% of rural household. For the 2/3 of rural community livestock give the livelihood. In India 8.8% of the population is
employed by livestock. India has so many livestock resources. Livestock gives contribution of 4.11% Gross Domestic Product and 25.6% of total agriculture Gross Domestic Product.

**Population of livestock and its importance**

The population of livestock 512.05 million in India as per 19th livestock census was conducted in year 2012. There are about 300 millions of bovine, 65.07 millions of sheep, 135.2 million of goat, 10.3 million of pig and 729.21 million of poultry birds as per 19th livestock census in the country.

Ranking of livestock population in the worlds as follows,

| Rank 1st | Buffalo |
| Rank 2nd | Cattle and Goat |
| Rank 3rd | Sheep |
| Rank 5th | Duck and Chicken |

The population of livestock increasing day by day due to its importance as a good source of money and animal protein. However, it is important source of draught power and undigested waste is used for preparation manure and as a source of fuel. Animal production is an important source of small farmers and landless labour.

**Milk production:** India rank first in milk production. In the year of 1960s India was produce 17-22 million tonnes of milk, has increased to 165.4 million tonnes during the year 2016-17, showing 6.37% annual growth rate. In the year of 2016-17 the per capita availability of milk is around 355gm./day. Highest per capita availability of milk in Punjab state is around 1075 gm./day. Utter Pradesh state rank first in milk production in India.

**Meat production:** Meat production in India is estimated at 7.4 million tonnes in 2016-17, rank 5th in world. Uttar Pradesh state contributes 18.23% in total meat production followed by Maharashtra (11.44%) and West Bengal (9.56%).

**Eggs production:** India rank 3rd in eggs production in world. Poultry sector is one of the important agriculture components in India today. Poultry production has taken a quantum leap in the last four decades. Currently the total poultry population in India is 729.21 million (19th Livestock Census) and produce 88.14 billion numbers of eggs during 2016-17. Tamil Nadu rank first in eggs production followed by Andhra Pradesh and Telangana during 2016-17. Indian poultry products have good market in other Asian countries.

**Wool production:** Livestock sector also contribute in wool production, India rank 7th in wool production in the world and share 1.8% in total wool production. India produces 43.5 million Kgs. of wool in 2016-17. Rajasthan state ranks first in wool production and contributes 32.9% in total meat production followed by Jammu & Kashmir (16.7%) and Karnataka (15.4%).

**Draft/Draught purpose:** In India bullocks are the backbone of agriculture used for pulling the cart and different agricultural operations like ploughing and sowing. The bullocks are save consumption of fuel using for mechanical power like tractors, combine harvesters etc. For the transport of goods from one place to another place the pack animals likesheep, camels, horses, donkeys, ponies, mules etc. are being extensively used.

**Employment generation:** Livestock sector play important role in employment generation among landless labour/peoples throughout the year.

**References**

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Pioneering work by agriculture scientists and the efforts of farmers had helped to achieve a breakthrough in the agriculture sector during 1960s, popularly known as the ‘Green Revolution’. High agricultural production and productivity achieved in subsequent years has been the main reason for attaining food security to a large extent. The country has not witnessed any big technological breakthrough in agriculture since then. The big question before us is how to feed billions of new mouths over the next several decades and how to save the rest of life.

Results of green revolution

1. Statistical Results
   a) Grain output of 131 million tons in 1978-79
   b) Yield per unit of farmland improved by more than 30 per cent between 1947 and 1979.
   c) More than 70 per cent of the wheat, 35 per cent of the rice and 20 per cent of the millet and corn crop area, used the high yielding variety seeds.

2. Economic Results
   a) Irrigation created need of new dams to harness monsoon water.
   b) Boosted industrial growth, created jobs and
   c) India paid back all loans it had taken from the World Bank

3. Sociological Results
   a) Created plenty of jobs creation of lateral facilities such as factories and hydro electric power stations.
   b) Sizable increases in returns to land
   c) Increase in demand for goods and services
   d) Political Results
   e) India transformed itself from a starving nation to an exporter of food.

Green Revolution and Evergreen Revolution: Pathways

4. **Green Revolution**: Commodity-centered increase in productivity, mainly because of Change in plant structural design, harvest index, changes in the physiology, insensitive to Photoperiodism, Lodging resistance. The major scientific pathway of the green revolution of the late 1960s was productivity enhancement of cereal grains, particularly wheat and rice. A quantum jump in the productivity and production

5. **Evergreen Revolution**: Increasing productivity in perpetuity without associated ecological harm.

NEED FOR EVERGREEN REVOLUTION

- About 56.7 per cent population is directly dependent on agriculture, it is the main component for most of the state economies in India
- Population growth is faster than food production
- Current growth rate of agricultural sector is stagnant or at best 2 per cent (in last ten years).
- Over 60 per cent of India’s net sown area still remain at the mercy of the monsoon
- 80 per cent of our farmers are small and marginal farmers.
- Per capita availability of food grains in India has decline from about 500 grams per capita per person to less than 400 grams per day over last two decades.
- Though the second largest producer in the world, yet over 300 million people go without two meals a day.
- Farming is no longer remunerative and over 40 per cent farmers will like to quit farming if they have an alternative option.
- The world’s population is growing dynamically.
• It is estimated that our planet will be inhabited by more than nine billion people in 2050.
• Per capita land availability will decline dramatically.

The challenge for the agricultural sector during the next few decades is clearly doubling the production by 2025 and tripling it by 2050 on less per capita land, with less water, under environmentally challenging conditions.

• Coming decades will also need an integrated and all round approach to move from Green Revolution to Evergreen Revolution, by
  – Sustainable Agriculture.
  – Inter-connected & interdependent.
• AGRARIAN CRISIS:
  – Farmer Suicides,
  – Starvation, Deaths,
  – Poor Returns to Cultivation
  – Weather related uncertainties
  – Problem related to marketing, credit,
  – Spurious inputs,
  – Yield loss
• NCRB-AD&SI-2009- (national crime records bureau and accidental deaths and suicides in India) nearly 216500 have committed suicide in India during 1997-2009.

Agricultural Research and Extension need to emphasize the following new dimensions in the Second/Ever- Green Revolution Era

• Emphasize application of biotechnology- tissue culture, GM crops etc
• Emphasize use of bio fertilizers, bio pesticides and bio remediation of ground water
• Address issues like sustainability, resource integration and technology integration as the primary focus

• Apply precision farming and mechanization
• Linkage with industry, market driven and export oriented agriculture
• Increase application of new technologies
• Focus on post harvest, food processing and value addition technology
• Highlight quality in addition to increase in quantity
• Integrate livestock and other allied agro-enterprises with crop production and Exploit advances in information technology.

Conclusion

The present extension scenario calls for private-public partnership, diversification, intensification, natural resource management, research on consumer preferences, and continuous capacity building of all the stakeholders in the agricultural development. Now extension becoming more diversified, technology intensive and more demand driven. The use of information technology (IT) can help the extension workers to be more effective in meeting farmers’ information needs. Large section of small and marginal farmers and landless laborers would need to be served by the public extension system. The other actors involved in extension/ transfer of technologies such as NGOs, farmers’ organizations, private sector and Para extension workers etc. would actively complement or supplement the efforts of the public extension agency and wherever possible replace it. Extension mechanism will have to be driven by farmers needs, be location specific and address diversification demands. Technologies required to address total farming systems are knowledge intensive and improve the skills of farmers. Therefore in order to attain continued self-sufficiency, self-reliance and sustainability. It is much emphasized to go for evergreen revolution.
11. HORTICULTURE

Application of LED for Quality Improvement of Fruits and Vegetables

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Introduction

Light emitting Diodes (LED) are semiconductor devices that produce visible light when an electrical current passed through them. Solid-state lighting using light-emitting diodes (LEDs) represents a fundamentally different technology from the gaseous discharge-type lamps currently used in horticulture. Testing of LEDs for plant growth in the United States was concomitant with the development of the first crude LED arrays in the late 1980s and early 1990s (Barta et al., 1991). Early trials were conducted with lettuce, potato, spinach and wheat. At that time, blue LED technology was not sufficiently advanced to provide useful levels of blue irradiance, so studies were conducted using red (660 nm) LEDs alone or in combination with blue fluorescent lamps. These early developments were driven by the need to develop better light sources for space based plant-growth. This early LED work quickly led to the development of LED-based systems for plant physiology experimentation and LEDs are now routinely incorporated into standard research instruments such as portable photosynthesis meters. At approximately this same time, LEDs began to be investigated for germinating seeds and rooting cuttings in the Netherlands. LED was first invented by Oleg Losevin 1927, but the first Practical LED was invented by Nick Holon yak in 1962. In post-harvest preservation LEDs are used because of low radiant heat emissions and better efficiency at lower temperatures.

Properties of LEDs

1. Light through electroluminescence
2. p-side and an n-side, with an interface termed the p–n junction
3. Current only flows from the p-side to the n-side
4. Produces low radiant heat emissions
5. Long operational life of up to 50000 to 100000 hours
6. LEDs emit light with emission wavelengths of narrow band widths, high photoelectric efficiency and photon flux or irradiance.

Advantages of LEDs

1. Quick Harvest Cycle: LED grow lights can be used for 24 hours a day with little effect on temperature. When growing plants indoors lack of environmental feedback means the plants rely on to tell them what season it is and with it, how they should behave. The use of LED lights enables to change the day light hours and the amount of red wavelength light at the exact right time to maximize the plant growth rate. When LED light is used to grow auto flowering plants, multiple harvests are possible in one season. The grower is able to alter flowering times in plants and increase production.
2. Increased Lifespan: LED grow lights have a lifespan of over 50,000 hours, which is much longer than traditional lighting systems. A large reason for this is the low operating temperature of the lights. Conventional lighting systems produce a lot of heat, which reduces their lifespans significantly. The longer lifespan of LEDs means, grow crops for many years without needing to replace the lighting systems, which reduces costs.
3. Energy Savings: LED grow lights are more efficient than traditional lighting systems, consuming 60% less energy to give the same level of light. They emit less heat and provide more usable light than traditional lighting systems. This is because an LED diode does not burn anything to produce light. Due to their reduced energy
use and heat production, LED grow lights lower energy bills considerably.

4. **Healthier Plants**: Light sources that emit more UV rays, IR rays and heat are counterproductive to plant growth. This is because they can cause plants to burn and dry up quickly, which leads them to need more water and energy to stay alive. With LED grow lights, heat and harmful wavelengths of light are limited. As a result, the water and energy is used to grow and develop healthier plants and not to merely survive.

5. **Target Wavelength**: The use of LED grow lights enables growers to regulate the wavelength of light, which enhances photosynthesis. Traditional lighting systems emit a lot of light in the green and yellow wavelengths, which plants don’t really use. This is basically wasted energy. With LEDs, you can give the plants the exact spectrum of light they need.

6. **Full Spectrum**: LED plant lights produce a balanced full spectrum of light. They give all the light plants need and nothing more. And most fixtures allow to turn off specific wavelengths, so LEDS can produce the perfect light for every stage of plant growth. This means that LED lights are actually better for your plants than natural light.

7. **Cool Operating Temperature**: LED grow lights do not give off a lot of heat. This is unlike HID lighting systems that produce temperatures approaching 400 or more degrees. LED light does not much affect the operating temperature in a greenhouse or grow room. LED plant lights eliminate the need to install cooling systems in growing areas.

8. **Environment Friendly**: LED grow lights are 100% recyclable. Unlike HID lights, they do not contain toxic substances like mercury. To ensure this, all quality LEDs are certified by RoHS.

**Applications of LEDs**

1. **Enhancing the nutritional quality**: Light stimulates the production of various nutrients, antioxidants and secondary metabolites in plants, which function to provide defence against reactive oxidation species (ROS), produced during photosynthesis or light stress (Darkoet al., 2014). LED light quality, intensity and photoperiod on nutrient accumulation in various vegetables in controlled growth environments.

2. **Accelerating or delaying fruit ripening**: Light has varying effects on different types of fruits. Mature green tomatoes irradiated with blue light (440 to 450 nm) for a period of 7 d had slower rate of colour change from green to red compared with mature green tomatoes stored in darkness or irradiated with red light (650 to 660 nm) for an equivalent duration.

3. **Delay the senescence**: Senescence is a genetically controlled process that serves to ensure the survival of plants through the relocation of nutrients and macromolecules from dying plant tissue to new or developing tissue. This leads to undesirable loss of quality in harvested plants. Pulsed white fluorescent light which was supplied to basil leaves (*Ocimum basilicum* L.) at a photon flux below the compensation point was still effective in delaying senescence (Costa et al., 2013).

4. **Post harvest preservation**: An important function of food processing techniques is to reduce post harvest losses in terms of quality and quantity. Good postharvest quality encompasses the acceptable visual, textural, nutritional and flavour qualities of food, the absence of foodborne pathogens, as well as the delay of food spoilage by microorganisms. LEDs have been observed to have on various postharvest properties.

**Conclusion**

The role of LEDs in food safety is also noteworthy. High dosages of monochromatic light are necessary for inactivating foodborne pathogens. *In vitro* studied LEDs are inactivating a variety of significant foodborne pathogens with minimal heating effect. LEDs can be used in conjunction with cold storage methods. Progress in LED technology there may be scope for utilizing LEDs in developing countries. Their further development will be of great benefit to the food industry and society.
References

12. AGRICULTURAL SCIENCE (EXTENSION)
The Internet and its Impact on Farm Advisory Services
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Introduction:
Twenty-first century would be widely acclaimed as the era of Information Technology (IT) for India and most of the developing world. This was the time when the Information Technology started making inroad into the hitherto unreached countries in a big way. India has been experiencing major changes in agricultural extension system since the beginning of the 21st century. The reform included both demand and supply side measures. Information and Communication Technology (ICT) has great potential to revamp agricultural extension in a big way (Anderson et al 2004). Until ICTs offered farmers a channel for communicating directly with distant technicians and experts, many farmers could wait months or years for an extension worker to provide technical advice, and often that advice did not address their immediate concerns. Communication has always been the most important ingredient of human existence on the earth. Importance of communication in socialization has been widely acknowledged by the social science researchers. In fact, both are the two sides of the same coin(Hazra 2005).

Impact on Advisory services:
Internet, the base of ICT, overcomes some of these most challenging issues related to advisory services like accessibility, literacy and language barriers, geographic coverage and local focus. The internet can play a vital role in this kind of new and fast changing agricultural extension system; as it facilitates the relationship between an organization (the agricultural universities/ICAR institutes, etc.) and its strategic public (the farmers). The internet consists of tactical tools that allow us to do things like send e-mail, surf the web and participate in discussion with anybody who shares our interests. Internet in general means ‘Electronic means of capturing, processing, storing and communicating information’, usually in digital form.

In the last decade, the internet has become a core global communication technology for effective agricultural extension. The organizations that use the internet have greater access to information and can interact in a better way at reduced cost and enhance the benefits of its end users. These benefits of internet are exemplified by the extensive use of eBay for auctions, Amazon for online purchasing, and @griculture Online for agricultural specific activities.

Right from its evolution, technology has benefited only specific sectors related to it. However, internet has wide ramifications in virtually every walk of life, be it industry, telecommunications, weather forecasting, remote sensing, telemedicine, research and development, education, entertainment, etc. Hence therefore, the Indian Government realized the importance of internet as a tool of national development and appointed a task force on IT and software development. The task force submitted its report in 1998, envisioned India as IT superpower by 2008, and suggested 108 recommendations. The government implemented most of them and it virtually sowed the seeds of e-governance in India.
E-Agriculture is an emerging field focusing on the enhancement of agricultural and rural development through improved information and communication processes. More specifically, e-Agriculture involves the conceptualization, design, development, evaluation and application of innovative ways to use internet in the rural domain, with a primary focus on agriculture. E-Agriculture is a relatively new term and we fully expect its scope to change and evolve as our understanding of the area grows. The main applications of internet in agricultural sector are: Office Automation, Wireless Technologies, Global Positioning System, Geographic Information Systems (GIS), Computer-Controlled Devices (automated systems), Smart phone Mobile Apps in Agriculture, Radio-Frequency Identification Technology (RFID), and Agricultural Resources and Services Management (ARSM). The important agricultural portals for agricultural development are: Haritgyan.com, TOEHOLDINDIA.com, ITC’s Soyachoupal.com, Plantersnet.com, Krishiworld.net, Agriwatch.com, Acquachoupal.com, Fertindia.com, Indiaagrisat.com, Indiancommodities.com, Fci.web.in, etc. Some initiatives in India that use internet for agricultural development are: National Agriculture Technology Project, AGMARKNET, Community Information Centres, Warana Wired Village Project by Government of India. Similarly state governments have also taken initiatives to use internet in various agricultural projects like, Janmithra (Rajasthan), Gyandoot (Madhya Pradesh), e-Seva (Andhra Pradesh), Bhoomi (Land Record Computerisation), Raitha Samparka Kendra Online (Karnataka), Rasi, Miyams Karchipular (Tamil Nadu), Seva - Automated Milk Collection Centres of Amul dairy cooperatives (Gujarat) and E-Srinkala (Kerala).

Agricultural extension is a general term meaning the application of scientific research and new knowledge to agricultural practices through farmer education. The field of ‘extension’ now encompasses a wider range of communication and learning activities organized for rural people by educators from different disciplines, including agriculture, agricultural marketing, health and business studies. Any particular extension system can be described in terms of both how communication takes place and why it takes place? There is a growing recognition that extension must go beyond transferring new food crop technology to farmers and focus on helping the rural poor by promoting agriculture diversification, increasing rural employment helping farmer gain access to biotechnology and access to export markets and also environment awareness and rural health awareness.

Conclusion

Internet is changing all the spheres of human lives. Hence, it is a popular belief that agricultural extension is also no exception to this. It is also expected that the Internet/IT (Information Technology) led extension systems are going to act as a key agent for changing agrarian situation and farmers’ lives by improving access to information and sharing knowledge. So, there is an urgent need of internet in agricultural extension especially in the areas like; to expand knowledge resources, to facilitate better information access, to supplement inadequate technical manpower, for stronger research-extension-client system linkage, to develop efficient feedback mechanism, for cost-effective extension delivery, to ensure gender equity in technology transfer process, to empower small and marginal farmers, to develop knowledge managers and to serve the farm stakeholders beyond technology transfer role.

References:

13. CROP PHYSIOLOGY

Significance of Hot Weather (Heat Stress) and its Impact on Crops

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Stress in biological terms means deviation in the normal physiology, development and function of plants which can be injurious and can inflict irreversible damage to the plant system. Stress in agricultural terms is defined as a phenomenon that limits crop productivity or destroys biomass. Biotic and Abiotic stress are the two major ones. Heat stress often is defined as where temperatures are hot enough for sufficient time that they cause irreversible damage to plant function or development. In addition, high temperatures can increase the rate of reproductive development, which shortens the time for photosynthesis to contribute to fruit or seed production. I also will consider this as a heat-stress effect even though it may not cause permanent (irreversible) damage to development because the acceleration does substantially reduce total fruit or grain yield. However, heat stress is a complex function of intensity (temperature in degree), duration and rate of increase in temperature. The extent to which it occurs in specific climatic zones depends on the probability and period of high temperature occurring during the day and/or the night. Also, crop species and cultivars differ in their sensitivity to high temperatures. Cool-season annual species are more sensitive to hot weather than warm-season annuals.

Heat tolerance is generally defined as the ability of the plant to grow and produce economic yield under high temperature. However, while some researchers believe that night temperature are major limiting factors others have argued that day and night temperature do not affect the plant independently and that the diurnals mean temperature is a better predictor of plant response to high temperature with day temperature having a secondary role.

Heat stress due to high ambient temperature is a serious threat to crop production worldwide. Gaseous emissions due to human activities are substantially adding to the existing concentrations of greenhouse gases, particularly CO₂, methane, chlorofluorocarbons and nitrous oxides. Different global circulation models predict that greenhouse gases will gradually increase world's average ambient temperature. As per the Fifth Assessment Report of IPCC published in 2014, globally averaged combined land and ocean surface temperature has risen by 0.85°C Celsius over the period 1880 to 2012. All India mean temperature have risen nearly 0.6°C over the last 110 years. Further India Meteorological Department (IMD) studies have highlighted that extreme events like heat waves have risen in the last 30 years. Rising temperature may lead to altered geographical distribution and growing season of agricultural crops by allowing the threshold temperature for the start of the season and crop maturity to reach earlier.

- At very high temperature, severe cellular injury and even cell death may occur within minutes, which could be attributed to a catastrophic collapse of cellular organization.
- At moderately high temperature, injuries or death may occur only after long term exposure.
Direct injuries due to high temperature include protein denaturation and aggregation, and increased fluidity of membrane lipids.

Indirect or slower heat injuries include inactivation of enzymes in chloroplast and mitochondria, inhibition of protein synthesis, protein degradation and loss of membrane integrity.

Heat stress also affects the organization of microtubule asters in mitotic cells, and elongation of phragmoplast microtubules. These injuries eventually lead to starvation, inhibition of growth, reduced ion flux, production of toxic compounds and reactive oxygen species. Heat stress causes multifarious, and often adverse, alterations in plant growth, development, physiological processes, and yield.

Impact of high temperature on seasonal plants.

The cool-season annuals, pea is very sensitive to high day temperature with death of the plant occurring when air temperature exceed about 35 °C for sufficient duration, whereas barely is very heat tolerant, especially during grain filling.

The warm season annuls, cowpea can produce substantial biomass when growing in one of the hottest crop production environments on earth (maximum day time air temperatures in a weather station shelter of about 50°C), and although it’s vegetative development may exhibit abnormalities such as leaf fasciation.

The season annuals, high daytime temperature can cause leaf firing which involves necrosis of the leaf tips and this symptom also can be caused by drought. Reproductive development of many crop species is damaged by heat such that they produce no flowers or if they produce flowers they may set no fruit or seeds.

So, Extreme temperature can cause premature death of plants.

Reference


14. AGRONOMY

Contingency Crop Planning Under Aberrant Weather Conditions

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Contingency crop planning refers to making available a plan for providing alternate crop or cultivar choices in tune with the resource endowments of rainfall and soils in a given location (Prasad et al., 2012). It is meant to mitigate any unexpected, unusual, unfavorable and hence unwanted weather situations occurring at any time before or after the crops are sown. The contingency crop planning therefore is proposed to mitigate such situation through the choice of appropriate crop and varieties, cropping systems or other necessary relevant farm practices.

To develop a contingency plan for an area, a detailed study of the rainfall amount and distribution should be done first. It is necessary to use a robust early warning system of spatio-temporal changes in weather as well as other environmental parameters for better planning. Long-term strategic approaches to efficiently conserve and utilize rain water on the one hand and in-season tactical approaches to mitigate the adverse effects of weather aberrations on the other are also needed (Joshi and Kar, 2009).
Use of alternative crops or cultivars adapted to the likely changes (Narain et al., 2006), alteration in the planting date, and management of plant spacing helps in reducing loss. Plant stress management through agro-chemical like thiourea spray (Garg and Burman, 2007) potassium solution spray (Ragamma and Naidu, 2006), Thioglycolic acid (TGA) spray (Dhikwal et al., 2013), salicylic acid spray (Matwa et al., 2017) and polythene mulch (Bhardwaj, 2013) might help in reducing the adverse impact. Selection of early flowering time and a shorter vegetative phase varieties can be very important in conditions of terminal drought (Shavrukov et al., 2017). Use of resource-conservation technologies and a shift from sole cropping to diversify farming system is highly warranted (Bhardwaj, 2013). Horticulture and agro-forestry need to be given more encouragement (Bhandari et al., 2014). Late onset of monsoon rains often leads to delayed planting; therefore specific crop contingency plans have been developed for different agro-climatic zones to address the issue.

Contingency crop planning is an important requirement; hence greater attention should be paid involving new findings on short duration crop varieties and research on plant stress management.

References


15. AGRICULTURE

**Water Resources Management in Arid Regions**

**Anjali Jingar**

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Water resources development in dryland regions can be divided into three categories:

1. Crop planning and climate analysis,
2. *In-situ* moisture conservation techniques.
and
3. Soil and water conservation measures including water harvesting

1. Crop planning and climate analysis
In monsoon climates, good correlations have been established between the dates of onset of the rainy season and total seasonal rainfall. The onset of monsoon decides choice of crop, plant population, mineral fertilizers and other inputs. Early onset indicates probability of receiving higher total rainfall. Based on this, medium duration crops/cultivars (85-90 days), higher plant population, and higher rates of mineral fertilizer can be used. If rainy season begins late, opposite action (shorter season crops and lower plant population & fertilizer) may be warranted. A number of cropping systems have been identified that effectively utilize the rainfall resources for arid zone and provide a stable income over the year.

2. In situ moisture conservation techniques
The second water resource approach is to utilize the water where it falls, by means of appropriate in situ moisture conservation practices. Efficient rainwater management acts as insurance for the crop during the rainfall deficit periods. Management techniques that increase infiltration and soil water storage, decrease water losses through runoff, evaporation, and evapo-transpiration by weeds increase the availability of water for subsequent crops. Maximizing infiltration and minimizing runoff can be achieved through a variety of land surface configurations, off-season deep tillage, mulching, compartmental bunding and interrow water harvesting.

Soil and water conservation measures including water harvesting
Soil and rainwater conservation practices for alfisols and aridisols of arid zone are contour bunding, wind strip cropping, minimum tillage, water harvesting, shelterbelts, sand dune stabilization etc. Wind erosion is a serious problem in western Rajasthan, causing land degradation and thereby posing a severe threat to agriculture and allied activities. Immediate attention for its control through planting wind breaks/ shelter belts, stabilization of sand dunes, use of minimum tillage and conservation of water are some of the measures found effective for checking wind erosion.

- Erosion- resistant crops like grasses are alternated with erosion- susceptible crops like pearl millet and arid legumes perpendicular to the wind direction.
- Contour bunding was found to check runoff and nutrient loss, resulting in increased crop production; wind strip cropping proved to be a useful practice in areas covered with soils prone to wind erosion, low rainfall and high wind regime.
- Ancient water harvesting structures like ponds, khadins and tankas are still in use in many dry land areas, including western Rajasthan. In fact, ponds were constructed for storing water available from adjoining natural catchments during the rainy season. In the khadin system, runoff from uplands and rocky surfaces is collected in the adjoining lower valley formations. Similarly, tankas are meant to store runoff water for drinking or irrigation purposes.
- The sand dune stabilization through Calligonum polygonoides, having extensive root system, was found the most efficacious sand binder.
- Shelterbelts reduced wind speed and evaporation and saved fertility loss from agricultural fields. A three-row shelter belt of Cassia siamea- Albizia lebbeck- Cassia siamea was found more effective in reducing the wind speed by 36 to 46% on the leeward side and the erosion from cultivated fields in western Rajasthan, increasing yield of pearl millet by 20 to 30%.

References
The country’s demand for power is growing at an average annual growth rate of more than 8%. In addition, there is a chronic and acute shortage of electricity and peak load shortage has been estimated to be more than 12%. The Indian power generation is dependent on coal based thermal power to the extent of more than 75%, which is depleting this precious but highly polluting resource, which is a major contributor to global warming. As far as liquid fuels for the transport sector is concerned, the country imports nearly 80% of its requirements of crude oil, which is expected to grow to 90% by 2020. Thus, it is important to look for alternatives that are less polluting and do not further exacerbate the accelerating global warming phenomena.

India has a large renewable resource that can be used to overcome the energy crisis of the country and promote sustainable energy and economy. Among the sources of renewable energy, biomass based biofuels, power and heat can play an important and significant role. Biomass based power and/or heat generation can be used to mitigate the acute and chronic energy crisis of the country. Ethanol, biodiesel, and second generation renewable liquid fuels obtained from biomass can supplement petrol, diesel, and other fuels such as jet fuel. Despite a large number of benefits, the development of this sector has been very slow. Fortunately, India is blessed with large biomass resources that are primarily required for the development of a large bio-energy sector, which can appreciably contribute to national development.

Benefits and Advantages of Bio-energy and Biofuels:

Sustainable and Renewable Energy: Biomass provides a sustainable source of renewable energy, if harnessed properly. Since it is based on renewable source of energy, it does not deplete finite fossil fuel resources and is sustainable.

Decentralized Distributed Generation: Biomass based power plants are much smaller in size than fossil fuel based coal or natural gas plants. They are decentralized and can be set up in a large number of locations to use the available biomass. This leads to a number of benefits, including lower transmission and distribution losses.

Energy Security: Since bioenergy is totally domestically produced, it enhances energy. India is increasingly facing shortage of indigenous fossil fuel and has to rely on imports from politically unstable countries.

Balance of payment: As the consumption of crude oil and coal is growing rapidly and the cost of fossil fuel is increasing steeply, the value of imports is mounting. This large value of imports has an adverse impact on the Indian economy. Since biomass based power and biofuels substitute imports of fossil fuel such as coal and crude oil, it will assist in improving balance of payment.

Rural Employment and Development: Biomass based power provides significant rural employment. This, in turn, leads to rural development and improves rural income by growing of energy plantation/agro-forestry as a cash crop.

Viable alternative for producing power: In most cases, biomass based power is economical, especially if the advantages are taken into consideration. Biofuels such as Ethanol are also competitive to cost of petrol.

Use of Waste product: Since bioenergy is based on waste from agro and food processing, it will improve viability of these units and also assist the development of rural sector.

Mitigation of Green House Gases: Since bioenergy is from renewable sources, it mitigates emissions of GHGs to the atmosphere and helps in controlling climate change.

Economic development: The Indian power
station, with significant shortages both in peak and off-peak, has been a critical constraint in the rapid development of the country. Biomass power will supplement power and assist in development of the country.

**Availability of resources**

The surplus biomass is based on total biomass available, deducting the biomass used by cattle and human for their own use such as cooking. The quantity of bioenergy that can be produced is dependent upon the surplus biomass available in the country. The quantity of surplus biomass can increase, if the rural population shifts from the use of biomass for cooking to more convenient means such as use of LPG/NG over a period of time and also uses efficient cooking stoves.

Total biomass available used on agro products in the country is estimated on the basis of production of agro-product, multiplied by the residue to product ratio (RPR). Another factor to be considered is the efficiency of collection and transportation of residue. In case of biofuels, the yield and area planted are most important factors related to availability. In case of Tree borne Oil seeds (TBOs), the gestation period is also an important factor.

The total biomass availability has been estimated to be around 500 million tonnes while the estimated surplus biomass availability is about 120-150 million metric tonnes per annum, covering agricultural and forestry residues. The states having maximum availability of biomass include Rajasthan, Punjab, Maharashtra, UP, Haryana and MP. Further, the availability of bagasse in sugar mills has been estimated at around 70 million tonnes, which is mainly available in sugarcane producing states.

The main resource form producing Ethanol in India is molasses. However, excess sugarcane, tropical sugar beet, sweet sorghum, and non-edible grain are resources that can be used. Another resource that can be utilized to produce cellulosic Ethanol in the medium term future is bagasse, in particular, and biomass, in general. The sugar producing states are also the largest producers of molasses.

The main resource form producing biodiesel is non-edible oils from TBOs such as Jatropha, Pongamia, Simarubha, etc. States that have taken major initiatives to promote TBO plantation include Chhattisgarh, Maharashtra, Karnataka and UP. They have undertaken the plantation of Jatropha and Pongamia.

Biomass is also a potential source of renewable liquid fuels, which are being named as ‘green gasoline’, ‘renewable diesel’, and ‘green jet fuel’. There are under development.

**Conclusion**

There urgent need is to have significant amount of biomass/feedstock available in the country to produce substantial quantities of bioenergy and biofuels so as to make major contribution to the nation’s economy. The benefits and advantages are many. However, the number of barriers are many too. The government should take interest and effective measures to assist the industry in overcoming barriers. Entrepreneurs should carefully examine the ricks in such projections and take proactive action to remove them.

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17. AGRICULTURAL ENTOMOLOGY

Intraguild Interaciton amongst Parasitoids

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**Introduction:**

Insects that are parasitic only during their immature stages are termed protelean parasites. The protelean parasites that attack invertebrates nearly always destroy their hosts. These parasites are often described as parasitoids, a term coined by Reuter to differentiate them from the typical parasites. Parasitoids include a vast number of species of the so-called parasitic Hymenoptera, the Strepsiptera, and a few of the Diptera, primarily in the family Tachinidae.

Parasitoids are a widely used group of invertebrate natural enemies as biological control agents and several species are being
used to control various aphid pests. In recent years, an increasing emphasis is being given to the conservation and manipulation of naturally-occurring populations of parasitoids in agricultural ecosystems over traditional approaches to biological control. But these approaches must be underpinned by basic knowledge in host preference behaviour and ecology of the parasitoid species being manipulated.

The aphid *Acyrthosiphon pisum*, is a very detrimental pest in agriculture. In addition to the direct damage caused by feeding on plants, aphids also act as ‘vectors of plant diseases’, transmitting a myriad of diseases to their hosts. Aphids are also able to reproduce rapidly and over the course of a few generations a single aphid could give rise to hundreds of individuals. However, nature does not allow one species to breed continuously without limiting population growth in some way. For aphids such as *Acyrthosiphon pisum*, these constraints come from three biologically different groups: predators (e.g. ladybirds), parasitic wasps and entomopathogenic fungi. These species are all natural enemies of *A. pisum*, so they are referred to as occupying the same guild.

The seven-spot ladybird, *Coccinella septempunctata* is a generalist predator which seeks out and eats aphids as a food source. Up next we have the entomopathogenic fungus, *Pandora neoaphidis*. This fungus enters the aphid and over time proliferates throughout its entire body. After around 5 days, the fungus kills the aphid, growing its fruiting structures outwards to distribute about 10,000 spores.

The seven-member of the guild is *Aphidius ervi*, a parasitic wasp native to Europe. Similarly, this wasp uses the aphid for reproduction purposes, but in a slightly different way. The wasp uses its sharp ovipositor to deposit an egg into the aphid’s body cavity. This environment is ideal for a developing wasp which goes through four growth stages (instars) that eat non-vital parts of the aphid’s body. Finally, at the end of the fourth instar, the young wasp devours the aphid’s internal organs and forms a cocoon within the empty body cavity in which it pupates and become an adult (completing its 10 day life cycle), and leaving a mummy behind.

These three organisms are situated directly above the aphid in the food chain – which means they are in the same guild. Inhabiting this position increases the likelihood that they may ‘bump into one another’ from time to time, as they physically occupy similar habitats and share a common goal: to gather resources from aphids, whether it’s for energy, reproduction or both.

The interactions between organisms in the same guild are called intraguild interactions and are important for us to understand if we are to optimise field margins. If, for example, intraguild species were competing aggressively with one another their ability to control the pest would be reduced (antagonistic interactions).

In experiments it is found that parasitoids consistently avoid leaves which have ladybird ‘footprints’ on them. This is because the ladybird leaves a chemical footprint trail when it walks across the surface of a leaf. The parasitoid uses these footprints to know that the ladybird is around and does not parasitise aphids - this prevents parasitised aphids from being predated by the ladybird and allows the parasitoid and ladybird to work together to control pests. In contrast, we found that ladybirds did not avoid fungus infected aphid cadavers. This was unsurprising, as the fungus itself has no negative affect on ladybirds - they can eat a healthy aphid or a fungus-infected aphid. Interestingly, we found that although fungal spores primarily get distributed by the wind, they also benefit by piggy backing on ladybirds, which is a much more precise way to get to aphids. Therefore the ladybirds and fungi can work together to control pests.

However, although the parasitoid and fungus both use the aphids to complete their lifecycle, the fungus is much faster. Therefore, if an aphid is both parasitised and infected by the fungus, the rapidly developing fungus will ‘win the race’ and the parasitoid will not survive. Fungi and parasitoids may therefore not be able to work together to control pests.

Conclusion

In conclusion, for a practical biological control program we should know not only how to use the natural enemies to control the pests but also the basic biology knowledge of natural enemies are needed. This is importance for sustainable development in biological control field.
References:

18. AGRICULTURAL ENTOMOLOGY

Brinjal Shoot and Fruit Borer (BSFB) and its Management Strategies

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Introduction

Brinjal Shoot and Fruit Borer (BSFB), *Leucinodes orbonalis* is a very dangerous pest of brinjal. It not only reduces the yield by making holes in shoots as well as in fruits but also reduces the aesthetic value of the fruits so loss get doubled. It is a monophagous pest feeds only on Brinjal.

Distribution and status

India, Bangladesh, Malaysia, Thailand, Burma, Srilanka, Laos, South Africa, Congo. It is a major and regular pest of brinjal causing damage to even 30-50 % of fruits or more.

Host range

Brinjal, potato, other wild plants belonging to solanaceae, peas.

Damage Symptoms

- The most destructive pest of brinjal
- Infests the crop both in vegetative and fruiting stage of the plant.
- The pest is active throughout the year at places having moderate climate but its activity is adversely affected by severe cold.
- Eggs are laid singly on ventral surface of the leaves, shoots, flower buds and occasionally on fruits.
- In young plants, the caterpillar bore into petioles and mid ribs of large leaves and young tender shoots, close the entry point with excreta and feed within. As a result the affected leaves dry and drop down while in case of shoots, the growing point is killed. In later stage caterpillars bore into flower bud and fruits.
- Larva bores into tender shoots and causes withering of terminal shoots / dead hearts - also bores petioles of leaves, flower buds and developing buds, causes withering of leaves, shedding of buds and make fruits unfit for consumption. Attacked fruits are with boreholes plugged with excreta. Fruits become out of shape also.

Biology

Egg period: 3-4 days. About 150-350 creamy white eggs laid singly on leaves, tender shoots, flowers and developing fruits. Larva is stout, pink coloured with sparsely distributed hairs on warts on the body and brownish head. Larval period 15 days - 5 instars. Pupa: 6-8 days in tough greyish cocoon on plant itself, boat shaped cocoon. Medium sized adult with white wings, flashed with triangular brown and red markings on forewing. Total life cycle: 17-50 days.

ETL: 1-5 % of fruit damage.

Management Strategies

- Avoid continuous cropping of brinjal and ratooning.
- Clipping and destruction of infested shoots along with the larvae at 15 days interval.
- Use less susceptible varieties like Punjab Barsati, Arka Kasumkar, PPC, Punjab Neelam.
- Grow resistance varieties like Annamalai, Pusa purple round, Arka Kasumkar, Doli-5, Chaklasi Doli, Pusa purple Long, Pusa Purple Round, SM 67, SM 68, Pant Samrat
- Collect and destroy the damaged tender
shoots, fallen fruits and fruits with bore holes to prevent population buildup

- Use light traps @ 1/ha to attract and kill the moths.
- Release egg parasitoids *Trichogramma chilonis* @1.0 lakh/ha.
- Spray Bt formulations of *B. thuringiensis* var. *kurstaki* such as Dipel @ 1.5 to 2 ml /L of water.
- Avoid using synthetic pyrethroids as they cause resurgence of sucking pests.
- Avoid using insecticide at the time of fruit maturation and harvest.
- Uproot and burn old plants before planting new plants since they harbour pest and carry over infestation
- Soil treatment with carbofuran @ 30 kg ai/ha at the time of transplanting.
- Foliar spray with insecticide such as Cypermethrin @ 50 g ai/ha, First spray for fruit borer should commensurate with 50 % flowering.

**Natural enemies against BFSB reported in India:**

**Predators:** Campyloneura sp (a bug), Cheilomenes sexmaculata (a ladybird beetle), Coccinella septempunctata (seven spotted ladybird beetle), *Brumoides suturalis* (three striped ladybird)

**Parasitoids:** Pseudoperichaeta sp, Phanerotoma sp, Itamoplex sp, *Eriborus argenteopilosus*, *Diadegma apostata*

**Entomopathogens:** Fungus (*Bipolaris tetramera*), Baculovirus, Nuclear polyhedrosis virus

**Prevention**

- Collect Information on pest history in the area
- Destroy old brinjal stubble
- Use tolerant varieties (Padagoda selection)
- Establish a 2 m high net barrier or physical barrier using locally available materials (Dried banana leaves, coconut leaves etc.) around the field
- Use maize as a barrier crop around brinjal fields (should establish 15 days before transplanting of brinjal)
- Do a crop rotation with pulses
- Plough the field to expose pupae to sunlight to kill them
- Strictly follow the recommended fertilizer practices
- Do mixed cropping (e.g. with maize, pulses)
- Conserve natural vegetation around the crop to increase population of natural enemies (*Trathala flavoorbitalis* etc.)

**References**


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**19. AGRICULTURAL ENTOMOLOGY**

**Papaya Mealybug and its Management Strategies**

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**Origin and Distribution**

The papaya mealybug is believed to be native of Mexico and/or Central America, where it never acquired the status of a serious pest, probably due to the presence of an endemic natural enemy complex. It was noticed in South and
Southeast Asia during 2008–09. In India it was recorded in July 2007 at Tamil Nadu Agricultural University, Coimbatore and subsequently spread to neighboring districts. The pest has been reported in Coimbatore, Tirupur, Erode, Salem, Namakkal and Karur districts of Tamil Nadu. The pest is now spreading to other districts too. The pest has been recently noticed in other states such as Karnataka, certain parts of Andhra Pradesh and Malappuram and Thrissur districts of Kerala. The pest has now spread to Pune area of Maharashtra also and is likely to be reported from other parts of the country as well.

**Damage Symptoms**

Papaya mealybug infestation appears on above ground parts on leaves, stem and fruits as clusters of cotton-like masses. The insect sucks the sap by inserting its stylets into the epidermis of the leaf, fruit and stem. While feeding, it injects a toxic substance into the leaves, resulting in chlorosis, plant stunting, leaf deformation or crinkling, early leaf and fruit drop, and death of plants. The honeydew excreted by the bug results in the formation of black sooty mould which interferes in the photosynthesis process and causes further damage to the crops. Heavy infestations are capable of rendering fruit inedible due to the buildup of thick white waxy coating.

**Mode of Dispersal**

Healthy plants can be infested from mealybug infested plants as juvenile mealybugs can crawl from an infested plant to another plant. Small ‘crawlers’ get readily dispersed by wind, rain, irrigation water, birds, ants, clothing, and vehicle, etc. The wax, which sticks to each ovisac and nymphs, also facilitates passive dispersal by equipment, animals or human beings. The female mealybug is not active and unable to fly. In fact, human beings greatly facilitate in the transport of these mealybugs. Long-distance movement is aided through transport of infested planting material and fresh fruits and vegetables from one end of a farm to the other or even across the country. Ants, attracted by the honeydew, have been seen carrying mealybugs from plant to plant.

**Biology**

Papaya mealybugs are most active in warm, dry weather. Females have no wings, and move by crawling short distances or by being blown in air currents. Females usually lay 100 to 600 eggs. Eggs are greenish yellow and are laid in an ovisac that is three to four times the body length and entirely covered with white wax. The ovisac is developed ventrally on the adult female. Egg-laying usually continues over a period of one to two weeks. Eggs hatch in about 10 days, and nymphs or crawlers begin to actively search for feeding sites. Adult males may be distinguished from other related species by the presence of stout fleshy setae on the antennae and the absence of fleshy setae on the legs. Females have three instars whereas males have four instars. Males have longer development time (27-30 days) than females (24-26 days) at 25±1°C, 65±2 % RH and 12:12 (L:D) photoperiod. Under greenhouse conditions, reproduction occurs throughout the year.

**Host plants**

Heavy attack of papaya mealybug has been noticed on a wider range of cultivated crops and weed hosts belonging to different families of plant kingdom. The following table provides the list of recorded hosts of *P. marginatus*.

| Cultivated agricultural and horticultural crops | Red gram, Papaya, Silk cotton, Cotton, Shoe flower, Jatropha, Tapioca, Mulberry, Guava, Tomato, Turkey berry, Brinjal and Teak |
| Weed hosts | Country mallow, Latjira, Wild mustard, Spider wort, Chandvel, Garden sprug, Hazardani, Dronapuhip, Tulasi, Congress grass, Gharma, Pig weed and Turkey berry |

**Management Strategies**

Plant protection products are of limited effectiveness against mealybugs because of the presence of waxy covering of its body. Management of mealybug involves the following tactics:

**Cultural and Mechanical**

Monitoring and scouting to detect early presence of the mealybug. Pruning of infested
branches and burning them. Removal and burning of crop residues. Removal of weeds/alternate host plants like Hibiscus, Parthenium etc. in and nearby crop. Avoiding the movement of planting material from infested areas to other areas. Avoiding flood irrigation. Prevention of the movement of ants and destruction of already existing ant colonies. Sanitization of farm equipment before moving it to the uninfested crop. Application of sticky bands or alkathene sheet or a band of insecticide on arms or on main stem to prevent movement of crawlers.

**Preventive:** In tapioca, stems are stocked for propagative purpose in the farms. These planting materials often carry mealybug infestation, if the previous year’s crop was already infested. Generally, before planting, setts, in parts, are soaked for 1 hr in dichlorvos (76 % EC; @10 ml/litre of water) to disinfest the mealybugs. There is a need that in the infected areas of all the planting material before stocking should be treated with chemical insecticides.

**Biological control**

Natural enemies of the papaya mealybug include the commercially available mealybug destroyer, *Cryptolaemus montrouzieri*, ladybird beetles, lacewings, hover flies, *Scymnus* sp. and certain hymenopteran and dipteran parasitoids. Conservation of these natural enemies in nature plays important role in reducing the mealybug population. In the nature, lepidopteran predator, *Spalgis epius* (Lycaenidae) is a well known representative of carnivorous butterfly feeding on various species of pseudococcids and coccids. *S. epius*, being the dominant predator, feeds efficiently on the ovisacs, nymphs and adult of papaya mealybug. Australian ladybird beetle (*C. montrouzieri*) predates on mealybugs, eating 3,000-5,000 mealybugs in various life stages and is released @ 10 beetles per tree or @ 5000 beetles/ha. When high activity of *S. epius* and other natural enemies is observed, care should be taken to delay spraying operations and measures should be taken to conserve them. Exotic parasitoids/predators such as *Anagyrus loecki* Noyes and Menazes, *Acerophagous papayae* Noyes and Schaff and *Pseudoleptomastrix mexicana* Noyes and Schaff (Hymenoptera: Encyrtidae) were released in Sri Lanka in May 2009 (imported from Puerto Rico) and resulted in 95 to 100% control of the papaya mealybug in some parts of that country by August 2009. There is a need to introduce such exotic parasitoids in India to contain the pest without harming the environment.

**Chemical control**

Locate ant colonies and destroy them with drenching of chlorpyriphos 20 EC @ 2.0 ml/litre of water. Regular monitoring of the crop for mealybug infestation and its natural enemies. Spot application of insecticide immediately after noticing mealybug on some plants in the crop field. If the activities of natural enemies are not observed, use of botanical insecticides such as neem oil (1 to 2%), NSKE (5%), or Fish Oil Rosin Soap (25g/litre of water) should be the first choice. Chemical control is only partially effective and requires multiple applications. Apply recommended chemical insecticides as the last resort such as profenophos 50 EC (2 ml/litre), chlorpyriphos 20 EC (2ml/litre), buprofezin 25 EC (2 ml/litre), dimethoate 30 EC (2 ml/litre), thiomethoxam 25 WG (0.6 g/ litre), imidacloprid 17.8 SL (0.6 ml/litre). Spray profenophos @ 2 ml /litre on stumps immediately after pruning in mulberry followed by second spray, 15 days after pruning, with dichlorvos @ 2 ml /litre along with azadirachtin (10000 ppm) @ 1 ml /litre. Stickers should always be added in spray solutions. Avoid repeating the use of the same chemical insecticide as there are chances for development of resistance in the pest. Drenching soil with chlorpyriphos around the collar region of the plant to prevent movement of crawlers of mealybug and ant activity is useful. Insecticide resistance and non-target effects on natural enemies make chemical control a less desirable control option.

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Agrometry: The Study of Agricultural Statistics, Mathematics and Informatics

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The statistics and mathematics are made easy to any branch of knowledge for research, analysis and information. Agricultural science also not defer to it. Generally, the statistics and mathematics are applied in agricultural science for research, analysis and information. Although, the branch of study of statistics and mathematics in biology is called biometry, yet, in agricultural science may be called agrometry. After application of agricultural statistics and mathematics in agricultural science, the new technique is being used is called informatics.

Therefore, “the study of application of statistics, mathematics and informatics in agricultural science may be defined as agrometry.”

Today, the application of mathematics in agricultural science has increased. About 5-6, decades back, it was not necessary to use mathematics in agricultural science, but the development in agricultural science since 5 decades, the mathematics become useful. Although, the interpretation of research, analysis and information, without mathematics can be understand and demonstrate, but, by the application of mathematics, it becomes very easy and clear. Prof. Paul A. Samuelsson has stated in ‘economic theory and mathematics’ “Although, to get position in economics, the knowledge of mathematics neither necessary nor compulsory, but, it may accessory.

But, just its opposite, to get position in agricultural science, the knowledge of statistics is also necessary and compulsory too. Now a day, the application of statistical methods has increased in all the branches of agricultural science. Statistics methods are necessary for the solution of agricultural research problems. The continuous research is the fundamental characteristics of agricultural science. Therefore the statistics are applied for the effective management of interpretation of experiments and data in agricultural research. There is no need to new methods for understanding and interpretation of known variations of data or observations. Whereas, opposite to physical science, agricultural science is a set of biological sciences, whose fundamental nature is unknown variations. Hence the test of significance of unknown variations is the fundamental of agricultural science, as- soil science, agronomy, horticulture, genetics and plant breeding, agricultural entomology, plant pathology, weed science, agricultural chemistry, animal husbandry and veterinary science, agricultural engineering, agricultural economics, agribusiness management, agricultural extension and rural sociology etc.

Soil, climate, seeds, crops, manures and fertilizers, irrigation, pests, diseases, weeds, livestocks, implements, individual society and economic behaviour of nation, etc. are the subject matters of agricultural science. Their observations are the subject matters of agricultural statistics. The unknown variations are observed in all such above subject matters. This unknown variation does not appear in systematic manner, but they are random in nature. So, unknown variations are also called random variations. The random variations uniformly affected the subject matters and produce unknown variations and such effects are known as variables. The variations of variable effects of research, analysis and information are represented by various methods in agricultural statistics, like- correlation, test of significance and analysis of variance etc.

Generally, the complicated principles are represented by formulas, functions, or, equations of variables. So the conversion or inversion of such formulas, functions, or, equations in agricultural science are the
fundamental subject matters of agricultural mathematics, like determinants, matrices, binomial theorem, coordinate geometry and calculus etc. The demand of an item is dependent on the income and the price of an item. It means, the demand of an item is differs at magnitude of prices and income of the consumer. So, demand, income and prices are variables. Hence, such variables can be written in the form of marks and signs, equations, functions and formulas, as-

\[ x = a + bp, \text{ or, } y = a - bp, \text{ or, } S = 25 + 25p, \text{ or, } D = 150 - 50p \]

Equilibrium = \( (S = D) = 200/3 \)

Where, \( x = \text{supply-S}, \ y = \text{demand-D}, \ a = \text{range}, \ b = \text{rate} \)

There equation can be find by the plotting on demand-supply graph. Hence, in this scenario, mathematics is not necessary, but, accessory. In such manner, like, correlation in statistics the marginal ratio of rate of related change of variables and the total of difference of that of related change of variables can be find by the mathematical method- calculus (differentiation and integration) but, it can also be find by the function curve. It means apposite to the statistics, mathematics is accessory to find marginal ratio and total of rate of difference of related change of variables.

So, the application of mathematics in agricultural science is accessory, not necessary. The mathematics is useful in agricultural science but, it is conditions that, user’s have adequate knowledge of mathematics. They might have know where, how and how much, the mathematics can be utilized.

After application of agricultural statistics and mathematics for research, analysis and information in agricultural science, the new technique is being used is called informatics or information technology. Informatics is a computer based branch of knowledge. Computer is a automatic machine which manipulate data with speed and accuracy. Computer and informatics are the great achievement of 21st century, which influenced and modified all the concerns of human life. The study of computer and software packages for the application of agricultural statistics and mathematics are called agroinformatics or Agricultural informatics. There are different types of software packages are applied for agro informatics, like- MS EXCEL, MATHEMATICA, SYSTAT, STATISTICA, SAS and SPSS etc.

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21. STATISTICS

Application of Parametric and Non-Parametric Tests in Agricultural Research

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Introduction: Agricultural research requires proper study design, management, data collection and analysis to obtain statistically sound results. Agricultural researchers and scientists have an important role to play in the agricultural production and development of a nation. In view of the day to day radical changes in agricultural research, the scenario is becoming tough for agricultural scientists and associated scholars. Statistical science is concerned with the aspect of theory of design of experiments and sample investigation and drawing valid inference from using various statistical methods. The statisticians design and technique helps to describe the involvement of complex phenomena and behavior of agricultural growth. The impact of associated factor can be analyzed with the help of simple
statistical design, sampling techniques with inferential statistics. The techniques of drawing valid interpretation depend on how the data has been gathered and also depending upon the research objective.

Agricultural research has played a key role in the development of statistical methods. The presence of wide heterogeneity in the experimental material that is often used in agricultural research, led to the application of statistical tools and consequently many refinements and newer development in statistics followed. The famous statisticians, Sir R. A. Fisher and his colleagues at Roth Amsted Experiment station in United Kingdom and elsewhere, while attempting statistical solutions to agricultural problems, led to the development of design of experiments and analysis or variance techniques which are fundamental to the subject of statistics.

**Parametric or Standard Tests of Hypothesis:** A parametric statistical test is one that makes assumptions about the parameters (defining properties) of the population distribution (s) form which one’s data are drawn or Parametric or Standard tests of hypothesis usually follow certain properties of the parent population from which samples are drawn.

**Assumptions of Parametric Tests**
1. The sample is large and comes from a population having normal distribution.
2. The observations are independent, which means selection of is not dependent on the selection of other.
3. The variables are expressed in interval or ratio scale.
4. These populations must have the same variances.
5. The means of these normal and homoscedastic populations must be linear combinations of effects due to columns and/or rows.

**Non-Parametric Tests or Distributions Free Test of Hypothesis:** Non-parametric tests or Distribution free test of hypothesis do not specify any conditions about the parameters of the population form which the sample is drawn Or A non-parametric test is one that makes no such assumptions. In this strict sense, “non-parametric” is essentially a null category, since virtually all statistical tests assume one thing or another about the properties of the source population(s).

For example, one assumption for the one way ANOVA is that the data comes from a normal distribution. If your data isn’t normally distributed, you can’t run an ANOVA, but you can run the nonparametric alternative- the Kruskal-Wallis test.

**Assumptions of Nonparametric Tests**
Certain assumptions are associated with most nonparametric statistical test, but these are fewer and weaker than those of parametric tests.

**Advantages of Nonparametric Tests**
- Probability statements obtained from most nonparametric statistics are exact probabilities, regardless of the shape of the population distribution form which the random sample was drawn
- If sample sixes as small as N=6 are used there is no alternative to using a nonparametric test
- Easier to learn and apply than parametric tests
- Based on a model that specifies very general conditions.
- No specific form of the distribution from which the sample was drawn.
- Hence nonparametric tests are also known as distribution free tests.

**Disadvantages of Non-parametric tests:**
- Losing precision/wasteful of data
- Low power
- False sense of security
- Parametric models are more efficient if data permit.
- It is difficult to compute by hand for large samples
- Tables are not widely available
- Less number of software’s to analyze
- Testing distribution only
- Higher ordered interactions not dealt with
- In cases where a parametric test would be appropriate, non-parametric tests have less power. In other words, a larger sample size can be required to draw conclusions with the same degree of confidence.
In general Non-parametric Test Methods are most useful when

1. The assumptions about normal distribution of the population is doubtful
2. If sample sizes as small as N=6 are used, there is no alternative to using a nonparametric test
3. The variables are expressed in nominal or ordinal form (i.e. the data are expressed in terms of ranks, difference among pairs etc.)
4. The non-parametric tests are quick easy and quite popular among the researchers.

Which is More Powerful?

Non-parametric statistical procedures are less powerful because they use less information in their calculation. For example, a parametric correlation uses information about the mean and deviation from the mean while a nonparametric correlation will use only the ordinal position of pairs of scores.

The following table lists the nonparametric tests and their parametric alternatives

<table>
<thead>
<tr>
<th>Nonparametric Test</th>
<th>Parametric Alternative</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-sample sign test</td>
<td>One-sample Z-test, One sample t-test</td>
</tr>
<tr>
<td>Two sample Wilcoxon Signed Rank</td>
<td>Two sample Z-test, Two sample t-test</td>
</tr>
<tr>
<td>Friedman test</td>
<td>Two-way ANOVA</td>
</tr>
<tr>
<td>Kruskal-Wallis test</td>
<td>One-way ANOVA</td>
</tr>
<tr>
<td>Mann-Whitney test</td>
<td>Independent samples t-test</td>
</tr>
<tr>
<td>Mood’s Median test</td>
<td>One-way ANOVA</td>
</tr>
<tr>
<td>Spearman Rank Correlation</td>
<td>Correlation Coefficient</td>
</tr>
</tbody>
</table>

The following table lists the parametric and non-parametric tests and their parametric alternatives

<table>
<thead>
<tr>
<th>Parametric</th>
<th>Non-parametric</th>
</tr>
</thead>
<tbody>
<tr>
<td>Information about population is completely known</td>
<td>No complete information about the population is available</td>
</tr>
<tr>
<td>Specific assumption are made regarding the population</td>
<td>No assumption are made regarding the population</td>
</tr>
<tr>
<td>Null hypothesis is made on parameters is made on parameters of the population distribution</td>
<td>The null hypothesis is free from parameters</td>
</tr>
<tr>
<td>Test statistic is based on the distribution (assumed distribution is normal distribution)</td>
<td>Test statistic is arbitrary (not necessarily normal distribution)</td>
</tr>
<tr>
<td>Parametric tests are applicable only for variables</td>
<td>It is applied for both variables and attributes</td>
</tr>
<tr>
<td>Assumed variance is homogeneous</td>
<td>Assumed variance be any</td>
</tr>
<tr>
<td>Can be applied when measurements are on the interval or ratio scale data</td>
<td>Can be applied when measurements are on the nominal and ordinal scale data</td>
</tr>
<tr>
<td>Parametric test is powerful, if it exist</td>
<td>It is not so powerful likes parametric test</td>
</tr>
<tr>
<td>Benefit: can draw more conclusions</td>
<td>Benefits: simplicity; less affected by outliers</td>
</tr>
</tbody>
</table>

Conclusion

- Research investigation is the part of wider development of nation, public health and it is associated with better life of human beings.
- In the advance agricultural research with the help of appropriate statistical tools and research designs provide the unbiased estimates, conclusions and appropriate interpretation.
- Testing of hypothesis is of utmost important in any type of research.
- Testing of hypothesis is carried out by using parametric and Non-parametric test in social science research.
- The normality of the population distribution forms the basis for selection of parametric and non-parametric tests.

References

Sharma, S.D., 2013, Role of statistics and computer in agricultural research. Journal of Statistic and Computers in Agricultural
Bio fertilizers and its uses in Agriculture

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Bio Fertilizer: A bio fertilizer is a substance which contains living microorganisms which, when applied to seeds, plant surfaces or soil, colonize the rhizosphere or the interior of the plant and promotes growth by increasing the supply or availability of primary nutrients to the host plant.

Role of bio fertilizers:
Bio-fertilizers add nutrients through the natural processes of nitrogen fixation, solubilizing phosphorus, and stimulating plant growth through the synthesis of growth-promoting substances. Azotobacter can be used with crops like wheat, maize, mustard, cotton, potato and other vegetable crops. Azospirillum inoculations are recommended mainly for sorghum, millets, maize, sugarcane and wheat. Blue green algae belongs to a general cyanobacteria genus, nostoc or anabena fix atmospheric nitrogen and used as inoculations for paddy crop grown under both upland and lowland conditions. Anabaena in association with water fern azolla contributes nitrogen up to 60 kg/ha/season and also enriches soils with organic matter.

Types of bio fertilizers:

1) Nitrogen fixing biofertilizers
- Increase soil nitrogen level and fixes the atmospheric nitrogen in the soil and make it available to the plants. Examples: Azotobacter, Nostoc, Rhizobium, Azospirillum

2) Phosphate biofertilizers

<table>
<thead>
<tr>
<th>Sl. No</th>
<th>Phosphorus solubilizing biofertilizers</th>
<th>Phosphorus mobilising biofertilizers</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Solubilize the insoluble phosphate from organic and inorganic phosphates sources.</td>
<td>Transfer phosphorus from the soil to the root cortex examples: Arbuscular mycorrhiza</td>
</tr>
<tr>
<td>2.</td>
<td>Releases insoluble phosphorus in soil and fix in clay minerals</td>
<td>Fungus penetrates the cortical cells of the roots. Increase surface area of roots</td>
</tr>
<tr>
<td>3.</td>
<td>Secrete organic acids and lower the pH to dissolve bound phosphates in soil. examples: Bacillus, Pseudomonas, Penicillium, Aspergillus</td>
<td>Displace of absorption equilibrium of phosphate ions which increases the transfer of P ions. Stimulate metabolic processes and Arbuscles absorb these nutrients into the root system</td>
</tr>
</tbody>
</table>

3) Biofertilizers for micro-nutrients
- Bacterial species are silicate and zinc solubilizers
- Degrade silicates and aluminium silicates in soil and help in silicate weathering example: Bacillus sp.

4) Plant growth promoting rhizobacteria (pgprs)
- It act as both biofertilizer and biopesticides
- Promote growth by: a. improved nutrient
availability (biofertilizers), b. suppression of plant disease (bioprotectants) and c. phytohormones production (biostimulants) Examples: Pseudomonas sp., Bacillus sp.

5) Compost biofertilizers

- Utilize animal dung to enrich soil with microorganisms
- Eco-friendly organic fertilizer
- Consists of nitrogen, phosphate solubilizing bacteria and various decomposing fungi
- Microorganisms breaks down organic matter Examples: cellulolytic fungi, Azotobacter

Liquid biofertilizers

- Liquid biofertilizers are suspensions having agriculturally useful microorganisms, which fix atmospheric nitrogen and solubilize insoluble phosphates and make it available for the plant
- Reduces the use of chemical fertilizer by 15-40%. Long shelf life and more temperature tolerant and contamination free. Easy to produce and apply and help to produce organic crops so as to compete in the global market

Algal and other bio-fertilizers:

- Biological nitrogen fertilizers play a vital role to solve the problems of soil fertility, soil productivity and environmental quality. Anabaena azollae, a Cyanobacterium lives in symbiotic association with the free floating water fern Azolla. The symbiotic system azolla-anabaena complex is known to contribute 40-60 kg n ha⁻¹ per rice crop. Anabaenaazolle can grow photo autotrophically and fixes atmospheric nitrogen.

References


23. DRYLAND AGRICULTURE

Water Harvesting Techniques In Semi–Arid Regions

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Introduction

Around 40% world area and 60% of Indian area lying under arid and semi-arid regions where the cultivation of crops are mainly dependent on rainfall, hence called rainfed/dryland agriculture. Rainfall in dry areas is characterized by short duration, high intensity and poor distribution. The low duration high intensity combination is conducive to high runoff production. The great rainfall variation with time presents the biggest challenge to dry land agriculture. Cropping seasons are usually longer than the rainfall seasons, and drought within the growing season is a common feature of most growing seasons. (Hai, 1998). The rainfall under these regions in India are erratically distributed, where the heavy rainfall in short period causes vulnerable runoff. These excess rainfall converting into runoff has to be stored using proper water harvesting techniques/structures to realize optimum crop yield under prolonged dry spells, when moisture is most limiting for crop production.

The excess rain water going into surface runoff can be collected using certain water harvesting structures/technique for future use of stored water for various agricultural use. The various water harvesting techniques/structures in semi-arid regions are described as below;

1. Dug well: Hand dug well have been used
to collect and store underground water and this water is lifted for irrigation. The quality of water is generally poor due to dissolved salts.

2. **Tank:** Runoff water from hill sides and forest is collected on the plains in the tank. Traditional tank has following components viz., catchment area, command area, storage tank, tank bunds, sluice and spillway. The runoff water from catchment area is collected and stored in storage tank on the plain with the help of a bund. To avoid a breaching of tank bund spillways are provided at one or both the end of tank bunds to dispose off excess water. The command area of many tanks range from 25 to 100 hectares. In area receiving annual rainfall of about 1000 to 1500 mm with runoff around 50 % where canal and well irrigation is not feasible due to topography and underground water table, tank are found suitable. An earthen dam of 12 m height is constructed to store about 55,600 m3 of water from forest watershed of 10 hectares. This tank can provide supplement irrigation for 20 hectare of rainfed farmland.

3. **Farm pond:** Farm pond of size 100 to 300 m³ may be dug to store 30 percent of runoff. The problem associated with farm is high seepage loss. This can be reduced by lining of walls. Some of the traditional method of seepage control are the use of bentonite, soil dispersant and soil cement mixture. Bentonite has excellent sealing properties if kept continuously wet, but cracks will be developed when dried. Soil cement mixture can be used but surface cracking developed when exposed to sun drying. A soil cement-cement lining of 100 mm thickness reduce seepage losses up to 10 per cent. The pit lined continuously develops cracks but no cracks will be developed when applied in blocks. The other alternative sealant for Alfisols is mixture of red and black soil in ration of 1:2.

4. **Percolation tank:** Flowing rivulets or big gullies are obstructed and water is ponded. Water from ponds percolate in to the soil and rises the water table of the region. The improved water level in wells surrounding the percolation tank is used for supplement irrigation.

5. **Inter row water harvesting:** In area of high rainfall, there is possibility for occasional water logging and yield of crop like maize is affected. Growing maize on bed and rice on furrow helps both the crops. The excess water collected on bed is stored in furrow which is beneficial for rice.

6. **Broad bed and furrow and farm pond:** The seed bed is made in to wide beds of 1.05 m alternated with the furrow of width 0.45 m. These are called broad bed & Furrow (BBF). This method is quite suitable for black soil and when combined with dry sowing. Excess water during rainy season is collected through the furrow and passed through grassed water ways in farm pond where the water can be stored for subsequent use.

**Reference**

Hai, M. T., 1998. RELMAT Technical Handbook No. 16

### 24. SOIL SCIENCE AND AGRICULTURE CHEMISTRY

**Nano Fertilizer: A New Way to Increase Nutrient Use Efficiency in Crop Production**

**Priyanka Pannu**

*Department of Soil Science & Agricultural Chemistry*

**Introduction**

World agricultural cropping systems intensively using large amount of fertilizers, pesticides, herbicides to achieve more production per unit
area but using more doses than optimum of these chemicals and fertilizers leads to several problems like environment pollution (soil, water, air pollution), low input use efficiency, decrease quality of food material, develop resistance in different weeds, diseases, insects, less income from the production, soil degradation, deficiency of micro nutrient in soil, toxicity to different beneficial living organism present above and below the soil surface etc. Despite these problems there is also challenge to feed the growing population of the world. Therefore in the future, there is need to produce nutritive agricultural produce rich in protein and other essential nutrient required to the human and animal consumption that is why emphasis should be laid on production of high quality food with the required level of nutrients and proteins. For solving these problems in crop production nano-fertilizers, pesticides and herbicides may be effective tools in agriculture for better pest and nutrient management because these nano-materials having more penetration capacity, surface area and use efficiency which avoid residues in environment. Size below 100 nm nano-particles can use as fertilizer for efficient nutrient management which are more eco friendly and reduce environment pollution. Hence, these agricultural useable nano-particle develop with the help of nanotechnology can be exploited in the value chain of entire agriculture production system. In present agriculture fertilizer contributes to the tune of 50% of the agricultural production but increasing use of higher doses of fertilizers does not guarantee to improve crop yield but it leads several problems like degradation of soil and pollution of surface and underground water resources.

Nanotechnology applications in agriculture

Now a days nanotechnology providing different nano devices and nano material which having a unique role in agriculture such as nano biosensors to detect moisture content and nutrient status in the soil and also applicable for site specific water and nutrient management, nano-fertilizers for efficient nutrient management, nano-herbicides for selective weed control in crop field, nano-nutrient particles to increase seed vigor, nano-pesticides for efficient pest management and chitosan nano-particles can be used as herbicide carrier material specially for herbicide such as paraquat (Silva et al. 2011). Nano herbicides are effective in weed management. Hence, nanotechnology have greater role in crop production with environmental safety, ecological sustainability and economic stability. The nano-particles produced with the help of nanotechnology can be exploited in the value chain of entire agriculture production system (Tarafdar, 2012a).

Nano-fertilizers are synthesized or modified form of traditional fertilizers, fertilizers bulk materials or extracted from different vegetative or reproductive parts of the plant by different chemical, physical, mechanical or biological methods with the help of nanotechnology used to improve soil fertility, productivity and quality of agricultural produces. Nanoparticles can be made from fully bulk materials.

At nano scale physical and chemical properties differ than bulk material. Rock phosphate if use as nano form it may increase availability of phosphorus to the plant because direct application of rock phosphate nano particles on the crop may prevent fixation in the soil similarly there is no silicic acid, iron and calcium for fixation of the phosphorus hence it increase phosphorus availability to the crop plants.

**Important properties of nano fertilizers which facilitate higher nutrient use efficiency**

The nano-fertilizers have higher surface area it is mainly due to very less size of particles which provide more site to facilitate different metabolic process in the plant system resulting production of more photosynthets. Due to higher surface area and very less size they have high reactivity with other compound. They have high solubility in different solvent such as water.

Nano fertilizer have large surface area and particle size less than the pore size of root and leaves of the plant which can increase penetration into the plant from applied surface and improve uptake and nutrient use efficiency of the nano-fertilizer. Reduction of particle size results in increased specific surface area and number of particles per unit area of a fertilizer that provide more opportunity to contact of nano-fertilizers which leads to more penetration and uptake of the nutrient [Liscano, 2000].
Fertilizers encapsulated in nano-particles will increase availability and uptake of nutrient to the crop plants. Zeolite based nano-fertilizers are capable to release nutrient slowly to the crop plant which increase availability of nutrient to the crop though out the growth period which prevent loss of nutrient from denitrification, volatilization, leaching and fixation in the soil especially NO$_3$-N and NH$_4$-N. Particle size below 100 nm nano-particles can use as fertilizer for efficient nutrient management which are more eco-friendly and reduce environment pollution. Main reason for high interest in fertilizers is mainly their penetration capacity, size and very higher surface area which usually differs from the same material found in bulk form. This is partially due to the fact that nano particles show a very high surface: volume ratio. Thus, the reactive surface area is proportionally over-represented in nano particles compared to larger particles.

Achievements of nano-fertilizers

Nano fertilizers providing greater role in crop production and several research study revealed that nano fertilizers enhanced growth, yield and quality parameters of the crop which result better quality food product for human and animal consumption. This translates into an improvement to three major areas of production.

Yields: Several research studies revealed that application of nano-fertilizers significantly increase crop yield over control or without application of nano-fertilizer it is mainly because of increasing growth of plant parts and metabolic process such as photosynthesis leads to higher photosynthes accumulation and translocation to the economic parts of the plant. Foliar application of nano particles as fertilizer significantly increases in yield of the crop [Taraftar, 2012b].

Nutritional Value: Nano fertilizers provide more surface area and more availability of nutrient to the crop plant which help to increase these quality parameters of the plant (such as protein, oil content, sugar content) by enhancing the rate of reaction or synthesis process in the plant system. Application of zinc and iron on the plant increase total carbohydrate, starch, IAA, chlorophyll and protein content in the grain [Taraftar, 2012c].

Nano-Fe$_2$O$_3$ increase photosynthesis and growth of the peanut plant [Rajaie, 2009].

Health: Some nutrient also responsible for disease resistance to the plant and due to the more availability of nano nutrient to the plant it prevent from disease, nutrient deficiency and other biotic and abiotic stress which indicate that nano fertilizers enhance overall health of the plant. ZnO nano-particles also helpful to plant under stress conditions [Taraftar, 2012a]. Aqueous solutions of Ag$^+$ and Au$^+$ drastically reduced the body weight of $P$. ricini larvae [Sahayaraj, 2014].

Advantages of nano fertilizers over traditional fertilizers

Nano fertilizers are advantageous over conventional fertilizers as they increase soil fertility, yield and quality parameters of the crop. They are nontoxic and less harmful to environment and human, they minimize cost and maximize profit. Nano particles increase nutrients use efficiency and minimizing the costs of environment protection [Naderi, 2012]. Improvement in the nutritional content of crops and the quality of the taste. Optimum use of iron and increase protein content in the grain of the wheat [Farajzadeh, 2009]. Enhance plants growth by resisting diseases and improving stability of the plants by anti-bending and deeper rooting of crops also suggested that balanced fertilization to the crop plant may be achieved through nanotechnology.

Conclusion

Application of different nano-fertilizers have greater role in enhancing crop production this will reduce the cost of fertilizer for crop production and also minimize the pollution hazard. The application of nano-fertilizers in agriculture should have a greater concern to society. Fertilizer nutrient use efficiency in crop production can be enhanced with effective use of nano-fertilizers. Nano fertilizers improve crop growth and yield up to optimum applied doses and concentration but they also have inhibitory effect on crop plant if concentration is more than the optimum which result reduces growth and yield of the crop.

Reference

Farajzadeh Memari Tabrizi E., Yarnia M.,
25. AGRONOMY

Sustainable Issues in the Rice-Wheat Cropping System

Himansu Sekhar Gouda¹, Subhashisa Praharaj² and Sanjib Kumar Sahoo³

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Rice–wheat cropping sequence (RWCS) is the India’s largest cropping system which occupy around 10.5 M ha and around 85 percent of this area falls in Indo-Gangetic plains (IGP) (Ladha et al. 2003).

The conventional practices adopted for production of both the crops by the farmers as per their indigenous knowledge are water-, capital- and energy-intensive and leads us to many issues which are a serious threat to the sustainable agriculture. Sustainability of RWCS system has been questioned with declining underground water table (Humphreys et al. 2010), yield stagnation (Ladha et al. 2003), unattended intervening periods Bhatt & Kukal (2015a), soil degradation (Bhandari et al., 2002) and atmospheric pollution (Bijay, Shah, Beebout, Yadvinder & Buresh, 2008).

Indigenous conventional system of rice–wheat cropping system leads to the following issues.

1. Ecological issues:
   a. Declining underground water table
   b. Ground water pollution
   c. Diverse weed flora
   d. Outbreak of diseases and insect pest outbreak

2. Agricultural issues:
   a. Degrading soil structure
   b. Degrading soil health
   c. Residue management
   d. Least attended intervening period
   e. Labour shortage
   f. Multi nutrient deficiency
   g. Declining crop response

3. Livelihood issues:
   a. High energy requirement
   b. Decreased land productivity
   c. Decreased water productivity
   d. Decreased efficiency of water use
   e. Poor income

4. Climatic issues:
   a. Environmental pollution
   b. Global warming

Conclusion:

As Rice–wheat cropping system in India has satisfied us in filling the empty stomachs of our country and contributed globally also. But it also created the above sustainability issues which may drove us to mass hunger. So we have to address the stagnated or decreased land/water productivity as well to incorporate some new and advanced Resource conservation technologies into our production system like SSNM, establishment methods, alternate tillage system etc. which will able to sustain our resources and able to meet ever increasing demand.

Reference

A.L. Bhandari, J.K. Ladha, H. Pathak, A.T. Padre,
Biofertilizer (also bio-fertilizer) is a culture of living microorganisms which, when applied to seeds, 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.

The mechanism by which plants respond to drought stress needs to be elucidated to grow stress tolerant plants. This process is very complex because of interaction between factors affecting and being affected by the specific stress, various physiological, biochemical and molecular phenomena resulting in an altered plant growth. Along with water stress, nutrient availability to the plant is severely affected under drought conditions which can be improved by the use of suitable microorganisms. In the past few decades, several plant growth promoting rhizobacteria (PGPRs) have been isolated and characterized for use in sustainable agricultural productions.

Interestingly, it was observed that inoculation of Azospirillum sp. can modify the root morphology through producing plant growth regulating substances (Bashan et. al, 2004) such as siderophore production (Saheooet. al., 2014). It also enhances the number of lateral roots and proliferates root hair formation to increase the root surface area to absorb sufficient nutrients (Mehdipour-Moghaddamet. al, 2012). This also improves the water status of the plant and aids the nutrient profile for the advancement of plant growth and development.

At the field level, decreased productivity is observed as the crops are affected by high salt, drought and heavy metals. Various plant hormones like cytokinins, auxins, gibberellins, ethylene and abscisic acid (ABA) are produced by the PGPRs. PGPRs have largely been reported from the genera Azotobacter, Arthrobacter, Azospirillum, Enterobacter, Bacillus, Psedomonas, Streptomycyes and Serratia.

These PGPRs support the growth of plant by two mechanisms—(1) direct and (2) indirect. In direct mechanism, growth of plant occurred when plant pathogen and other harmful rhizospheric microorganisms are absent. In indirect mechanisms, plant growth enhanced by the removal of deleterious effects of plant pathogen.

Various adaptation mechanisms are used by plant to tolerate drought. Phytohormones play a very important role in this process. Osmolytes, enzymes, siderophores, antibiotics, nitric oxide, organic acids, etc. are also produced by PGPRs. Nodulation of legume plant is affected by ethylene (a negative regulator). 1-aminocyclopropane- 1-carboxylic acid (ACC) is a precursor of ethylene. So it is necessary to maintain the ACC level in plants. PGPR has ACC deaminase enzyme which...
degrade ACC and promote root growth. It can use ACC as a nitrogen source. In this way PGPRs decrease plant ethylene level and support plant growth. PGPRs are highly valuable for agricultural system because they provide cross protection against multiple stresses by systemic identification of bacterial strains. The basis of cross protection is the non specificity of plant perception by PGPRs.

Glycine betaine produced by PGPRs provide cross protection against water deficiency as well as frost and salinity. In accordance, increased level of superoxide dismutase (SOD) is a general response to drought stress. K⁺, glutamate, trehalose, proline, glycine betaine and ectoine are produced by rhizobacteria to maintain cytoplasmic osmolarity during drought stress.

Conclusion:
Environmental stresses are now becoming a major obstacle and productivity is declining at an unprecedented rate. Hence by knowing the importance of PGPRs we can improve the stress tolerance and as well sustain the productivity of crop as well as soil ecosystems.

Reference:

27. HORTICULTURE (ENTOMOLOGY)

Pest Management in Parthenocarpic Cucumber under Protected Cultivation”

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University of Agricultural Sciences, Dharwad

Greenhouse cultivation and the pests:
Cultivating crop under protected cultivation has lot of advantages like year round production by providing controlled environment for plant growth etc. The environment inside the greenhouse not only favours plants growth but also for certain sucking pests to live within by creating resistance against all the chemical insecticides we spray which makes it tough to manage them inside the greenhouse once it is established, where prevention followed by biological control comes to play major role (Paulitz and Elanger, 2001).

Cucumber under greenhouse
Cucurbitas are highly cross pollinated crops which means they need pollinators inside the greenhouse where the introduction of bumble bees inside the greenhouse was encouraged in Europe which totally changed the pest management strategy as it harms bees which indirectly encouraged adopting biological control measures especially for cucurbits (Smith et al., 2012). In Indian conditions introduction of parthenocarpic cucumber made it possible to grow the crop inside the greenhouse without any pollinators.

Major greenhouse pests of parthenocarpic cucumber
Common pests that occur in parthenocarpic cucumber inside the greenhouse are red spider mite (T. urticae Koch) which is predominant pest and Whitefly (B. tabaci Gennadius) which is usually noticed during the early season of the crop and Leaf miner (Liriomyza trifolii Burgess) whose incidence occurs mainly in nursery stage of the crop and considerably low afterwards. Thrips (Melon and Onion thrips) also seems to appear and additionally cucurbits are susceptible to root-knot nematodes (Kaur et al., 2010). Recently fungal gnat (Bradyisia sp) also been reported in north Indian conditions (Sabir and Singh, 2012). As already stated
above, once these sucking pests entered and started to multiply it is very tough to manage them without any economical loss. So it is very important to identify the pest incidence in the initial stage and adopt the following managing practices. Following are some of the pest management practices that can be adopted to manage the major pests of parthenocarpic cucumber under greenhouse condition.

Cultural control
Cultural control measures are the cornerstones of cucumber greenhouse pest management, followed by biological control and chemical controls should be minimized or avoided inside the greenhouse due to fact of creation of resistance and which affect the activity of natural enemies inside (Perdikis, 2008). Major practices that should be followed includes, Insect proof screening for vents and other openings (cooling pad and ventilation units).

There are different mesh nets available based on the major insect pests and their sizes (Flower thrips and Aphids 340 microns, Whiteflies: 462 microns and Leaf miners: 640 microns). Recent studies are suggesting to use the Longlasting Insecticide treated nets (LLITNs) too.

New crops should not be planted near greenhouses, Marigold intercropping can be done to repel away nematodes. Adjacent areas may be kept free from wild or cultivated plants which act as reservoirs. Hedges around the greenhouse should be avoided as they harbor lot of thrips.

Use of air-lock type entrance. Use of foot baths to prevent entry of unwanted soil. Double door system. Restricted access to visitors. Strict weed management during off-season especially summers helps in reducing mites. Right time harvesting for mites control. 10-30 feet around the greenhouse area should be kept free (Sabir, 2017).Recent studies are suggesting to use the ultraviolet absorbing plastics which can reduce insect problems (Elfadly et al., 2016).

General monitoring
Success of any management practice depends on the time when the practice should be done which will only be possible when there is a continuous monitoring is practiced.

There are two main ways to monitor for common cucumber pests
1. Trapping pests using yellow sticky cards: These are used to monitor for whitefly, thrips and fungus gnats. Blue traps are also used for thrips but yellow traps are usually preferred because they can be used for whitefly as well. Inspect traps weekly; replace every 3-4 weeks as glue becomes less effective. Place traps at the top of the plant canopy for whiteflies and thrips; place them about 25 cm (1 foot) above the growing media for fungus gnats. 2. Visual inspection of plant leaves: Should be done Weekly for two spotted mites, aphid infestations and other problems.

Biological control
Greenhouse condition is not only conducive to the pest multiplication but also for the natural enemies build up when it is introduced artificially when the host pest is identified correctly. Natural enemies that are successfully utilized to manage the pests includes.

For Whitefly: Releasing Encarsia formosa until 80% of whitefly pupae are parasitized. In case of Fungus gnats and thrips: Introducing Hypoaspis at the start of the crop and when pests are detected apply insect parasitic nematodes. If the major pest is Two-spotted mites application of Persimilis, Stethorus as needed. In case of Western flower thrips apply A. cucumeris as needed; add Orius sp if thrips numbers are high (Gillespie,1989). For Aphids release Aphidius sp, Aphidoletes sp and, if aphid numbers are high, Harmonia and Hippodamia lady beetles. In addition for the sucking pest complex entomopathogenic fungi like (EPF) Beaveria bassiana, Verticillium lecanii also found very effective but their compatibility with the other natural enemies is debatable.

Biological control is highly successful in case of cucumber production in greenhouse with some practical challenges like controlling pests during winter months. When the natural daylength is short it induces many biological controls to go into diapause. And the other problem is lack of pollen in cucumber crop flowers. This means there is no alternative food source for biological controls, making them more difficult to establish. Chemicals used to control plant diseases. Fungicides to control Pythium root rot and powdery mildew can
interfere with development of biological controls (Bale et al., 2008).

**Chemical control**

Only the green chemicals that is registered to use inside the greenhouse (eg, Spinosad, Spiromesifen) should be used that to in the need basis as it may intervene in the living natural enemies population too.

**Conclusion**

Now a days as the awareness about the organic food is increasing and resistance and resurgence activity of the sucking pests is alarming, it is very important to manage the pest with no chemical pesticides or with lesser amount only when it is necessary.

**References**


### 28. GENETICS AND PLANT BREEDING

**Biofortification: Nutritious Crops**

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**Biofortification** – It is development of nutrient dense staple crops using the best traditional breeding practices and modern biotechnology. It makes foods more nutritious as plants are growing rather than having nutrients added to plant foods during processing. Appreciations to a new approach named Biofortification; these micronutrients provided to millions of people through the staple foods that they eat every day, foods such as maize, sweet potato and wheat. While these staples are frequently packed full of energy, they usually lack essential micronutrients such as vitamin A, iron and zinc. When people don’t get enough of these micronutrients, they suffer from a hidden hunger. This puts them at increased risk of stunting, anemia, blindness, infectious diseases and even death. Women and children are especially vulnerable. Biofortification leads the global effort to improve nutrition and public health. Biofortification association’s with agriculture, nutrition and public health, thereby engaging a wide range of sectors. Crop scientists, nutritionists, economists and behavioral-change experts all work together to ensure that nutrient-rich crops are effective and meet the demands of farmers and consumers. Biofortification targets the people most at risk of hidden hunger and the foods that they
habitually eat. The Green Revolution initiated in the 1940s and 50s brought about large increases in crop yields and saved millions of people from mass famine. Yet malnutrition remains widely prevalent around the globe and, while many people eat enough calories, many do not get enough nutrients.

**Biofortification works:** Crops can be improved to produce higher levels of certain desired nutrients by influencing their genetic makeups. This can be done through conventional plant breeding or genetic engineering. Plant breeding methods consist of testing many wild relatives of a domesticated crop for a certain nutrient, selecting the ones that contain higher levels of that nutrient and crossing those wild relatives with the domesticated crop. The crossings can eliminate desired qualities of the domesticated crop, such as edibility (many wild relatives are inedible), appeal and yield. Because of that, it often takes a long time for crops to be biofortified using this method.

**Conventional Plant Breeding:** Traditionally, plant breeders have bred for size, visual appeal and yield in their crops, often avoiding or sometimes unintentionally removing qualities such as flavor and nutrients. Crop biofortification is much more expensive and time-consuming through plant breeding, even though techniques like marker-assisted selection have dramatically reduced the time and resources required for plant breeding. “Imagine screening tens of thousands of plants for levels of different nutrients.”

**Genetically Modified Plants for nutritious:** Genetic engineering is more precise and implicates isolating individual genes from the wild relatives of a domesticated crop or other species that code for increased production of certain nutrients and transferring them into the plant. It is also potential for different genes coding for increased levels of different nutrients to be “stacked” in a crop using genetic engineering methods, so that a crop can be biofortified with more than one desired nutrient.

**Examples of Biofortification:**

Strawberries: Is a good source of vitamin C, have been genetically modified to provide 3 times as much vitamin C. Gene in the strawberry plant called GalUR gene codes for an enzyme that converts a protein in the plant to vitamin C. A similar gene is found in the Arabidopsis thaliana. Researchers created a DNA plasmid using the A. thalianagene and the bacteria Agrobacterium inserted into the strawberry plant to over-express GalUR gene and produce 3 times as much vitamin C.

**Golden Rice:** Golden rice is the one of the good example of biofortified crop. Vitamin A Rice Biofortification was done by Prof. Ingo Potreykus & Dr. Peter by introduction of three genes [1. phytoene synthase (psy) from daffodil (Narcissus pseudonarcissus) 2. lycopene B-cyclase (crt) from daffodil (Narcissus pseudonarcissus) 3. phytoene desaturase from bacterium (Erwinia uredovora)] in rice grain via Agrobacterium tumefaciens. In 2005, a team of researchers at Syngenta produced Golden Rice 2. In 2018, Canada, Australia, New Zealand and the United States approved golden rice for cultivation. The Philippines and Bangladesh were considering applications for cultivation. (Coghlan, 2018).

**Public opinion:** The benefits of genetic engineering has over plant breeding in crop biofortification projects seem to be nullified by widespread public dissent. The Golden Rice project began in 1992, but it is still languishing in research institutes. Meanwhile, successfully distributed iron-fortified beans in Rwanda, iron-fortified millet in India and beta-carotene-fortified cassava in Nigeria, all produced through conventional plant breeding methods.
Resources

"Crops deliver less nutrition with more carbon dioxide in air, biofortification in GE crops can help," Bloomberg

“Future of biofortified foods: Will ‘super bananas’ share the fate of golden rice?” Genetic Literacy Project.

XiaoZhi Lim | October 29, 2017 | Genetic Literacy Project.

29. AGRICULTURE SCIENCE

Chemical Composition of Vermicast and Economics of Vermiculture

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Earthworms and their excreta (vermicast) promises to usher in the ‘Second Green Revolution’ by completely replacing the destructive agrochemicals which did more harm than good to both the farmers and their farmland. Earthworms restore and improve soil fertility and significantly boost crop productivity. Both earthworms and its vermicast and body liquid (vermiwash) are scientifically proving as both ‘growth promoters and protectors’ for crop plants.

VERMICOMPOSTING

Vermicomposting is a term given to the process of conversion of biodegradable matter by earthworms into vermicast. In the process, the nutrients contained in the organic matter are partly converted to more bioavailable forms. The species of earthworms that are being used for compost production are Eisenia fetida, Eudrilus eugeniae, Perionyx excavatus, Lumbricus rubellus and Pheretima elongata. Earthworms degrade all types of organic waste, such as agricultural waste, animal droppings, weeds, industrial effluents, forest leaf litter, etc.

VERMICAST

Vermicast is usually a finely divided peat-like material produced by the earthworm with excellent structure, porosity, aeration, drainage and moisture holding capacity. Vermicast is rich in plant nutrients. It provides vital macro elements such as N, P, K, Ca, Mg and micro elements such as Fe, Zn, Cu, etc. Apart from this, it contains plant growth-promoting substances such as NAA, cytokinins, gibberelins, etc. It also harbours beneficial microflora.

Worms also have the capacity to store heavy metals and pesticides in their tissues. Thus, to a certain extent, they play a role in detoxifying polluted soils, too.

**TABLE 1: Chemical composition of worm cast**

<table>
<thead>
<tr>
<th>Nutrient</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Organic Carbon%</td>
<td>9.15 to 17.88</td>
</tr>
<tr>
<td>Total Nitrogen%</td>
<td>0.5 to 0.9</td>
</tr>
<tr>
<td>Phosphorus%</td>
<td>0.1 to 0.26</td>
</tr>
<tr>
<td>Potassium %</td>
<td>0.15 to 0.256</td>
</tr>
<tr>
<td>Sodium %</td>
<td>0.055 to 0.3</td>
</tr>
<tr>
<td>Calcium and Magnesium (Meq/100g)</td>
<td>22.67 to 47.6</td>
</tr>
<tr>
<td>Copper mgL⁻¹</td>
<td>2.0 to 9.5</td>
</tr>
<tr>
<td>Iron mgL⁻¹</td>
<td>2.0 to 9.3</td>
</tr>
<tr>
<td>Zinc mgL⁻¹</td>
<td>5.7 to 9.3</td>
</tr>
<tr>
<td>Sulphur mgL⁻¹</td>
<td>128.0 to 548.0</td>
</tr>
</tbody>
</table>

Worms provide high levels of bio-available nutrients in balanced form for plants

Vermicast are coated with mucopolysaccharides and enriched with nutrients. The cellulolytic, nitrifying and nitrogen fixing microbes are found established in the worm cast. Earthworms directly cycle the nitrogen by excretion in the casts, urine and mucoprotein and through the turnover of earthworm tissues. Earthworms increase the amount of mineralized nitrogen from organic matter in soil. The microbial composition changes qualitatively and quantitatively during passage through the earthworm intestine. It is well studied that worm casts are richer in 'inorganic phosphorus compounds' and the exchangeable phosphorus (P) was three (3)
times greater in vermicasts than in the soils. It has been suggested that the passage of organic matter through the gut of worm results in phosphorus (P) converted to forms which are more bio-available to plants. This is done partly by worm’s gut enzyme ‘phosphatases’ and partly by the release of phosphate solubilizing microorganisms in the worm cast. Earthworm casts contained greater percentage of finer fractions like silt and clay than in the surrounding soils. The chemical analysis of Vermicasts revealed that they were richer in soluble salts, neutral or alkaline in reaction and had higher percentage of exchangeable Na, K and Mg but a lower exchangeable Ca than in corresponding soil. Earthworm casts also contained greater amounts of Nitrogen (N), Phosphorous (P) and Potassium (K). Vermicompost also contained Mg, Ca, Fe, B, Mo and Zn in addition to some of the plant growth promoters and beneficial microflora. Several valuable compounds were also produced through the earthworm – microfloral interaction, which included vitamins such as B12 and plant growth hormones such as gibberellins.

**Economics of Vermiculture**

The goal is to continually increase the number of worms in order to obtain a sustainable harvest. The worms are either used to expand a vermicomposting operation or sold to customers who use them for the same or other purposes. If the goal is to produce vermicompost then we want to have maximum worm population density all of the time. If the goal is to produce worms then we keep the population density low enough that reproductive rates are optimized. Any farmer wishing to go into the business of making and selling vermicompost has to consider it to be a long-term investment, and one with some considerable degree of risk. Vermi-composting could be taken up on any scale starting from 10 tonnes per annum (tpa) to 1000 tpa and above. As the production is proportional to the vermi-bed space, it is advantageous to start with less capacities and later expands the unit after gaining production experience and developing assured market for the product. In order to operate the unit, expenditure on some items has to be incurred on a recurring basis. These items include salaries of the staff, wages to the labourers, cost of raw material, fuel cost on transport of raw materials and finished goods, packing material cost, repairs and maintenance, power, insurance, etc. The numbers of office personnel and labourers have to be decided breaking each activity into a number of sub-activities and for each sub-activity estimating the work involved and the capacity of the labour to finish the work in a given time.

**Benefits**

It is assumed that there will be around 2-3 cycles of production in the first year and 5 – 6 cycles in the subsequent years with a duration of each cycle at around 65-70 days. Further, taking into account various limitations and operational problems, the capacity utilization is further assumed at 50% in the 1st year and 90% from 2nd year onwards. Benefits include the income from sale of vermi-compost @ 4500 per MT and worm @ 200/- per kg. The net income from the 2nd year onwards would be about Rs.6,48,000 annually.

**References**


Mechanism of Action of Plant Growth Promoting Rhizobacteria (PGPR)

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Plant Growth Promoting Rhizobacteria (PGPR) is a group of bacteria which protect the plant from disease and other abiotic stress by their different mechanism and make the close association with plants. Rhizosphere contains millions of living organism like fungus, bacteria, nematode, virus etc. which affect the plant growth. In Rhizospheric region some bacteria act as protectant against pathogenic microbes by their direct and indirect action on pathogen as well as host plant.

Mechanism of Plant Growth Promotion:

1. Increased supply of nutrients
2. Phytohormones
3. Ethylene levels
4. Nitrogen fixation
5. Induced Systemic resistance
6. As Biocontrol agent

1. Increased supply of nutrients
   a) Important mechanisms of bacterial plant growth promotion include providing plants with resources/nutrients that they lack such as fixed nitrogen, phosphorus and iron.
   b) Sequestering Iron: Iron present less quantity in soil and it affect plant growth. PGPR can produce compounds called siderophores, which acquire ferric iron (Fe\textsuperscript{3+}), root cells can then take this by active transport mechanisms. Several studies using radiolabeled ferric siderophores as sole source of iron showed that plants are able to take up the labelled iron.
   c) Phosphorus solubilization: Phosphorus is major macronutrient for plant growth but in soil it is present in unavailable form due to its reactive nature with elements like aluminum, iron. PGPR releases organic acids which solubilize organic phosphorus thus plants are able to take up this phosphorus.
2. Nitrogen Fixation: There are number of aerobic and anaerobic bacteria like Rhizobium spp., Azotobacter etc. which convert free nitrogen into available form for plant.
3. Phytohormones: Some bacteria are releases hormones like auxin, gibberellins and cytokinins which promote lateral root formation and shoot development of plant.
4. Ethylene Level: In plants ethylene at moderate to high level inhibit the root elongation. Some bacteria have been found to contain enzyme deaminase which cleaves the plant ethylene precursor and lowers the level of ethylene in plants.
5. Induced Systemic Resistance (ISR): Plant growth promoting Rhizobacteria (PGPR) induce the systemic resistance by increasing the cell wall strength, changing the host physiology and biochemical production leading to enhanced synthesis of plant defense chemicals upon challenge by pathogen and abiotic stress factors.
6. As biocontrol agent: Some bacteria like Pseudomonas spp., Bacillus spp. have antagonistic effect on deleterious microorganism and works as biocontrol agents. There are no of mechanism known by which PGPR act on plant pathogenic microbes and protect plants. Modes of action of biocontrol agents are:
   a) Competitive root colonization
   b) By synthesis of allelochemicals
   c) Antibiosis
   d) Detoxification and degradation of virulence factor

Reference

31. AGRICULTURAL EXTENSION

Gender Sensitization Forelimination of Discrimination against Women

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Introduction

The meaning of the key word “Gender”. Gender is generally confused with sex. Going by biological and psychological definitions, there lies a wide difference in the meaning of the two terms. In carrying forward the Government commitment to gender and equality issues, gender mainstreaming through the Public Service is of utmost importance. It is important to conduct gender sensitisation/ training for Government Servants as it pertains to human resource management. The main goal of the Government is to ensure that the Public Service is gender sensitive in its planning, implementation, monitoring and evaluation of all public service policies, programmes and activities. The Government is currently implementing the Public Service Reforms, Local Government Reforms, the Public Finance Management Reforms and other sector reforms. Gender sensitisation plays a crucial role in the transformation process to realise the vision of these reform programmes and to minimise negative impacts because of reform processes.

As a result of gender sensitivity and equality of opportunities, the public service will be able to recruit, retain and develop the best available people and as such realise the goal of an effective and professional public service.

Through gender sensitivity and equal employment opportunities, the representation of women in public service will improve.

Gender sensitization has even more far reaching goals, as it will help

1. To review existing policies, rules, regulations and procedures with a view to encompassing gender values, needs and aspirations as well as removing those which are gender blind or out-of-date.

2. To formulate Gender Perspective Guidelines for policy formulation and implementation

3. To plan, implement, monitor and evaluate gender specific initiatives.

4. To coordinate and monitor gender activities in all ministries, independent departments and regions as they relate to Public Service activities.

Need For Sensitisation

The convention on the Elimination of Discrimination Against Women (CEDAW) is the first significant international legal document which pays specific focus to the violence that women suffer due to legal, social and cultural traditions. All agencies of the criminal justice system must acquaint themselves with the perspective and understanding adopted by CEDAW in considering women’s disadvantages and the consequent inequity and how they undergo when it comes to the violence they face. The survey conducted among 109 judges by SAKSHI, an NGO of Delhi, reveal that 79 per cent judges had never heard of CEDAW, while 21 per cent who knew it by name, and were not aware of its contents. India ratified CEDAW on August 8, 1993. Many senior police officers and judges are not aware of Recommendation No.19 of CEDAW which describes the acts of inflicting physical, mental or sexual harm or suffering or threats of such acts, coercion and other deprivations of liberty as violation of women’s fundamental human rights.

The Recommendations of CEDAW cast an obligation on the state to take all legal and other measures which are necessary to provide effective protection to women against gender based violence, including, interalia:

1. Effective legal measures, including penal
sanctions, civil remedies and compensatory provisions to protect women against all kinds of violence, including violence and abuse in the family, sexual assault and sexual harassment in the workplace;

2. Preventive measures, including public information and education programmes; “gender sensitive training for judicial and law enforcement officers and other public officials” to change attitudes concerning the roles and status of men and women;

3. Protective measures, including refuge, counselling, rehabilitation and other support services for women who are the victims of violence or who are at risk of violence.

The police officers, prosecutors and judges at all levels of hierarchy need to be exposed to gender equality education which would enlighten them on existing assumptions, myths, and stereotypes about women and how these can interfere with fair and equitable administration of justice. There is urgent need of training of the personnel involved in the criminal justice system on the nature of violence against women in general and domestic violence, sexual violence and dowry offences in particular. The participation of the victims, NGOs, lawyers and social activists in such training programmes may help in internalizing the gender based violence by the law enforcement agency and the judiciary and this process may in the long run help our criminal justice system to be more responsive and sensitive to the victims of domestic violence and crimes.

Conclusion

Women empowerment is an essential element in national development. There can be no development unless the needs and interests of women are fully taken into account. In fact, empowered women are a nation’s strength. Social transformation which is the need of the hour and this can be done through women empowerment. Higher Education of women plays a crucial role in releasing their energy and creativity and enabling them to meet the complex challenges of the present world. In acknowledging them as potential human resources, investment must be made in developing their capacity in terms of education, skill development, and technology transfers through technical training. Special emphasis needs to be given to Research and Development of appropriate scaled-down occupations engaging women in large proportions. Illiteracy and cultural barriers need to be removed without any further delay. For women to make personal strides forward, a synergy of effort, concentration, planning and cohesive functioning at the Higher Education level will create possibilities of a different future.

The most critical component of women’s empowerment is found to be education. It leads to improved economic growth, low fertility rate, health and sanitation and an awareness of factors that disempowered women. Work participation rate and political participation also grows in women’s education.

Women’s health is an important component of women’s empowerment. However the accumulated research evidences show that the achievement levels in providing better health care and safe motherhood for women, especially for rural women, are not at expected levels. In India, the highest number of deaths in the age group of 16 to 25 is recorded among women. Anaemia is one of the most commonly found deficiency among the women and it is also mentioned by several studies that they are often not too healthy when they bear the first child and none of them are physically ready to bear a second child.

Work participation empowers women. However the condition of women in India is more miserable than the rest of the world in almost every field of social life. They are paid half of three-quarters of the money while their male counterparts earn for the same job. India is predominantly agricultural country. Women do more than half of the total agricultural work. But their work is not valued. On an average a woman works 15 to 16 hours a day unpaid at home and underpaid outside.

References


Agriculture is a highly complex enterprise worth 7–8 trillion dollars worldwide (10% of global GDP). There is a huge potential, and the need to induct new and innovative technologies involving computers and related fields in the entire agriculture value chain from production to food on the table: enhance production efficiency; improve inputs use; conserve the resource base (soil, water and biodiversity); reduce its pollution and carbon footprint in production, processing, storage, packaging and transport, retail distribution, and consumption; reduce food wastage in all forms; make it resilient to climate change (climate-smart agriculture), and enhance its ecological services. These different factors are all interconnected and interact in a highly complex manner. This is where computers and related software programs come into play to make agriculture highly efficient and productive, profitable, resilient to climate and sustainable over long-term. Some examples are given below:

### A. In field production
- **Precision farming:** Managing variable soil fertility grid and variable nutrient application, need-based pesticide and herbicide application, generation and use of big data, sensors, robotics, drones, farm management software, etc.). Farmers use drones to monitor their fields, make timely decisions to avoid yield losses;
- **Input use technologies:** Computers play a significant role in production and efficient use of crop varieties, seeds, fertilizers, pesticides, soil amendments, water, and farm machines;
- **Climate change prediction and disaster warning:** Location-specific micro weather forecasting, satellite imagery for assessment crop performance, and determining the extent of damage by drought, floods and storms for crop insurance purpose, forecasting of destructive insect pest movement across regions;
- **Mechanization:** Smart machines and pieces of equipment with sensors for all farm operations from land preparation to harvest processing and storage and retail;

### B. Forecasting crop yields and production in different countries
- This is helpful in managing food supplies, food trade and food aid across countries and regions.

### C. Supply chain management
- **Processing and quality control technologies:** efficient storage and quality control; product traceability; smart and eco-efficient packaging; farm-to-consumer distribution and retail; e-groceries; food safety and nutrition quality management;
- **Market intelligence and price fluctuations:** Computers help in monitoring near and distant markets and commodity prices for farmers to plan in advance;

### D. Reducing food loss and wastage
- **Agricultural supply chain generates wastes in every step of the value chain:** Computers help in monitoring the wastes and designing waste reduction strategies.
- **Conversion of food and agricultural wastes into new resources like bio-energy, water, organic fertilizers and other valuable bio-
materials.

Expectations are high on the usefulness of computers and related ICTs in agriculture. We need to wait until the new technologies mature and provide real benefits to farmers in a simple-to-use and cost-efficient manner to assess their final worth.

References

33. AGRICULTURAL ENGINEERING

Effect of Ballasting on Tractor Performance

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Introduction

Tractors used throughout the year for farming, with diverse implements to conduct different field operations. Tractors considered the main machines that generate power for field operations in agriculture. Draft of a wheeled tractor, which is an important index of power efficiency, is a result of stress–strain interaction between the tractor wheels and the topsoil. Research shows that 20–55% of tractor’s power can be lost in the process of interaction between the tires and the topsoil because of the slip and the rolling resistance. This is not simply a wasted power - it creates a soil compaction, which may be detrimental to crop production Traction ability of any tractor depends on the following main factors: tractor’s mass, contact area between traction tires and the soil surface, hitch points, type of mounted implements, traction control and other relevant systems, and, naturally, the soil strength.

Efficiency of work is one of the main tractor rates, i.e. the use of power to carry out useful work. A tractor works economically when no less than 80% of its engine power is used. Seeking to work with greatest economical effectiveness it is necessary to use as great as possible tractor’s traction force. Increasing this force increases slippage of tractor wheels. The slippage can be reduced by using wider and duplicated wheels, tires with better protector or by decreasing air pressure in the tires and by pressing driving wheels to the earth with greater force.

The name “ballast” is derived from the nautical term describing heavy material added to a vessel to improve stability. In 1917 first water ballasted tractor wheel was introduced.

Ballasting is weight added to the tractor for the purpose of improving tractors performance. Add-on weight used to increase safety, efficiency or performance of a device. Ballast is added to a tractor or implements to improve tractor traction and stability and/or improve penetration of soil-working tools. Ballasting is the art and science of putting the right amount of weight on each axle of your tractor to get the best tractive performance.

A ballast tractor can pull and push extreme loads that would be beyond the strength of a normal tractor. It has a connecting device called a "drawbar" that allows it to get behind an object to push while still in drive. This is what sets it apart from an articulate tractor, which has to go into reverse to push a heavy load.

Reason for adding weight to rear wheel:
1. It gives added traction for ploughing.
2. To maintain traction with heavy load on the front.

Reason for adding weight to front wheel:
1. To balance the lifting action of front wheel
due to rear mounted implement.
2. To help in keeping the front wheels on road while driving up a slope i.e. Steering stability.

**Different types of ballasting methods are available in tractor:**
1. Mounting cast Iron
2. Liquid ballasting

**By Using Cast Iron Weight:**
Cast Iron weights are used for the ballasting. Cast iron weights are fixed or attached to the rim by extension bolts. This method of ballasting has an advantage over water ballasting in that these can be easily removed when not required. The maximum amount of weight a tyre can carry depends upon the tyre size, ply rating and maximum pressure. Hence it is always recommended to follow the operational manual to decide the weight. Inflation of tyres has to be maintained less in field work than road work to increase the traction and reduce excessive wheel slip. But the minimum tyre pressure should not be less than the recommendation of tyre manufacture to avoid creeping of tyres over rims. Over inflation will also increase wear of tyre lugs wheel and vibration.

Front wheels are sometimes counter-balanced with weights to increase the stability when heavy loads are superimposed on the drawbar or heavy equipment is to be mounted on the rear end of tractor. Also it avoids front lifting of tractors at gradient at hilly works. CI weights are mounted at central of front axle or front wheels.

While using the ballast weight always consider the load carrying capacity of tyre and simultaneously strength of rear axle design. Always remember that tyre ballasting is recommended for better field performance. The field ballasting should not be used for haulage (the commercial transport of goods) work because more weight to drive wheels results to more rolling resistance and there by more consuming engine power. Hence more fuel consumption.

**Iron weights attached in two forms.**
1. Iron weight can be attached to tractor frame
2. Iron weight can be attached to drive wheel hubs

**Use of Liquid Ballasting**
This method is used only in those areas where temperature does not fall to the freezing point of the water. In this method clean water is used for this purpose. In areas where water freezing can take place calcium chloride (CaCl₂) is added to make anti freeze solution. Tyres can be filled for 75% as well as 100% liquid filling. However, generally the tyre industry recommends for 75%, filling which is easier process.

The following procedure is recommended for liquid ballasting the tyre.
1. Rotate the tyre until the valve stem is at the top.
2. Remove the valve core housing & screw on the adaptor.
3. Liquid can then be forced into the tube from a tank placed atleast.5 feet higher than the tractor tyre or by using a compressor & pressure tank filled with water.
4. When the liquid has reached the required level, remove the adaptor, screw in the valve core & inflate it to the recommended pressure.
5. Water should not be filled more than 75% of the total volume of the tyre.

In extreme cold conditions, use calcium chloride with water in the following proportions. 2.5 kgs of calcium chloride to 10 ltrs of water.

To empty the tube: if it is required to remove the water at any time, turn the tyre to bring the valve to the 6 o clock position, remove valve and allow the drain to go away. Complete removal of water can only be obtained by first removing the tube from the tyre.

**Types of Liquid Ballasting:**
1. Water.
2. Calcium Chloride.
3. Antifreeze.
5. Methanol.
6. Beet Juice and
7. Polyurethane Foam.

**Conclusions**
- Optimized ballast management between the front and the rear wheels can maximize tractive efficiency and minimize compaction
while increasing tractor drive-train life and increase profitability.
- Ballasting at heavy pulling work reduces slipping.
- Optimum ballasting is required to the minimum power lost during a tillage operation.
- Several types of ballast used on farm tractors to increase their tractive ability.
- Ballasting increases the overall energy efficiency of tractor.

References

34. AGRICULTURAL ECONOMICS

Drought Problems: Divert to Rural Economy

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Introduction
The drought is a natural disaster that is occurring frequently in the nation. It shows a significant short of water that can be due to shortage of rainfall and more demand of water. The drought is a normal, recurrent feature of climate and occurs in all climatic regimes and is usually characterized in terms of its spatial extension, intensity and duration (DA&C, GoI, 2009). Symptoms of drought include loss of turgor in leaves, wilting, yellowing of leaves, premature of fruits & needles, die back and bark cracks of branches. In case of extreme conditions plant can be dead. The National Commission on Agriculture in India defines three types of droughts, namely, meteorological, agricultural and hydrological droughts.
1. Meteorological drought: Deficiency of precipitation varying from 25-50% of total rainfall
2. Hydrological drought: Deficiencies in surface and subsurface water supplies leading to a lack of water for normal and specific needs.
3. Agricultural drought: When soil moisture and rainfall due to of above given droughts are inadequate during the crop growing season causing extreme crop stress and wilting.

These forms of droughts get generated independently but inseparable and are linked to each other through the water cycle.

| TABLE: 1 Monsoon wise Distribution of Rainfall in India |
|----------------------|----------------------|------------------|
| Season               | Duration             | Percentage of Rainfall distribution |
| Winter Rains         | January-February    | 2.9              |
| Pre-monsoon          | March-May            | 10.4             |
| Post Monsoon         | October-December    | 13.2             |
| South West Monsoon   | June-September      | 73.4             |

Source: India Meteorological Department, Government of India.

Drought account in India:
Since 1871 to 2017, there 26 major drought
years were declared by the Indian Meteorological Department, GoI in India. About 44% of food production is accounted from 56% rain-fed net cultivated area of the country. Among the drought years, the 1987 drought was one of the worst droughts of the century since; this year overall rainfall deficiency was 19 percent. About 60% cropped area and 285 million populations were affected in the year.

In 2002 too, the overall rainfall deficiency for the country as a whole was 19%. More than 300 million living people spread over 18 States were affected by drought in varying degrees. Around 150 million cattle were affected due to lack of fodder and water. No other drought in the past had caused reduction 29 million tonnes in food grain production. About 73% of total country’s rainfall is contributed by South West Monsoon (June to September).

**TABLE: 2** During Drought Year Percent Shortage of annual rainfall in India

<table>
<thead>
<tr>
<th>Drought Year</th>
<th>% Shortage of annual Rainfall from Normal Rainfall</th>
<th>Drought Year</th>
<th>% Shortage of annual Rainfall from Normal Rainfall</th>
</tr>
</thead>
<tbody>
<tr>
<td>1965</td>
<td>-18</td>
<td>2000</td>
<td>-5</td>
</tr>
<tr>
<td>1966</td>
<td>-16</td>
<td>2001</td>
<td>-8</td>
</tr>
<tr>
<td>1985</td>
<td>-7</td>
<td>2002</td>
<td>-19</td>
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<tr>
<td>1986</td>
<td>-13</td>
<td>2014</td>
<td>-12</td>
</tr>
<tr>
<td>1987</td>
<td>-19</td>
<td>2015</td>
<td>-14</td>
</tr>
<tr>
<td>1999</td>
<td>-4</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: Department of Agriculture Cooperation and Farmers welfare

Timely and spatial distribution of rainfall is very important for the cultivation of Kharif crops that accounts for about 90% of paddy, 70% of coarse cereals and 70% oilseed production of the country (Drought Management Division, GoI, 2018).

**Impacts of Drought on Rural Economy:** According to the provisional reports released on 31 March 2011, 83.3 crore (68.84%) Indians live in rural areas while 37.7 crore stay in urban areas out of 121 crore population. Therefore rural live is the pivotal of Indian economy. The rural livings mainly depend on agricultural and allied sectors. The agricultural sector directly affected by adverse agro-climatic conditions such as heavy rainfall, flood, drought etc. The extent and intensity of drought impacts is determined by prevailing economic conditions, the structure of the agricultural sector, management of water resources, cereal reserves, internal and external conflicts, etc. (Benson and Clay, 1998). Based on nature and intensity drought impact could be direct or indirect.

**Direct Impact:** There are four broad category of direct impact as physical, social, economic and environmental impacts.

**Physical Impact:** The direct impact of drought situation is easily seen on production sectors like food grain, fodder, input, assets, livestock, capital, power cut, etc. the result of production loss directly affect to agro-based industries in terms of lack of raw material supply.

**Social Impact:** Restrictions on the domestic use of water consequently pressure of health illness, living standard, food insecurity, crime, etc. situation could be created in the society. It included the well-being of farm family members and small business owners, educational access, income loss and work rule changes.

**Economic Impact:** On the economic side expenditure on consumption, health, water availability, food stuff would be increased. It is also play a crucial role in reducing country’s GDP, export earning and employment opportunities in rural areas. The greater pressure of drought could be increased poverty and migration of people toward urban or metro cities.

**Environmental Impact:** The impacts of drought are not only restricted to the above three sectors but also they radiate to other sectors, as well. The forest and environment sectors do suffer from drought along with tourism and energy. it has widespread impacts on ecosystem, environment, economics and social conditions. Fresh water levels & water discharge during drought are very low resulted into less dilution in ecosystem, it increase the concentration of chemicals, solid particles & decrease in dissolved oxygen. After dry out of water bodies the aquatic animal die lead to habitat destruction, it affect on food chain & ecosystems. The wildlife animals will migrate to long distance in search of water. They end up
new habitats making them vulnerable & endangered, while others face new threats.

**Indirect Impact:** when the direct effects have multiplier effect on economy and societies are termed as indirect effect. The directly reduction in agricultural production affect to livelihood of rural people through indirect impacts such as reduction in income of farmers & agribusinesses and employment, increase in price of food, default agricultural advances, etc. are not directly seen in agriculture but

**Conclusions**

Every year some parts of the country are affected by drought. But the she has failed so far to diagnose the drought phenomenon and to come up with a long term solution. The nature of drought is such that it does not occur in the same intensity across the county and also has differential impacts. Unless this complexity is understood drought declaration will always be a controversial and not transparent. As a large population and area is affected by drought, a large amount is needed for drought relief work, which the nation cannot support.

**References**


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**35. HORTICULTURE**

**Lemongrass (Cymbopogon flexuosus) a Promising Aromatic Crop of Paschimanchal: Its Prospects and Possibilities**

*Souvick Banik* and C. S. Karthik *

Lemongrass is a perennial grass plant widely distributed worldwide and most especially in tropical and subtropical countries (Francisco et al., 2011). *Cymbopogon* is a genus of about 55 species, which are indigenous in tropical and semi-tropical areas of Asia and are cultivated in South and Central America, Africa and other tropical countries. These are tufted perennial C₄ grasses with numerous stiff stems arising from a short, rhizomatous rootstock, as with citrus flavor, and can be dried and powdered or used fresh. The name Cymbopogon is derived from the Greek words “kymbé” (boat) and “pogon” (beard), referring to the flower spike arrangement. **East Indian lemongrass oil is known as Cochin oil in the world trade and it accepted as the finest oil.** At present, India grows this crop in 3,000 ha area, largely in states of Kerala, Karnataka, U.P. and Assam and the annual production ranges between 300-350 t/annum.

**Importance of Lemon grass in India and World Scenario:** Lemongrass is a grass which yields an aromatic oil containing 70-90% citral. The name lemongrass is given to this crop because of typical strong lemon-like odor of the plant which is predominantly due to the high citral content in the essential oil present in the leaves. Lemongrass oil of commerce the world trade as 90% of it is coming from Cochin port. Kerala has the monopoly in the production of lemongrass oil. The annual world production of lemongrass oil is around 1000 tonnes. Lemongrass oil is one of the most important essential oils being widely used for the isolation of citral which can be converted into ionones having the odour of violets. β-ionone is used for the commercial synthesis of vitamin A. In some Far Eastern countries like Java, Japan, China and India the leaves are used for flavouring foods, drinks and tea and for scenting bathwater. The oil is used as a repellent against flies and mosquitoes. The spent grass is an excellent fuel, manure and mulch and forms raw
material for the production of silage, mushroom and paper boards. The crop is also cultivated along the bunds as alive mulch. The well ramified root system of the plant helps in soil and water conservation.

**Botany:** Lemongrass belongs to the family Gramineae (Poaceae) and the genus Cymbopogon. Three species are generally identified.

1. *C. flexuosus* (Nees ex Steud.) Wats. (2n=20,40): It is known as East Indian, Cochin or Malabar grass. Under this species two varieties are identified based on the stem colour are a) *C. flexuosus var. flexuosus* have not enough oil yield but the citral content of the oil is high (75-90%). b) *C. flexuosus var. albescens*: The oil is poor in solubility but oil yield is high but poor in citral content (60-75%). Cymbopogon flexuosus is a tufted robust perennial grass, 2 m tall. It flowers freely. Leaves linear, lanceolate 125x1.7 cm. Panicles very large, drooping, lax, greyish-green, rarely with a purplish tinge, with the raceme pairs in dense masses, spreading, 100-135 cm long, slightly hairy, lower glumes of the sessile spikelets 3-4, 4-5 mm long, 1 mm wide with 1-3 definite or obscure intracranial nerves, shallowly concave with one to two depressions.

2. *C. citratus* (DC.) Stapf. (2n=40,60): It is known as West Indian or American lemon grass. It is a stemless perennial grass with numerous stiff tillers arising from short rhizomatous rootstock, making large tussocks. It seldom flowers in cultivation. Leaf blade narrow, linear, glaucous, drooping, 50-100 x 0.5-1.5 cm with scabrous margins. Ligule truncate, 0.2-0.8 cm long. Inflorescence rarely produced, a large loose panicle; spathe bracts long and narrow, sessile spikelets, awn less, linear-lanceolate.

3. *C. pendulus* (Nees ex Steud.) Wats: It is known as Jammu lemongrass and it is white stemmed and dwarf in stature. The plant is frost resistant and suited to Sub-Himalayan areas of Northern India.

**Cultivation prospects:** Lemon grass is very hardy, drought tolerant crop. It require warm and humid climate, with abundant sunshine and well distributed rainfall. Heavy and waterlogged soil are not suitable for its cultivation. Seeds are sown in nursery beds during April-May and covered with thin layer of soil and irrigated at regular interval. It is planting in the main field at a spacing of 30x30cm or 60x45 cm.

**Postharvest technology:** The essential oil is produced by distillation of the grass with water. For obtaining good quality oil, steam distillation in stainless steel units is preferred, with a steam pressure of 18-32 kg/cm² in the boiler. The grass is distilled either fresh or after wilting. Wilting of grass for 2 days and chopping to 3 cm size gave about 30% more oil and citral. The oil yield and content in the grass depend upon several factors such as fertility of the soil, climatic conditions, age of the grass, time of cutting, the state of the grass distilled (whether fresh or dry) etc. On an average the oil recovery is 0.2-0.4% and the oil yield is 100-125 kg/ha/year.

**Physico-chemical properties of oil:**

The physico-chemical properties of *Cymbopogon flexuosus* red and white types, *C. pendulus* and *C. citratus* are given in the following. East Indian lemongrass oil is more soluble in alcohol than others and hence it is more preferred for direct use in perfumery. *C. flexuosus* oil contains 75-85% of aldehydes consisting largely of citral. Other constituents in the oil are linalool, geraniol, citronellol, nerol, 1,8-cineole, citronellal, linalyl acetate, geranyl acetate, -pinene, limonene, caryophyllene, -pinene, -thujene, myrcene, -ocimene, terpinolene, methyl heptanone and terpineol. The essential oil of *C. citratus* contains approximately -pinene 0.13%, -pinene 0.19%, delta-3-carene 0.16%, myrcene 12.75%, dipentene 0.23%, -phellandrene 0.07%, -cymene 0.20% methyl heptanone 2.62%, citronellal 0.73%, -elemene 1.33%, -caryophyllene 0.18%, citronellyl acetate 0.96%, geranyl acetate 3.00%, citral b 0.18%, citral a 41.82%, geraniol 1.85%, elemol 1.20% and -caryophyllene oxide 0.61%. The average composition of *C. pendulus* oil is reported to be -pinene 0.19%, camphene 0.01%, -pinene 0.16%, car-3-ene 0.04%, myrcene 0.04%, dipentene 0.35%, phellandrene 0.30%, -cymene 0.36%, methyl heptanone 1.05%, citronellol 0.49%, linalool 0.07%, -elemene 0.70%, -caryophyllene 2.15%, citronellyl
acetate 0.72%, geraniol acetate 3.58%, citral b 32.27%, citral a 43.29%, geraniol 2.60%, elemol 2.29% and ß-caryophyllene oxide 1.56%.

**Constituents:** Citral-a (46.6%) and Citral-b (12.8%) is the major chemical constituent. The oil is distilled from leaves and flowering tops of Lemon grass with an oil recovery of 0.2-0.3%.

**Area of Prospects in Paschimanchal:** Average oil yield per ha per year is 480 kg with a gross return of Rs. 288000/ha which is too high as compared with the net return of rainy season rice of Rs. 22500/ha and can change the economic status of the rural people of these area. As soil and climatic conditions of Paschimanchal favours the crop, therefore there is a tremendous prospect to grow the crop in the unused land or unproductive lands with a good economic return.

**Reference**

### 36. AGRICULTURAL BIOCHEMISTRY

#### Antifungal Defensins for Plant Defense

**KrupaliRamanuj**
Anand Agricultural University, Anand.

**Introduction**
Fungal pathogens severely limit agricultural production worldwide. It is estimated that approximately 10% of crop yields are lost due to these pathogens. Many cultivated crops have minimal resistance to these pathogens and require intensive inputs of chemical fungicides for disease management. In order to protect themselves from invading pathogens, plants have developed numerous counter measures which result in the activation of a plethora of defense mechanisms both locally at the infection site and systematically throughout the plant.

These plant defense mechanisms include:
- Cell wall reinforcements
- Production of reactive oxygen species (ROS)
- Synthesis of antimicrobial metabolites
- Pathogenesis-related (PR) proteins
- Antimicrobial peptides

These defense mechanisms are part of the innate immunity of plants and successful pathogens overcome them to colonize plants and establish disease. Plant defensins are small (5kDa, 45 to 54 amino acids), basic, cysteine-rich (typically eight cysteine residues) peptides with antimicrobial activities. These defensins are cationic peptides which provide a first line of defense against potential pests and pathogens. The first member of this family was isolated from the endosperm of barley and wheat in the year 1990 and was proposed to form a novel subclass of the thionin family (γ-thionins) that was distinct from α and β-subclasses. Most plant defensins isolated in the first half of the 1990s were seed-derived. Plant defensins are also expressed in vegetative tissues where they accumulate in the cell layers of cotyledons, hypocotyls, endosperms, tubers and floral structures. They are either constitutively expressed in storage and reproductive organs or produced upon pathogenic attack or injury as part of a systemic defense response. In addition, production of plant defensins is also induced in response to environmental stress, such as drought, and signalling molecules, including methyl jasmonate, ethylene and salicylic acid. Plant defensins are present in all plant families, including:
• Brassicaceae
• Fabaceae
• Solanaceae

Structure
Plant defensins exhibit a conserved tertiary structure that consists of a triple-stranded antiparallel β-sheet and one α-helix that are stabilized into a compact shape by the disulfide bridges. These bridges form a cysteine-stabilized α-helix β-sheet motif (CSαβ). Apart from the cysteine-stabilized αβ (CSαβ) structure, the two most important characteristic features of plant defensins that are evolutionarily conserved include net cationic charge (+2 to +11) and the presence of disulfide bonds. Most plant defensins are stabilized by four intramolecular disulfide bonds. In addition, hydrophobic amino acid residues distributed in such a way that the functional protein attains an amphipathic structure, which might aid in protein solubility in the aqueous as well as lipid environments. Also, sequence comparison studies revealed that all antifungal plant defensins studied to date have a highly conserved cysteine and hydrophobic patch of amino acids in the interposed loop region between β2 and β3 strands strongly suggesting that these conserved patches are most likely important for binding to the fungal membranes and/or translocation into the cell. Despite the low level of amino acid sequence identity between defensins, their three dimensional structures are remarkably similar between different plant defensins.

Function
• In addition to their roles in plant defense against fungal pathogens, plant defensins have also been shown to play other biological roles which include:
  – Antibacterial activity
  – Zinc tolerance
  – Proteinase inhibitory activity
  – α–amylase inhibitory activity
  – Ion channel blocking activity
• Effect of defensins on root development: Accumulating evidence suggests that plant defensins and defensin-like peptides not only play a role in defense response against phytopathogenic fungi but that they are also involved in plant growth and development.
• Role in symbiotic interactions: Recent data indicate that plant defensins and defensin-like peptides are involved in symbiotic interactions with both mycorrhizal fungi and nitrogen-fixing bacteria.

Along with antibacterial activity the defensins possess other biological activities shown in table.

<table>
<thead>
<tr>
<th>Biological activity</th>
<th>Examples</th>
<th>Plant source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Antifungal</td>
<td>Rs-AFP1-4</td>
<td>Raphanus sativus</td>
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<td></td>
<td>Ah-AMP1</td>
<td>Aesculus hippocastanum</td>
</tr>
<tr>
<td></td>
<td>AlfAFP</td>
<td>Medicago sativa</td>
</tr>
<tr>
<td>Antibacterial</td>
<td>Pth-St1</td>
<td>Solanum tuberosum</td>
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<td></td>
<td>Fabatin-1 and -2</td>
<td>Vicia faba</td>
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<td></td>
<td>SoD1-7</td>
<td>Spinacia oleracea</td>
</tr>
<tr>
<td>Insecticidal</td>
<td>VrCRP</td>
<td>Vigna radiata</td>
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<tr>
<td>Protein synthesis inhibitor</td>
<td>γ1−H</td>
<td>Hordeum vulgare</td>
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<tr>
<td></td>
<td>γ1−P</td>
<td>Triticum turgidium</td>
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<tr>
<td></td>
<td>ω−H</td>
<td>Hordeum vulgare</td>
</tr>
<tr>
<td></td>
<td>HvAMP1</td>
<td>Hardenbergiaviolacea</td>
</tr>
<tr>
<td>α-amylose inhibitor</td>
<td>Slα1-3</td>
<td>Sorghum bicolor</td>
</tr>
<tr>
<td>Proteinase inhibitor</td>
<td>CFD2</td>
<td>Cassia fistula</td>
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<tr>
<td></td>
<td>Cp-thionin</td>
<td>Vignaunguiculata</td>
</tr>
<tr>
<td>Sodium channel inhibitor</td>
<td>γ1−Z and γ2−Z</td>
<td>Zea mays</td>
</tr>
</tbody>
</table>

Conclusions
• Plant defensins are small (~5kDa, 45 to 54 amino acids), basic, cysteine-rich peptides which act by different mechanisms and
exhibit a complicated and sophisticated mode of action resulting into fungal growth arrest. Defensin functions are not only limited to antimicrobial activity but they also appear to be involved in cellular signaling and growth regulation.

- The diversity and widespread occurrence of defensins in the plant kingdom suggests that they are rich source of peptides with antimicrobial activities.

- The involvement of plant defensins during the plant defense response has been established based on (i) their stress-related induction (ii) in vitro antimicrobial activity and (iii) the increased resistance of plants expressing a specific heterologous plant defensin. Research during the past decade revealed that plant defensins bind to specific membrane receptor targets in order to exhibit antimicrobial action.

- The antimicrobial activity and high stability of plant defensins make them ideal tools for applications in the biological control of fungal pathogens for organic agriculture.

Future thrusts

- Plant defensins correspond to a world of possibilities for defense mechanisms and new peptides with different activities are still to be discovered, as well, studies with thousands of plant species need to be performed.

- Molecular tools can be deployed to develop transgenic crops that not only exhibit effective long-term resistance to plant pathogens but also provide normal yields when grown under different environmental conditions.

- Better understanding of the structure-activity relationships and modes of antifungal action of plant defensins will facilitate engineering crops for more robust and durable resistance to fungal pathogens in future.

- In the near future, antifungal defensin-based commercial agro-products be targeted which can play crucial role in Integrated Disease Management for increased crop production.

37. PLANT BREEDING AND GENETICS

Role of Biofertilizers in Agriculture

Shaukeen Khan¹ and Ram Narayan Ahirwar²

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This is general article which describes role of biofertilizers in agriculture. Biofertilizers are effective strains of micro-organisms like algae, fungi, bacteria, algae. A Bio fertilizer is a substance which possesses living microorganisms which (when applied to seeds, plant surfaces, or soil) colonize the rhizosphere or the interior of the plant and promotes growth by increasing the supply or availability of primary nutrients to the host plant. They are classified into three main categories as per the nutrients provided by them.

1. Biofertilizers for nitrogen fixation.
2. Biofertilizers for phosphate solubilization.
3. Biofertilizers for decomposing organic matters

When these microorganisms are incorporated with seed or seedling soil application, they increase crop production through Biological Nitrogen Fixation, solubilization of immobilized phosphate, uptake of P & other mineral nutrients and synthesis of growth promoting substances.

Biofertilizers are generally classified into two categories-nitrogen fixing biofertilizer and phosphate mobilizing biofertilizer. Nitrogen fixing biofertilizers are further classified into two categories like symbiotic and asymbiotic bacteria. Symbiotic bacteria include Rhizobium, Acetobacter, Azolla. Asymbiotic bacteria include azotobacter, azospirillum, BGA etc. Similarly, phosphate mobilizing biofertilizers are further classified into two categories like phosphate solubilizer and phosphate absorber. Phosphate mobilizing biofertilizers include Bacillus,
Pseudomonas, Aspergillus, Pencillium etc. Phosphate absorber biofertilizers include VAM.

**Role of Biofertilizers**

1. They Contribute plant nutrients through biological nitrogen fixation and solubilization of fixed phosphate.
2. These are cost effective and reduce chemical fertilizer consumption.
3. They also provide atmospheric nitrogen directly to the plants.
4. They bear beneficial effect of micro-organisms in soil.
5. They are helpful in improving soil properties and sustain the soil fertility.
6. They also convert plant nutrients in available form.
7. They are eco-friendly and pollution free.
8. They are helpful in releasing of vitamins, hormones like auxins and gibberellins etc.
9. These also increase 10-20 per cent of crop yield.
10. They also control and suppress soil borne diseases.

**Advantages**

1. They are having more shelf life.
2. There is no chance of contamination.
3. There is no loss of properties due to storage upto 45º C.
4. They have characteristics of better survival on seeds and soil.
5. There is no need of running Bio-fertilizer production units throughout the year.
6. They are easy to use by the farmer.
7. Dosages is 10 time less than carrier based powder Bio-fertilizers.
8. They give rise high commercial revenues to farmers
9. They have high export potential.
10. Very high enzymatic activity since contamination is nil.
11. Greater potentials to fight with native population.
12. High populations can be maintained more than 109 cells/ml upto 12 months to 24 months.
13. Easy identification is possible

**Problems in Biofertilizer Technology**

1. Technological problems
2. Infrastructural constraints
3. Financial problems
4. Environmental constraints
5. Human resources and quality constraints
6. Skill is required.

**Reference**


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