Readers Shelf

VOLUME NO:19	ISSUE NO: 06	March 2023
No. of Pages in this issue		44 pages
Date of Posting: 10-11 at RMS, Jodhpur		

Editorial Office

J.V. Publishing House
15, Gajendra Nagar, Near Old FCI Godown
Shobhawaton Ki Dhani, Pal Road, Jodhpur-5

Website: www.readersshelf.com
Email: info@readersshelf.com,readersshelf@gmail.com
Typesetting: Ankita, Jodhpur
Printed by: Manish Kumar, ManakOffset, Jodhpur

Published by
Smt. Neeta Vyas

For J.V. Publishing House,
Jodhpur
RNI No.: RAJENG/04/14700
ISSN No.:2321-7405

Subscription Charges: Single Copy: Rs.50.00
Annual Subscription: Individual: Rs.**500.00**
Annual subscription: Institution:Rs.**900.00**

Contents

1. **Biochar**
   Bhanu Pratap and Amisha.....4
2. **Nutri Cereals- Powerhouse of Nutrients**
   N.Senthil Kumar and M. Paramasivan.....5
3. **Artificial Intelligence for Scientific Intervention in Plant and Seed Science**
   Neha Thakur.....7
4. **Importance of Solar Energy in Agriculture**
   A.Premalatha and S. Saravanakumar.....9
5. **Oxfor Nanopore MinION Sequencing Device- Next Generation Sequencing**
   Ganesuni Lakshmi Prasanna and Saranya S.....11
6. **Indegenous Tuber Forming Vegetable Crops**
   Jagarlamundi Nethra.....13
7. **Wild Mushrooms and Their Medicinal Properties**
   Ganesuni Lakshmi Prasanna, Saranya S.....16
8. **Green Manure Crops and its Importance**
   A.Premalatha and S. Saravanakumar.....20
9. **Agro-Meteorology: A Route Map for Indian Agriculture**
   Agatambidi Balakrishna, Shaikh Jakir Basha and Shivaji Raja.....23
10. **Clay Mineral- Microbial Interactivity**
    M.Bhargava Narsimha Yadav.....26
11. **High Throughput Phenotyping: A Revolution towards Precision Breeding**
    Chaudhary Ankit R,Sharma Deepak D.....28
12. **Fall Armyworm: An Onvasive Pest**
    Patel Apurvkumar M. Sharma Deepak D.....31
13. **Multiple Choice Questions- New Section**
   33
14. **Combating Mosquitos in Green Way**
    D. Saicharan.....34
15. **Phloem Restricted Trypanosomatid: An Emerging Microscopic Pathogen of Tropical Region**
    Patel, Kailash.....36
16. **Sensors in Agriculture**
    C.Sharmila Rahale.....38

1. AGRICULTURE

Biochar

Bhanu Pratap Ghasil and Amisha Choudhary

SKNAU, Jobner, Jaipur-Rajasthan

Biochar is a fine-grained, carbon-rich, porous product remaining after plant biomass has been subjected to thermo-chemical conversion process (pyrolysis) at low temperatures (350–600°C) in an environment with little or no oxygen. Biochar has either 77% carbon, 0.46% nitrogen, 2.7% phosphorus, 3.9% potassium and some of other micronutrients like, sulphur, magnesium, zinc and cupper etc.

Biochar is the lightweight black residue, made of carbon and ashes, remaining after the pyrolysis of biomass. Biochar is defined by the International Biochar Initiative as "the solid material obtained from the thermochemical conversion of biomass in an oxygen-limited environment". Biochar is a stable solid that is rich in pyrogenic carbon and can endure in soil for thousands of years.

The refractory stability of biochar leads to the concept of pyrogenic carbon capture and storage (PyCCS), i.e. carbon sequestration in the form of biochar. It may be a means to mitigate climate change. Biochar may increase the soil fertility of acidic soils and increase agricultural productivity.

Pyrolysis:- Pyrolysis, is a processs in which the biomass is heated to produce a gas that can be used to generate power while also producing a solid by-product called biochar. This biochar can be effectively used for preparing adsorbent materials for carbon sequestration.

Opportunities

- Increased water holding capacity
- Increasing nutrient use efficiency
- Remediation of heavy metals in soil reduced emission of
- Ghgs
- Enhancement of biological nitrogen fixation
- A tool for carbon sequestration.

The word "biochar" is a late 20th century English neologism derived from the Greek word βιος, bios, "life" and "char" (charcoal produced by carbonization of biomass). It is recognized as charcoal that participates in biological processes found in soil, aquatic habitats and in animal digestive systems.

Pre-Columbian Amazonians produced biochar by smoldering agricultural waste (i.e., covering burning biomass with soil) in pits or trenches. It is not known if they intentionally used biochar to enhance soil productivity. European settlers called it terra preta de Indio. Following observations and experiments, a research team working in French Guiana hypothesized that the Amazonian earthworm Pontoscolex corethrurus was the main agent of fine powdering and incorporation of charcoal debris in the mineral soil.

Effect of Biochar on Soil Quality

1. Influences on soil physical properties
   a. Soil bulk density
   b. Soil porosity
   c. Soil water holding capacity
   d. Soil compaction
2. Influences on soil chemical properties
   a. Soil CEC
   b. Soil PH
   c. Active soil organic matter
   d. C , N, P contents of soil
3. Influence on soil microbes
4. Influence on adsorption of poisonous and pernicious substances
5. Influence on the reduction of greenhouse gas emissions

Constraints

- Reduces the weed control efficacy.
- Regular supply of a sustainable and consistent feedstock is a challenge.
- Several competing end-users for the waste biomass.

- Small scale local production limited by the seasonal biomass production.
- Safety issues in the transport of feedstock.
- Increasing health hazard.
- Uncertainty of production gains.
- Higher cost of biochar.

Future Prespectives

- Biochar has the potential to mitigate global climate change.
- Biochar can increase the water holding capacity of sandy soils.
- Research on the practical benefits of fast pyrolysis biochar is important.
- Effect of biochar on vegetables and fruit crops under field conditions should be explored.

The soil carbon sequestration is the long-term storage of carbon in soil which could well be accomplished by the application of biochar as a soil amendment. Biochar (BC) is a fine grained, highly carbonaceous, pyrolysed (low temperature) product of biomass. The pyrolysis temperature strongly influences the stability of biochar in soil; the higher the pyrolysis temperature higher would be the stability. Biochar being highly stable in soil due to its aromaticity, presence of amorphous structure and turbostatic crystallites, rounded structures and reduced accessibility to decomposers has lot of potential for long-term carbon sequestration(Purakayastha 2015). The higher stability of biochar in soil is also due to strong interactions with mineral surfaces. Biochar interacts with native soil organic matter (SOM) in a complex way; Interest in the use of biochar to improve soil productivity has rapidly increased. Nitrogen (N) loss, retention and bioavailability in biochar-amended soils fertilized with NH_4^+–N and NO_3^-–N were studied using leaching and pot experiments. NO_3^-–N leaching from the soils fertilized with NH_4^+–N and NO_3^-–N was significantly reduced by biochar addition (Zheng2013).

References:

Ministry of New and Renewable Energy (MNRE) 2014.

Purakayastha, T. J. Kumari, S. Sasmal, S and H. Pathak(2015)Biochar Carbon Sequestration in Soil - A myth or Reality.International Journal of Bio-resource and Stress Management. 6(5):623-630.

Zheng, H.Wang, Z. Deng, X.Herbert, S and Xing, B.(2013) Impacts of adding biochar on nitrogen retention and bioavailability in agricultural soil.Elsevier. 206: 32-39

2. AGRONOMY

Nutri Cereals - Powerhouse of Nutrients

N. Senthil Kumar[1] and M. Paramasivan[2]

[1]Agricultural College and Research Institute, Kudumiyanmalai, Tamil Nadu,[2]Agricultural College and Research Institute, Killikulam, Vallanad-628252, Tamil Nadu

Nutri cereals

Nutri cereals are the oldest cultivated grains in the world but largely confined to the traditional consumers in the rural and tribal belts of the country, the **'superfood'** is increasingly seeing a healthy growth in terms of production as well as consumption. Taking one step ahead after the United Nations' announcement to declare the year ***"2023 - International Year of Millets"***. India is advancing to project millet as an organic superfood in the global food and agriculture market. While the rural population in India consumes millets, many urban consumers are still unaware of its nutritive quality. It has contain fibre-rich, probiotic, magnesium, phosphorus, calcium, protein, naturally gluten-free food but also need to look into natural products like millets which are underrated but are a powerhouse of nutrients. Because of its nutritional properties, today scientists from all over the world call millets super food. Millet is a wholegrain which contains much higher amounts of fibre and essential minerals than wheat, rice and other cereal grains. Besides being loaded with fibre, it is an excellent source of complex carbohydrates with numerous health benefits. Plus boost roast

millet is a nutritional powerhouse providing a healthy, gluten-free source of energy, fibre, protein, B vitamins, iron, zinc and magnesium. Millets are also rich in healthpromoting phytochemicals like polyphenols, lignans, phytosterols, phyto-oestrogens, phytocyanins. These function as antioxidants, immune modulators, detoxifying agents etc. and hence protect against age-related degenerative diseases like cardiovascular diseases (CVD), diabetes, cancer etc.

Present junk food available to us is more over like pizza, burgers, pastas etc. These foods may give good taste to our tongues but no health beneficiaries. But a change is occurring people are getting back to past foods items concentrating on millets which are really power house of proteins, nutrients etc. Apart from being a powerhouse of nutrients, millets are also eco-friendly. They require less fertiliser, water and can grow in any kind of land. Besides, people, land and water are largely saved from the poison of chemicals, fertilisers and pesticides. The major reasons of decrease in consumption is the lack of awareness of nutritional merits, inconveniences in food preparation, lack of processing technologies, and also the government policy of disincentives towards millets and favoring of supply of fine cereals at subsidized prices. It has become imperative to reorient the efforts on the sorghum and millet crop to generate demand through value-addition of processed foods through diversification of processing technologies, nutritional evaluation and creation of awareness backed by backward integration

Benefits of millet

- Rich in antioxidants
- Lowers bad cholesterol levels, thereby boosting cardiovascular health
- Regulates blood sugar levels, and thus may help prevent type II diabetes
- May help regulate blood pressure
- Promotes improved digestion and colon health
- May help prevent breast and colon cancers
- May aid weight loss as part of a healthy diet.

Types of millets

In India, eight millets species (Sorghum, Pearl millet, Finger millet, Foxtail millet, Kodo millet, Proso millet, Barnyard millet and Little millet) are commonly cultivated under rain fed conditions. Further, in each of the millet growing areas at least 4 to 5 species are cultivated either as primary or allied crop in combination with the pulses, oilseeds, spices and condiments. Hence, the spatial distribution of millets either as a primary crop or as allied crops largely depends on the growing habitat and the amount of rainfall the region receives.

Pearl millet (Pennisetum glaucum) / Cumbu

Pearl millet is well adapted to growing areas characterized by drought, low soil fertility, and high temperature. It performs well in soils with high salinity or low pH.Grown and consumed extensively in the African and Indian subcontinent from ancient times, pearl millet is rich in phosphorus which helps cells store energy, and many other vital minerals. The lignin and phytonutrients in millet act as strong antioxidants thus preventing heart related diseases. This is why, pearl millet is considered good for heart health. Often cooked in winter, pearl brings warmth to the body and increases energy levels. The millet recipes include kambankoozh, an old-time porridge from Tamil Nadu and bhakri roti, eaten across India, from Maharashtra to Gujarat and Karnataka.

Finger millet (Elusina corocona) / Ragi

Has the highest calcium content of any millet and grows easily in arid areas. Often referred to as an anti-diabetic grain, its high fiber content also checks constipation, cholesterol and

intestinal cancer. The millet recipes include Ragi balls or ragimudde as they're locally known, are a staple in Karnataka. Ragimalt, or porridge being highly nutritious and easy-to-digest is a common weaning food.

Fox tail millet (Setaria italica) / Tinai

Possibly the oldest cultivated millet, it is thought to have originated in Northern China, where it is highly regarded as a healing food for postpartum and digestive health. Foxtail millet has a rich mineral content, and is specially high in iron. A popular fasting food in some parts of India, it is interestingly called *xiaomi*, or little rice in Chinese. The millet recipes include Idli, upma, payasam, biryani.

Little millet (Panicum sumatrense) / Samai

The smallest of the millet family, Little millet is another reliable catch crop in view of its earliness and resistance to adverse agro-climatic conditions grown across India. It is very easy to cook and is often simply used as rice and in fact, can be used in any recipe that demands rice. Higher iron content gives it an edge over rice especially for those with anemia.

Kodo millet (Paspalumscrobiculatum) / Varagu

It has high protein content (11%), low fat (4.2%) and very high fibre content (14.3%). Kodo millet is very easy to digest, it contains a high amount of lecithin and is excellent for strengthening the nervous system. Kodo millets are rich in B vitamins, especially niacin, B6 and folic acid, as well as the minerals such as calcium, iron, potassium, magnesium and zinc. Kodo millets contain no gluten and is good for people who are gluten intolerant. Regular consumption of kodo millet is very beneficial for postmenopausal women suffering from signs of cardiovascular disease, like high blood pressure and high cholesterol levels. The millet recipes: Upma, idli, pulau/biriyani and porridge.

Proso millet (Panicum miliaceum) / Panivaragu

Though its protein content is similar to that of wheat, it is considered a far higher quality protein source because it is not only rich in essential amino acids (leucine, isoleucine and methionine), it is also gluten-free. About as old as foxtail, proso is one of the more delicious and temperate millet varieties. The millet recipes include Upma, pulau/biriyani and porridge.

Barnyard millet (Echinochloa crusgalli) / Kuthiraivali

Barnyard millet grows faster than other millet crops. Nutritionally too, it is a good source of protein, which is highly digestible and is an excellent source of dietary fiber with good amount of soluble and insoluble fractions. The carbohydrate content of barnyard millet is low and slowly digestible, which makes the barnyard millet a nature's gift for the modern mankind who is engaged in sedentary activities.One of the highest fibre and iron content amongst the millets. The millet used to make different types of porridges. In barnyard millet the major fatty acid is linoleic acid followed by palmitic and oleic acid. It also shows a high degree of retrogradation of amylase, which facilitates the formation of higher amounts of resistant starches. Hence it can be potentially recommended for the patients with cardiovascular disease and diabetes mellitus. Barnyard millet is most effective in reducing blood glucose and lipid levels. Slightly sticky when cooked, samvatkechawal is popular during navratras, when they are used to make *upma, khichdi* and *pulav* during fasts.

3. AGRICULTURE

Artificial Intelligence for scientific intervention in plant and seed science

Neha Thakur

College of Horticulture and Forestry, Thunag, Dr. Y S Parmar, UHF Nauni, Solan

Correspondence

AI currently being used to monitor the crop growth and its progress in fields. Also using

computer based drones identification of insects, diseases can be done. This novel technique also finds its field application in the readiness of crop and health of livestock. Further the strength and wellness of soil which is of the atmost importance to agriculture can be easily diagnosed with AI-based algorithms. This also enhances the potentiality of AI in growing a healthy and disease free crop. AI also promotes precision farming as AI can manage the amount of water and pesticides to be delivered to the plants. This further reduces the cost as well as wastage of these costly inputs in the crop production substantially. The big data in AI helps farmers to become more sustainable by improving farm efficiency and increase profitability. Using computer based technology and improve the productivity and reduce the man power need in field.

Artificial intelligence ; a machine learning approach, its mention way back dated to the year 1869 with its mention in volume 308 of the nature magazine. John McCarthy, an America based computer scienctist for the first time used this term. Hence he is also known as the father of AI. in the year 1955It has come a long way to practical application in the field of medical science, agriculture, environment, seed science, pharmaceuticals, speech recognition, aviation and many more. In day to day work we apply the science of AI ,whether giving instructions to siri of I phone or alexa or google assistance., using google maps AI can be complex problem solving algorithms or any robot that simplifies human effort or that help us to solve and make usable any bog data. As Prof Stephen Hawking once said in an intervirew to BBC that 'efforts to creat thinking machines can pose a threat to our very exsistence'. He further added that 'development of full artificial intelligence could spell the end of human race.' The rise in robots and robotic voice is not hidden from us. We are well aware of these application , thus the sciec ebehoind it is nothing but Artificial Intelligence.

In particularly how AI systems solves complex datas or problems is very simple. As computer does not know we are feeding it pictures or images to sort. It will only identify the numbers (input layer) that too in units as bits i.e. 0 or 1. So sorting the given pictures in layers a compter based AI system sorts or analyses a particular image. The output of one layer will be the input of another layer (Fig. 1). These computer based AI systems can be Artificial neural Networks (ANNs), Genetic Algorithms or the Fuzzy logic

Seeds are the most needed and inevitable input in agriculture. Seeds or rather true seeds may increase crop production by 40 percent. Hence good quality seeds when placed in good quality land will yield abundant produce. The quality parameters of seeds viz., genetic , physical and physiological quality, as well as seed health, is assessed manually which creates a lot of data per the sample analyzed. But after the scientific intervention of artificial intelligence (AI) this tedious task may be sorted very effectively. AI deals with algorithms that are designed to solve the problems associated with complex data. Such as using the AI in dormancy breaking and germination induction as well as checking the field emergence. The bottleneck in studying the interaction of various factors associated with these seed quality parameters can be emitted by using AI software and networks. This a very unique and new technology that was out of touch in seed science and technology. This novel technique can tell us about the factors which can interfere with germination and other physiological processes and their interactive effect on the same.

Application of AI in seed science and technology

Scientist	**AI Tool used**	**Research/ findings**
Haj Seyed-Hadi and González-Andújar (2009)a	Genetic algorithms	Weed seedling emer-gence of *Avena fatua*

(Chantre et al., 2012)	Artificial Neural Networks(ANN)	Estimating weed emergence under field conditions
Blanco et al. 2014	Genetic algorithms	Modeling seed dormancy release and germination for predicting Avena fatua L. field emergence:
Ayuso et al., 2017	Neurofuzzy logic	Computer-assisted recovery of threatened plants: Keys for breaking seed dormancy of *Eryngium viviparum*
González et al., 2018	Neural network tools	Deciphering kiwifruit seed germination using neural network tools
Shadrin et al., 2019	Convolutional Neural Network (CNN)	perform the seeds recognition, and germination detection through the images processing.

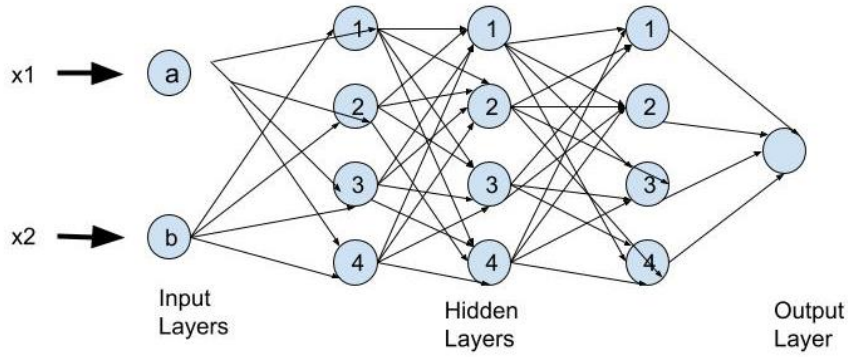


Fig 1. An artificial Neural Network (ANN)

4. AGRICULTURE

Importance of solar energy in Agriculture

A. Premalatha[1] and S. Saravanakumar[2]

[1]Scientist (Soil Science), [2]Scientist (Agronomy)

ICAR – Krishi Vigyan Kendra, MYRADA, Gobichettipalayam, Erode District, Tamilnadu

Renewable energy has started playing an increasingly important role for augmentation of grid power, providing energy access, reducing consumption of fossil fuels and helping India pursue its low carbon development path. India has set a target to increase the country's share of non-fossil-based installed electric capacity to 40% by 2030. India has been playing a leadership role in encouraging the establishment of a solar based economy across the globe. Solar power is one of the most versatile forms of energy, with boundless potential, if tapped wisely. Solar Energy can be a game changer for the Agricultural Sector in India, saving precious water resources, reducing dependency on the grid, and even becoming an additional revenue stream for farmers.

Among the various renewable energy resources, solar energy potential is the highest in the country. In most parts of India, clear sunny weather is experienced 250 to 300 days a year. The annual radiation varies from 1600 to 2200 kWh/m^2, which is comparable with radiation received in the tropical and sub-tropical regions. The equivalent energy potential is about 6,000 million of GWh of energy per year. The National Action Plan on Climate Change also points out: "India is a tropical country, where sunshine is available for longer hours per day and in great intensity. Solar energy, therefore, has great potential as future energy source. It also has the advantage of permitting the decentralized distribution of energy, thereby empowering people at the grassroots level".

What is Solar Energy?

Solar energy is the most abundant of all energy resources and can even be harnessed in cloudy weather. The rate at which solar energy is intercepted by the Earth is about 10,000 times greater than the rate at which humankind consumes energy.

Solar energy is the energy obtained from the sun. The radiant light and heat energy are harnessed by solar collectors. The sun's energy can be captured to generate electricity or heat through a system of panels or mirrors. Solar or photovoltaic cells convert sunlight directly into electricity while solar thermal collectors use heat-absorbing panels and a series of attached circulation tubes to heat water or buildings.

Agricultural applications of solar energy

1. **Solar Energy-Powered Water Pumps:** In many places where electric supply might be limited or not available, solar water pumps are lifesavers. Solar pumps use solar energy and pump water from reservoirs, and canals to the farms which would save hours of time for farmers. Solar panels are employed to harness the solar energy and using inverters, DC power is supplied to the power grid or stored in batteries. This power will be used efficiently to run the pumps to supply water.
2. **Water and Space Heating:** Livestock and dairy operations have specific space and water heating requirements around the year at different seasons. Since, in most cases, cattle farming is done in closed structures, the temperature and air quality are vital for operations. Solar power is used to manage this around the year. By employing a solar-powered heating system, farmers can easily save costs incurred on electricity bills. These systems use solar panels that effectively power the temperature control systems as required.
3. **Crop and Grain Drying:** Using sunlight to dry crops and grains is one of the oldest applications of solar energy used by farmers. While this is a completely free, viable method that can easily be employed, it has a risk of exposing the crops to the wind, rodents, impurities, etc. contaminating them. With advancements in technology today, there are solar dryers that can help in harnessing maximum solar energy and concentrating it in a closed container where trays are used to dry the produce. These systems will also help in accelerating the process and reducing the time required.
4. **Green House Heating:** Greenhouse heating is essential for the proper growth of certain crops and plants. Commercial greenhouses use sunlight for lighting and not for heating. Mostly, they depend on oil and gases for maintaining the required temperatures. Solar green housing heating systems are used to feature both the lighting and heating that is required. A solar greenhouse has a solar panel to collect the energy and batteries to store the energy. It also has insulation that will help in retaining heat during cold days and nights.
5. **Remote Supply of Electricity:** Farms might be located in remote areas where the electricity supply is limited and farmers may constantly face issues related to power outages and shortages for running their equipment, and tools on the farms. Solar PV systems are employed in the farms to produce the required electricity that is stored in the batteries and used when required. This not only helps in reducing the power consumption from the electricity supply but also saves money for farmers in the long run.

6. **Solar-powered cooling systems:** In many cases, farmers face huge losses due to the lack of availability of proper refrigeration and cooling systems in their farms. Even if they have a refrigeration system, it becomes very difficult to power them all day with constant power cuts and outages. Solar-powered cooling systems will help in tackling this problem. The refrigeration systems used will have a continuous supply of power from the batteries hooked to the solar panels where the power is supplied directly in the morning and the backup power stored is supplied during the night.

Benefits of using solar power in the agriculture sector

- Saves costs incurred in power and electricity in the long run
- Continuous supply of uninterrupted power in many cases
- Use of renewable energy sources
- Availability of power systems locally, even in remote locations
- Easy management of power usage

Conclusion

Solar energy for farms can greatly transform the agriculture sector in India by providing farmers with cheap electricity for everything from pumping water to harvesting crops. Moreover, solar energy farming will enhance the livelihoods of small to marginal farmers by increasing the chances of bumper crop yields even in places with insufficient electricity supply.

5. AGRICULTURE- PLANT PATHOLOGY

Oxford Nanopore MinION Sequencing Device- Next Genegeration Sequencing (NGS)

[1]Ganesuni Lakshmi Prasanna and [2]Saranya S

Ph. D. Research Scholars, Department of Plant Pathology
[1]Dr. YSR Horticultural University, Andhra Pradesh; Subscription No.: 3100/2022
[2]Navsari Agricultural University, Gujarat

First- and second-generation sequencing (SGS) technology have changed genomics over the past 20 years, making it possible to complete important programmes like the Human Genome Project among many others. Sanger created the first method for sequencing DNA in 1975, and Maxam and Gilbert created a second approach in parallel in 1977, dubbed the "chain-termination method" and the "chemical sequencing method," respectively. The chain termination approach subsequently became widely utilized for first-generation sequencing because it was less difficult to scale up and less expensive than the chemical sequencing method. It is simple to create DNA libraries with various insert sizes, which is helpful because reads with mixed insert sizes are advantageous for whole genome assembly. But the first-generation sequencing's limited throughput and expensive cost prompted a fundamental change in approach that brought us to SGS. Because SGS technologies can produce a huge volume of data at a low cost, they have dominated the sequencing market for the past ten years. However, due to challenges in resolving repeated sequences in the genome, short reads generated by SGS result in extremely fragmented assemblies when it comes to *de novo* assembly of bigger genomes. Next-generation sequencing (NGS) is a massively parallel sequencing technique that provides unique and quick methods for mRNA, small RNA, transcription factor region, chromatin structure, DNA methylation patterns, microbiology, and metagenomics genome wide characterization and profiling.

A new TGS platform, the MinION device, was made available by Oxford Nanopore Technologies (ONT) in 2014 through an early access

programme (The MinION Access Program, MAP). The ONT data's read length profile has a maximum length of a few hundred thousand base pairs, which is extremely close to PacBio's read length profile. ONT reads, on the other hand, have accuracy ranges of 65-88% but have greater error rates than PacBio's reads. Additionally, the throughput per MinION flow cell run currently varies from less than 0.1 GB to 1 GB of raw sequence data, which is not particularly reliable.

Difference between NGS and Sanger sequencing:

Both sequencing techniques operate on the concept that DNA polymerase sequentially adds fluorescent nucleotides to a growing DNA template strand. The fluorescent tag on each inserted nucleotide serves as an indicator. Dideoxy or capillary electrophoresis sequencing are other names for Sanger sequencing. Sanger sequencing and NGS differ significantly in terms of sequencing volume. In contrast to the Sanger method, which can only sequence one DNA fragment at a time, next-generation sequencing (NGS) can sequence millions of DNA fragments at once. This procedure results in the simultaneous sequencing of hundreds to thousands of genes. When combined with deep sequencing, NGS also gives better discovery capability to find new or uncommon variants.

Applications of NGS:

- Rapidly sequence whole genomes and faster turnaround time for high sample volumes
- Higher sensitivity to detect low-frequency variants
- Deeply sequence target regions and Comprehensive genomic coverage
- Utilize RNA sequencing to discover novel RNA variants and splice sites, or quantify mRNAs for gene expression analysis and analyze epigenetic factors such as genome-wide DNA methylation and DNA-protein interactions
- To identify novel pathogens and lower limit of detection; Ability to sequence hundreds to thousands of genes or gene regions simultaneously.

Nanopore MinION sequencing

The sequencing of polynucleotides in the form of DNA or RNA is done using a special third-generation method called nanopore sequencing. The MinION is the smallest sequencing equipment currently on the market, measuring only 10 x 3 x 2 cm and weighing only 90 g. (Figure 1). With minimal hardware requirements and straightforward configuration, it may be plugged directly into a normal USB3 port on a computer. Sequencing can be done on a computer running Windows 7 or 8 with a solid-state drive (SSD), more RAM than 8 GB, and harder disc space than 128 GB. On the host computer, to which the MinION is connected, specialised software called MinKNOW is running. In order to guarantee that the platform chemistry functions properly when processing the samples, MinKNOW handles a number of key duties, including data gathering, real-time analysis and feedback, data streaming while offering device management, as well as sample identification and tracking. Nanopore devices are built around a central sensing component called a nanopore that is embedded in an arrayed sensor chip. An application-specific integrated circuit (ASIC) designed specifically for the device is used to monitor and control the experiments.

Nanopore: An electrically-resistant polymer membrane contains a protein nanopore.

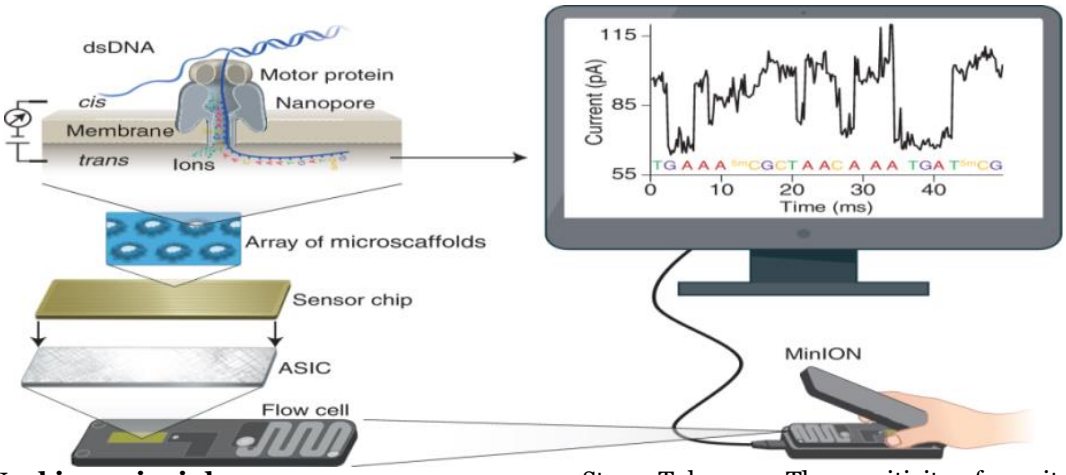
Micro-scaffold array: Each micro-scaffold houses a membrane and a nanopore. Throughout shipping and use, the array maintains the stability of the many nanopores.

Sensor chip: Each micro-scaffold is connected to a channel in the sensor array chip via an electrode that is unique to it. Any number of channels can be used to create sensor arrays.

ASIC: The custom ASIC controls and measures each nanopore channel separately. This makes it possible to run several nanopore studies simultaneously. ASICs of various sizes are being created by Oxford Nanopore for a variety of uses, and a device

may contain more than one ASIC.

Figure 1: Illustration of nanopore MinION sequencing tool



Working principle

Every nanopore sequencing equipment uses flow cells, which are made of an electro-resistant membrane and a collection of microscopic holes known as nanopores. Each nanopore has a corresponding electrode that is attached to a sensor chip, a channel, and a chip that measures the electric current that passes through the nanopore. A characteristic "squiggle" results from the disruption of the current caused when a molecule moves through a nanopore. Base calling techniques are then used to decode the squiggle and determine the DNA or RNA sequence in real time.

Advantages of nanopore sequencing:

1. DNA sequencing requires short protocols
2. The MinION device is similar to USB and can be used in fields with laptop computers
3. Gives fast sequencing within minutes
4. The maximum output range is 10 gb of DNA sequences
5. Stress Tolerance: The sensitivity of a unit to internal environmental conditions
6. Ease of Fabrication: The ability to produce a unit- usually in regards to mass-production

Disadvantages of nanopore sequencing:

Sequencing error rate @ 10% and It works only at its full capacity of 10 gb of DNA sequencing.

References

Jain, M, Fiddes, I.T, Miga, K.H, Olsen, H.E, Paten, B. and Akeson, M. 2015. Improved data analysis for the MinION nanopore sequencer. *Nat Methods*. 12: 351-356.

Motro, Y. and Gilad, J.M. 2017. Next-generation sequencing applications in clinical bacteriology. *Biomolecular detection and quantification*. 14: 1-6.

Dijk, E.L, Jaszczyszyn, Y, Naquin, D. and Thermes, C. 2018. The third revolution in sequencing technology. *Trends Genetics*. **34**: 666-681.

6. HORTICULTURE

Indegenous Tuber Forming Vegetable Crops

Jagarlamudi Nethra*

**M.Sc. (Hort.) Vegetable Science Scholar, Department of Horticulture, MS. Swaminathan School of Agriculture, CUTM, Parlakhemundi, Odisha, 761211, India*

Sophlang:

***Flemingia vestita* (Benth.) ex Baker** is a very less popular vegetable cum medicinal plant that belongs to the family Fabaceae and grows as a perennial crop and previously under the genus *Maughania* and about is first published in "The Flora of British India" by W. J. Hooker in 1876. It is commonly called sophlang and is highly consumed by the tribes of the Northeastern part of India i.e., Meghalaya, and other parts of the Himalayan region like Nepal, China, etc. It is a tuber crop with a thin slender stem that grows up to a height of 50-60cm and flowers annually during August or September producing bright reddish colour flowers. (Feyissa T., 2020).

Peeled tubers of Sophlang

Flour or Starch Production: The sophlang tubers can be used in making flours, which have high nutritional value and are used in making baked products. The tubers are having a sweet nutty flavour and smooth creamy texture when the skin is removed and are also used in cooking and making vegetable curries among the tribals. Marboh, V., & Mahanta, C. L. experimented with replacing wheat flour with *Flemingia vestita* flour and its Impact on the rheological, physicochemical, antioxidant, and antifungal properties of cakes and concluded that the sophlang flour is having a high amount of dietary fiber and antioxidant compounds compared to wheat flour which is due to its less refining process of the tuber.

Anti-helminthic property: Helminths are parasitic worms that live in the hosts i.e., human beings or other animals and sophlang is similar to other crops having an anti-helminthic property like ginger, garlic, and turmeric, and is used in olden medicine but this crop is given less importance in drug production is due to presence of flavonoid called Genistein which causes cell death and some ovarian problems (Klein & King 2007).

Anti-carcinogenic property: As the presence of Genistein causes cell death by apoptosis it is very useful in treating cancer cells mainly in kidney cancer which is on par with studies conducted by Sasamura *et al*. (2004) and Hiara *et al*. (2013)

Anchote

- Anchote Plant
- Vines
- Immature Fruit
- Mature Fruit
- Seeds
- Tubers

***Coccinia abyssinica* (Lam.) Cogn.** is a native crop of highlands in Ethiopia grown as a staple crop for nutritious food and fodder that belongs to the family Cucurbitaceae and is perennial in habit, dioecious in nature, and also a climber which grows up to a length of 5 meters, and both male and female plants produce solitary flowers which are yellow to light orange in colour. There are two colours of tubers in Anchote i.e., red and white colour.

Food and Fodder: The tubers are rich in starch and are cooked. The leaves and shoots are also edible and cooked in the different states of Ethiopia.

Medicinal Property: The Anchote tubers are rich in calcium and help humans during the recovery of fractured bones.

Making of Thermoplastic films: The starch extracted from tubers of Anchote is used in

the making of thermoplastic films which can be replaced with plastic films so these films are ecologically friendly and help to replace plastic shopping and trash bags.

CHOW-CHOW

***Sechium edule* (Jacq.) Sw.** is a perennial crop of Cucurbitaceae family and very popularly known as Chayote and probably originated from Mexico. It is less popular and not commercially exploited member of the cucurbits but currently gaining importance all over the world due its nutritional contents and starch rich tubers.

Food: Chayote fruit is rich in vitamin-C and Amino acids and is used as a vegetable for culinary purpose and the shoots consumed raw as salads. The tubers are used as potatoes among the rural areas.

Fruit of Chayote

Mummification agent: In Columbia it is used for preserving human bodies skin and flesh due to its cell regenerative properties.

Packing films: Using tubers of chayote the starch films are made called as chayo-textile starch films which are used in food packaging replacing the plastic.

References

Abera, G., Woldeyes, B., Demash, H. D., & Miyake, G. (2020). The effect of plasticizers on thermoplastic starch films developed from the indigenous Ethiopian tuber crop Anchote (Coccinia abyssinica) starch. International Journal of Biological Macromolecules, 155: 581–587.

Aung, L. H., Ball, A., & Kushad, M. (1990). Developmental and nutritional aspects of chayote (Sechium edule, Cucurbitaceae). Economic Botany, 44(2), 157–164.

Feyissa, T. (2020). Coccinia abyssinica (Lam.) Cogn. (Anchote) Biology, Productivity, and Prospects of Genetic Improvement Using Biotechnological Tools. Journal of Horticultural Research, 28, 1-10.

Getnet Abera, Belay Woldeyes, Hundessa Dessalegn Demash, Garret Miyake, The effect of plasticizers on thermoplastic starch films developed from the indigenous Ethiopian tuber crop Anchote (Coccinia abyssinica) starch, International Journal of Biological Macromolecules, Volume 155: 581-587, https://doi.org/10.1016/j.ijbiomac.2020.03.218.

Hirata, H., Ueno, K., Nakajima, K., Tabatabai, Z. L., Hinoda, Y., Ishii, N., & Dahiya, R. (2013). Genistein downregulates onco-miR-1260b and inhibits Wnt-signalling in renal cancer cells. British journal of cancer, 108(10), 2070-2078.

Hora, A. (1995). "Anchote: an endemic tuber crop", Jimma College of Agriculture, Jimma, Ethiopia, 75 pp.

Jayanetti, Madara. (2022). Qualitative Phytochemical Screening and Antibacterial Evaluation of Sohphlang - Flemingia vestita.

Marboh, V., & Mahanta, C. L. (2022). Substituting wheat flour with sohphlang (Flemingia vestita) flour: Impact on rheological, physicochemical, antioxidant and antifungal properties of cakes. International Journal of Gastronomy and Food Science, 100546.

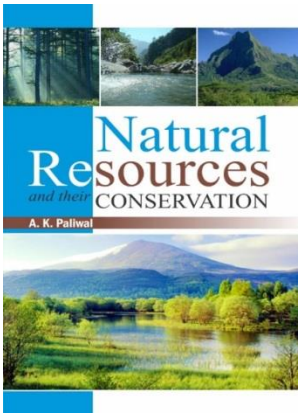
Muñoz, Sara Schaefer (October 2015). In this small Colombian town people love their mummies. Wall Street Journal.

Parmar A., Gebre BA., Legesse A., Demelash Y., Fladung K., Hensel O. Nutritional Comparison of White and Red Coccinia Abyssinica (Lam.) Cong. Accessions: An Under-Utilised Edible Tuber of the Ethiopian Highlands. Foods. 2017; 6(8):71. https://doi.org/10.3390/foods6080071

Sasamura, H., Takahashi, A., Yuan, J., Kitamura, H., Masumori, N., Miyao, N., & Tsukamoto, T. (2004). Antiproliferative and antiangiogenic activities of genistein in human renal cell carcinoma. Urology, 64(2), 389-393.

Selene Aila-Suárez, Heidi M. Palma-Rodríguez, Adriana I. Rodríguez-Hernández, Juan P. Hernández-Uribe, Luis A. Bello-Pérez, Apolonio Vargas-Torres, (2013) Characterization of films made with chayote tuber and potato starches blending with cellulose nanoparticles, Carbohydrate Polymers, 98(1), 102-107

*****



7. AGRICULTURE (PLANT PATHOLOGY)

Wild Mushrooms and Their Medicinal Properties

[1]Ganesuni Lakshmi Prasanna and [2]Saranya S

Ph. D. Research Scholars, Department of Plant Pathology
[1]Dr. YSR Horticultural University, Andhra Pradesh; [2]Navsari Agricultural University, Gujarat

Since the time of the ancient Greeks, who ate mushrooms frequently and thought of them as a source of strength for warriors in battle, mushrooms have been a popular food. The Romans, on the other hand, thought of mushrooms as "Food of the Gods" and only provided them to people on special occasions. The traditional definition of a mushroom was a macrofungus with a characteristic fruiting body that could be seen with the unaided eye and manually harvested (Chang *et al*., 2004). The mushroom instead creates a vast variety of extracellular enzymes because they lack the pigment chlorophyll, which allows the plant to use energy from sunlight (Leo *et al*., 2016). They are able to do this by breaking down complicated organic matter into soluble components that can be ingested for sustenance and stored as secondary metabolites. An individual mushroom species' capacity to create enzymes that break down the substrate's primary constituents, such as cellulose, hemicelluloses, and lign, will determine how well that species grows and produces fruit on a given substrate (Lallawmsanga *et al.,* 2018). The bioactive compounds and useful enzymes that macrofungi create have a variety of therapeutic uses. In order to create various medical and biotechnological products, they are therefore regarded as flourishing organisms (Singh *et al*., 2018). According to estimates, there are around 140,000 species of mushrooms on earth, only 5% of which are being studied for potential uses, and 7000 of these species may have therapeutic use to humans (Thatoi *et al*., 2014).

Due to the existence of biologically active chemicals with known health advantages, natural products derived from both edible and non-edible mushrooms have recently attracted significant attention from the general public and health professionals. The interest in medicinal mushrooms has increased recently as a result of the rising desire for natural bioactive substances as an alternative to some synthetic medications or additives in the pharmaceutical and food industries. Due to the collected quantity of secondary metabolites, the prospective uses of mushrooms have emerged as a nutraceutical, nutritional treatment, phytonutrients, phytotherapy, and medicinal. Medical mushrooms have been found to contain a number of biologically active substances, including polysaccharides, krestin, lentinan, coriolan, schyzophillan, sesquiterpenes, quinones, hydrophobins, galectins, sterols, ergothionin, tri-

teripenes, sterols, germanium, nucleotide, drosophilin, armillasin, amphal (Chaturvedi *et al.,* 2018). Additionally, extracellular proteolytic enzymes with fibrinolytic and thrombolytic activity are produced by mushrooms. Wide-ranging biomolecules found in medicinal mushrooms have been linked to a variety of therapeutic benefits, including antioxidant, cytotoxic, anti-inflammatory, insecticidal, and anti-fungal properties.

Wild Medicinal Mushrooms

Mushroom type	Scientific name	Pictorial diagram	Description	Growth habitat	Active principle	Medicinal use
Reishi mushroom / bracket fungi	*Ganoderma lucidum*		Stipe is tawny to russet colored; context tissue is pink-buff to cinnamon-buff and corky, showing concentric growth zones and no resinous or melanoid deposits.	Grows as saprotroph on dead wood or as parasites on the live wood of palms and conifers	-Triterpenoids: (GLTA &GLTB), Ganodermanon-triol -Ganoderic acid -Polysaccharide peptides (GLPP) -Heterogalactan	- Anti-viral -Regulate gut microbiota and cardiovascular risk factors -Prebiotic effects
White root fungi	*Rigidoporus ulmarius*		A broad 20 cm wide orange to red or brown, leathery, faintly velvety fruiting body, imbricate with the substrate.	Grow on and adhere strongly to the surface of the root bark	-Bioactive polysaccharides (1,3-ß-glucan)	-Antiangiogenic -Antiinflammatory -Antitumor effect
Witch's butter/golden jelly/ yellow brain fungi	*Tremella mesenterica*		Orange-yellow, gelatinous fruit body have convoluted or lobed surface that is greasy or slimy	Grows on crevices in bark and appears during rainy weather	Polysaccharides (Glucuronoxylomannan	-Cancer prevention -Immunostimulatory -Antidiabetic -Anti-inflammatory -Hypocholesterolemic

						- Hepatoprotective
Almond mushroom / mushroom of sun, Gods mushroom	*Agaricus blazei/ A. subrufescens*		White to grayish or dull reddish brown fruit body and has the taste of green nuts, with the order of almond	Forms fruit bodies singly or in clusters in leaf litter in rich soil, often in domestic habitats	-Ergosteroids derivatives (Blazeispirols)	-Prevent osteoporosis and peptic ulcer -Curing arteriosclerosis and osteoporosis
Maitake mushroom / hen of the wood fungi/ dancing mushroom	*Grifola frondosa*		Cluster of multiple grayish brown caps which are often curled or spoon shaped with wavy margins with milky white stile	Perennial fungi grows at the base of trees, particularly old growth oaks or maples	-Glycoproteins (ß-glucans: D-fraction, MD-fraction) -Heteroglycans: MZF, GFPW	-Antitumor -Anti-viral -Anti-hypertensive -Antihyperlipidemic -Antidiabetic -Immune enhancing
Shiitake mushroom	*Lentinus edodes*		Tan to brown coloured umbrella shaped fruit body, edges of the cap roll down and inwards with white to cream coloured stem	Grows on decaying wood of deciduous trees like shii, maple, beech, poplar and ironwood	-Adenine derivatives	-Antiinflammation -Antitumorigenic -Gastroenteropathy -Vertigo, -Hepatocirrhosis -Arteriosclerosis -Hypocholesterolemic
Gilled polypore/ birch mazegill	*Lenzites betulina/ Trametes betulina*		Bracket or kidney shaped, densely hairy fruit body with concentric zones, without stem	Saprobic on deadwood of hardwoods, occasionally on conifers named betulina	-Steroids -Terpenoids	-Antioxidant -Immunosuppressive -Antimicrobial -Antitumor
	Trametes		Thick, leathery cap shows	Grows in tiled layers in	-Polysaccharide (PSP, ß-1,3 & ß-1,4 glucans)	- Used in adjuvant therapy -Dietary

Turkey tail	*versicolor / Coriolus versicolor*		typical concentric zones of different colours with light colour margins without stalks	groups or rows on logs and stumps of deciduous trees	-Lanostane type tetracyclic triterpenoid sterol ergosta-7,22,dien-3ß-ol -Fungisterol	supplements
Willow bracket/ fire sponge	*Phellinus igniarius*		Longest persisting fungal fruit bodies, displaying up to eighty annual growth rings	Grows on hardwoods, willow, birch and alder	Cyclophellitol, aromadendrin, folerogrenin, eriodictyol, coumarin	-Influenza virus A & B -Avian flu, -Antioxidant, -Anti-tumor, antiviral, -Immune stimulating
Veiled polypore fungi	*Cryptoporus volvatus*		Spherical to hoof shaped, cream or tan coloured fruit body, which decomposes the rotting sapwood of conifers	Found on the deadwood of conifers, often on burnt trees, fruit mid to late winter	Ergosta-7,22-dien-3b-ol, fungisterol, 1,3 beta D glucans	Antitumor, antiallergic, antiinflammatory, immune modulating, antioxidant, transforms phlegm, stops coughing venus
False turkey tail/ Golden curtain crust	*Stereum ostea*		Red coloured, shell like fruiting body with hairy/smooth surface, mimics like *Trametes versicolor*	Deadwood of hardwood found throughout the year	-Stereumones (A-E) -Methyle 2,4-dihydroxy-methylbenzoate -Laricinolic acid	-Antifungal -Antibacterial

Conclusion

A novel idea in the medical and food industries is the use of medicinal mushrooms in modern medications and nutraceuticals. Government organizations must encourage research to help agricultural development in the identification, isolation, cultivation, and exploitation of wild mushrooms in order to successfully transform them into palatable, nutritious foods. Additionally, it is crucial to document the ethno-medical qualities of wild mushrooms in order to continue their use in the future and to provide access to significant mushroom strains that may contain bioactive substances.

Reference

Chang, S. T. and Miles, P. G. 2004. Mushrooms-cultivation, nutritional value,

medicinal effect and environmental impact. 2nd ed. Boca Raton, London: CRC Press. pp. 2-4.

Leo, V. V, Passari, A. K, Joshi, J. B, Mishra, V. K, Uthandi, S. and Gupta, V. K. 2016. A novel triculture system (CC_3) for simultaneous enzyme production and hydrolysis of common grasses through submerged fermentation. *Frontiers in Microbiology*. 7:447.

Lallawmsanga, L. V. V, Passari, A. K, Muniraj, I. K, Uthandi, S, Hashem, A. and Abd-Allah, E. F. 2018. Elevated levels of laccase synthesis by Pleurotus pulmonarius BPSM10 and its potential as a dye decolorizing agent. *Saudi Journal of Biological Sciences*. 26(3):464-468.

Singh, B. P, Chhakchhuak, L. and Passari, A. K. 2018. editors. Biology of Macrofungi. Switzerland: *Springer International Publisher*.

Thatoi, H. and Sameer, K. S. 2014. Diversity, nutritional composition and medicinal potential of Indian mushrooms. *African Journal of Biotechnology*. 13(4):523-545.

Chaturvedi, V. K, Agarwal, S, Gupta, K. K, Ramteke, P. W. and Singh, M. P. 2018. Medicinal mushroom: Boon for therapeutic applications. Biotechnology. 8(8):334.

*****

8. SOIL SCIENCE

Green Manure Crops and its Importance

A. Premalatha[1] and S. Saravanakumar[2]

[1]Scientist (Soil Science), [2]Scientist (Agronomy)

ICAR – Krishi Vigyan Kendra, MYRADA, Gobichettipalayam, Erode District, Tamilnadu

Introduction

No crop will grow well without adequate nutrition and it has to be remembered that maximum performance will depend on a good nutrient balance, adequate moisture levels and an appropriate pH. As a rule short term green manures should not need additional fertility inputs as long as nutrient balances are addressed. Green manures as fertility building crops, they have been used in traditional agriculture for thousands of years but conventional farming systems largely rejected them as the use of fertilizers and pesticides became more common. Although they have many roles they are still often under utilized by today's organic farmers. A wide range of plant species can be used as green manures and green leaf manure. Different ones bring different benefits.

Green Manure

Crops grown for the purpose of restoring or increasing the organic matter content in the soil are called green manure crops. Green manure crops are grown and incorporated in the same field.

Classification of Green Manure:

Green manure		
Legume		Non-legume
Daincha, Sesbania rostrata Sun hemp, Cowpea, Pillipesara, Field bean, Lucern	Clusterbean, Tephrosia, Indigo, Azolla, Greengram, Blackgram, Berseem, Alfalfa,	Sunflower, Buck wheat, Rye, Mustard

Legumes are usually utilized as green manure crops as they fix atmospheric nitrogen in

the root nodules through symbiotic association with a bacterium, rhizobium and leave part of it for utilization of the companion or succeeding crop.

Crop Selection Criteria for Green Manure crops:

- Fast growing crops with more foliage and ability to cover the land quickly
- Short duration
- High biomass and nutrient accumulation
- Preferably legume in nature, so that, they fix atmospheric N and improves the soil fertility and supply nutrients to component crops and (or) subsequent crops
- High N sink in underground plant parts
- Low cost of production Resistance/tolerance to natural calamities
- Ability to grow in all agro-climatic zones
- Ability to grow with less water thus high water use efficiency
- Various uses (fodder, green manure, N fixation, seed, shade, cover crop, erosion control) Insensitive to photo and light periods
- Ability to fit between two main crops
- High seed production potential
- High seed viability for longer period
- Low lignin content
- Low C:N ratio
- Easy for incorporation and decomposition
- Easy and timely release of nutrients

Green Manure Crops:

Sesbania aculeata (Daincha): Season: Grown all seasons when sufficient moisture is available, March–April sowing is best for seeds production

- Soil: Grown in all soil conditions
- Seed rate: 25–30 kg/ha for green manure, seed purpose 20 kg/ha
- Seed treatment: Mix seeds with specific rhizobium strain @ 5 pkts/ha
- Spacing: Broadcasted, for seed purpose adopt 45 × 20 cm
- Irrigation: Once in 15–20 days
- Harvest: Incorporate the green matter within 45–60 DAS and collect seeds from 100 DAS
- Yield: Green biomass-20 t/ha, Seed-500–600 kg/ha

Sesbania Rostrata (Manila agathi):

- Season: Grown all seasons. February–May sowing biomass yield is more, March–May sowing is best for seeds production
- Soil: Black and red soils suitable, Saline alkaline soils not suitable
- Seed rate: 40 kg/ha for green manure, seed purpose 7–8 kg/ha
- Seed treatment: Seeds to be scarified with concentrated H_2SO_4 (100 ml/kg) by soaking for 10 minutes then wash thoroughly (10–15 times). Mix seeds with specific rhizobium strain @ 5 pkts/ha
- Spacing: Broadcasted, for seed purpose adopt 45 × 20 cm
- Irrigation: Once in 15–20 days
- Nipping: For seed purpose, it should be done 60 DAS to increase branching and seed yield
- Harvest: Incorporate the green matter within 45–50 DAS and seeds can be collected from 100 DAS (3–4 harvest)
- Yield: Green biomass–20 t/ha, Seed–500–600 kg/ha

Crotalaria Juncea (Sunnhemp):

- Season: Grown in all seasons, March–April sowing is best for seeds production
- Soil: Loamy soils are suitable
- Seed rate: 25–40 kg/ha for green manure, seed purpose 20 kg/ha
- Seed treatment: Mix seeds with specific rhizobium strain @ 5 pkts/ha
- Spacing: Broadcasted or 30 × 10 cm, seed purpose adopt 45 × 20 cm
- Irrigation: Once in 30 days
- Harvest: Incorporate the green mater within 45-60 DAS and for seed production, collect the seeds from 150 DAS

- Yield: Green biomass 13–15 t/ha, Seed–400 kg/ha

Tephrosia Purpurea (Wild Indigo):

- Season: Grown all seasons, March–April is best for seeds production
- Soil: Grown all soils, sandy soils are suitable
- Seed rate: 25–40 kg/ha for GM, seed purpose 10 kg/ha
- Seed treatment: Soak the seeds in concentrated sulphuric acid (100 ml/kg seed) for 30 m and then thoroughly wash the seeds in water for 10–15 times and shade dry
- Spacing: Broadcasted, for seed purpose adopt 30 × 10 cm
- Irrigation: Once in 30 days Harvest Incorporate within 60 DAS and for seed collect from 150 DAS
- Yield: Green biomass 3.5–5 t/ha, Seed–400–500 kg/ha

Sesbania Speciosa (Sithagathi):

- Season: Grown all seasons, March–April sowing is best
- Soil: Grown in all types of soil condition
- Seed rate: 30–50 kg/ha for green manure, seed purpose 15 kg/ha
- Seed treatment: Mix seeds with specific rhizobium strain @ 5 pkts/ha
- Spacing: Broadcasted and for seed purpose adopt 45 × 20 cm
- Irrigation: Once in 15–20 days
- Harvest: Incorporate the green matter 45–60 DAS and for seed, collect the seeds on 130 DAS
- Yield: Green biomass-10–18 t/ha, Seed 400–600 kg/ha

Other Uses of Green Manure Crops:

- Catch crops,
- Shade crops (to provide shade in young orchards besides adding N and improving fertility)
- Cover crops (Covering the bare soil or fallow lands with vegetative cover in hill slopes during rainy season and avoid soil, water and wind erosion besides suppressing the weeds)
- Forage crop: provide fodder

Nutrient content of green manure crops:

Plant	**Scientific name**	**Nutrient content (%) on air dry basis**		
		N	P2O5	K
Sunhemp	*Crotalaria juncea*	2.30	0.50	1.80
Dhaincha	*Sesbania aculeata*	3.50	0.60	1.20
Sesbania	*Sesbania speciosa*	2.71	0.53	2.21
Tephrosia	*Tephrosia purpurea*	1.7	0.28	1.25
Mungbean	*Vigna radiata*	2.21	0.26	1.26

Benefits of Green Manuring

- Improves soil structure
- Increases water holding capacity and
- Decreases soil loss by erosion
- Green manuring helps in reclamation of alkaline soils. Root knot nematodes can be controlled by green manuring.
- It decomposes rapidly and retains the organic matter in the soil
- Green manures help the soil to improve both physical and chemical content
- It gives energy to microbes
- They provide nutrients to the present crop and also to the next crop
- green manure crops help to control weeds
- Most of the green manure crops are legumes, the use of nitrogenous fertilizers can be reduced

Conclusion

Green manure provides organic matter which can play a major role on organic farming which reduces composting cost drastically. Once can be sure that these green manure crops are environmentally friendly which can reduce the application of chemical fertilizer and herbicides which is part of agriculture.

*****

We invite good, informative and knowledge spreading articles for publication in Readers

Shelf. Please contribute your articles. It has been our honest effort to incorporate more and more articles in the magazine and request readers to please subscribe and send the articles for publication in Readers Shelf. The articles can be mailed on our mail address readersshelf@gmail.com

*****

9. AGRICULTURE/AGRICULTURAL METEOROLOGY

Agro-Meteorology: A Route Map for Indian Agriculture

***Agatambidi Balakrishna, Shaik Jakeer Basha and Shivaji Raja**

**Ph.D, Scholar, Department of Climate Change and Agricultural Meteorology, Punjab Agricultural University, Ludhiana-141001, India*

Introduction

Agro-meteorology is the study of the interactions between meteorological phenomena and agricultural systems. It plays a crucial role in understanding the weather and climate patterns that affect crop growth and productivity, and developing strategies for managing these factors to improve agricultural yields and resilience. In India, agro-meteorology is a critical field for addressing the challenges facing the country's large and diverse agricultural sector. One of the main challenges facing Indian agriculture is the high variability and uncertainty of weather and climate conditions. The country is home to a wide range of climates, from the tropical monsoon regions in the south to the semi-arid regions in the west, and the cold mountainous regions in the north. This variability makes it difficult to predict weather patterns and their impact on crop growth and productivity. Agro-meteorology can help by providing a better understanding of weather and climate patterns, and how they affect different crops and regions.

Another key challenge facing Indian agriculture is the increasing frequency and severity of extreme weather events, such as droughts, floods and heatwaves. These events can cause significant damage to crops and reduce yields and can also increase the risk of crop failure and food insecurity. Agro-meteorology can help by providing early warning systems and forecasting tools that can help farmers prepare for and respond to extreme weather events. Agro-meteorology also plays a critical role in developing climate-resilient agricultural systems. With climate change expected to bring more frequent and severe weather events, it is important to develop strategies that can help farmers adapt to these changes. Agro-meteorology can provide the necessary information to design and implement these strategies, such as identifying the best crop varieties and planting dates for different regions, and developing irrigation and water management strategies.

In order to address these challenges, India needs to invest in the development of agrometeorological research and services. This includes building a strong network of weather and climate monitoring stations across the country, as well as developing advanced forecasting and modeling tools. It also includes training and capacity building for farmers and extension workers, so they can access and use the latest agrometeorological information and technologies. One of the most important aspects of agro-meteorology is its interdisciplinary nature. The field draws on knowledge from various disciplines such as meteorology, climatology, agronomy, soil science, plant physiology, and crop physiology. This interdisciplinary approach is important for understanding the complex interactions between weather and climate conditions, and crop growth and productivity. In India, there are several research organizations, universities and institutes which are working in the field of agro-meteorology. Indian Agriculture Research Institute (IARI), Indian Meteorological Department (IMD), Indian Institute of Technology (IIT), Indian Institute of Tropical Meteorology (IITM) are some of the major organizations working in the field of agro-

meteorology.

In conclusion, agro-meteorology is a critical field for addressing the challenges facing Indian agriculture. It provides a better understanding of weather and climate patterns and how they affect different crops and regions and helps to develop strategies for managing these factors to improve agricultural yields and resilience. With the increasing frequency and severity of extreme weather events, and the threat of climate change, investing in agrometeorological research and services is more important than ever.

Agro-meteorology has some significance as follows in Agriculture

1. Agro-meteorology helps to understand the impact of weather and climate on crop growth and productivity.
2. It enables farmers to make informed decisions on planting dates, crop varieties, and irrigation strategies.
3. Agro-meteorology provides early warning systems and forecasting tools to prepare for and respond to extreme weather events.
4. It helps to develop strategies for managing water resources, including irrigation and drainage systems.
5. Agro-meteorology is critical for identifying and mitigating risks associated with climate change.
6. It helps to optimize the use of natural resources, such as sunlight and water, to improve crop yields.
7. Agro-meteorology is essential for designing and implementing sustainable agricultural systems.
8. It helps to improve the efficiency of crop production by reducing losses due to weather-related factors.
9. Agro-meteorology enables farmers to adapt to changing weather and climate conditions.
10. It helps to reduce the environmental impact of agriculture by improving water and energy use efficiency.
11. Agro-meteorology is critical for understanding the interactions between weather and air pollution and their impact on crop health and growth.
12. It helps to improve the resilience of agricultural systems to extreme weather events and climate change.
13. Agro-meteorology enables farmers to monitor and manage crop pests and diseases.
14. It helps to improve food security by increasing crop yields and reducing the risk of crop failures.
15. Agro-meteorology plays an important role in the management of natural resources and biodiversity.

Agro-meteorology importance in agricultural climatic zones

1. Agro-meteorology helps to understand the specific weather and climate patterns in different agricultural climatic zones.
2. It enables farmers to develop crop-specific strategies that are tailored to the unique conditions of their climatic zone.
3. Agro-meteorology can help to identify the most suitable crop varieties for different climatic zones, increasing yields and reducing crop failure risks.
4. It helps farmers to schedule planting and harvesting times based on the specific weather patterns of their climatic zone.
5. Agro-meteorology can help in identifying the best irrigation strategies for different climatic zones, which can conserve water resources and improve crop yields.
6. It can help to understand the impacts of climate change on different agricultural climatic zones and develop adaptation strategies.
7. Agro-meteorology can aid in forecasting and managing extreme weather events such as floods, droughts, and heatwaves that are specific to certain climatic zones.
8. It helps to identify the most suitable soil and nutrient management practices for different climatic zones.
9. Agro-meteorology can help to improve the efficiency of crop production by reducing losses due to weather-related factors in different climatic zones.
10. It enables farmers to develop crop management strategies that are in harmony with the natural resource base of their climatic zone.
11. Agro-meteorology can help to develop sustainable agricultural systems that are specific to different climatic zones.
12. It can aid in identifying the best pest and

disease management strategies for different climatic zones.
13. Agro-meteorology can improve food security by increasing crop yields and reducing the risk of crop failures in different climatic zones.
14. It can aid in the management of natural resources and biodiversity specific to different climatic zones.
15. Agro-meteorology can help to develop climate-resilient agricultural systems that are specific to different climatic zones.

Specialised agency responsible for cooperation and coordination on the state and behaviour of the Earth's atmosphere, its interaction with land oceans, the weather and climate it produces.

1. WMO (World Meteorological Organisation)
2. IMD (India Meteorological Department)
3. IITM (Indian Institute of Tropical Meteorology)
4. NCMRWF (National Centre for Medium Range Weather Forecasting) etc.

The World Meteorological Organization (WMO) is an intergovernmental organization that promotes international cooperation in meteorology and related disciplines. The organization was established in 1950 and has a membership of 191 Member States and Territories. WMO's main functions include the collection, analysis and dissemination of meteorological, climatological and hydrological data, as well as the provision of technical assistance and scientific advice to its Member States. One of the key activities of WMO is the Global Observing System (GOS), which is a coordinated system of observing networks that provide data on the state of the atmosphere, oceans, and land surface. This data is used for weather forecasting, climate monitoring, and research. WMO also provides guidance on the use of this data to its Member States, as well as to the private sector and the public.

Another important activity of WMO is the World Weather Watch (WWW), which is a global system of weather forecasts and warnings. The WWW provides information on weather patterns and extreme weather events, such as hurricanees, floods, and droughts. This information is used to protect lives and property, and to support the development of sustainable economic and social activities. WMO also plays a key role in the development of international standards and guidelines for meteorological and hydrological services. These standards and guidelines help to ensure the quality and consistency of the data and information provided by its Member States, and they are widely used by the international community.

In India, the Indian Meteorological Department (IMD) is the specialized agency responsible for cooperation and coordination on the state and behavior of the Earth's atmosphere, its interaction with land and oceans, the weather, and climate it produces. The IMD is an agency of the Ministry of Earth Sciences and is headquartered in New Delhi. The IMD is responsible for providing weather forecasts and warning services, monitoring and studying the Earth's climate, and conducting research on atmospheric science. It operates a network of weather monitoring stations and meteorological observatories across the country, and uses this data to produce weather forecasts, warnings, and climate projections. The IMD also provides services to other government agencies, the private sector, and the public, including aviation weather services, agrometeorological services and weather-related information for disaster management. The IMD is one of the oldest meteorological organizations in the world, having been established in 1875. It has a long history of providing weather and climate services to the country, and has played an important role in the development of meteorology and atmospheric science in India.

The Indian Institute of Tropical Meteorology (IITM) is a premier research institute in India that conducts research on the monsoon, the tropical atmosphere, and the oceans. It is located in Pune, Maharashtra, India and is an autonomous research organization under the Ministry of Earth Sciences, Government of India.

The National Centre for Medium Range Weather Forecasting (NCMRWF) is a premier research organization in India that specializes in weather forecasting and climate monitoring. It is located in Noida, Uttar Pradesh, India and is an autonomous research organization under the

Ministry of Earth Sciences, Government of India.

References

Guide to Agricultural Practices (GAMP) ISBN 978-92-63-10134-1, WMO pun No. 134

Package of Practices for Crops of Punjab, KHARIF 2022 (Punjab Agricultural University)

Prabhjyot-Kaur, sukhjeet Kaur and Harleen Kaur (2021) Climate Smart Agriculture in the Era of Climate Change. A Booklets

India Meteorological Department (IMD) Annual Report 2021

Indian Meteorological Department. https://www.imd.gov.in/pages/aboutimd.php

Indian Meteorological Department. https://www.imd.gov.in/pages/history.php

Singh R K and Singh R (2018). The Indian Meteorological Department: A historical perspective. *Journal of Earth System Science*, 127(5), 1-16.

Tek A K, Singh R K, Singh R, Singh R and Singh R (2017). Agro-meteorology in Indian agriculture: Present status and future prospects. *Journal of Agro-meteorology*, 19(1), 1-12.

The role of meteorological parameters in determining yield of rice cultivated under flooded transplanted conditions irrigated plains of central Punjab – A Case Study. *Journal of Agrometeorlogy* (2022) 24 : 3

10. SOIL SCIENCE AND AGRICULTURAL CHEMISTRY

Clay mineral-Microbial Interactivity

M. Bhargava Narasimha Yadav*

PhD Scholar, Department of Soil Science and Agricultural Chemistry, UAS Dharwad

Over recent decades there has been growing appreciation that the prime involvement of clay minerals in the geochemical cycling of elements and pedosphere genesis should take into account the biogeochemical activity of microorganisms. The relationships between claymineral-microbial interactions are a puzzle-like manner which points towards a relationship that can be truly termed co-evolution. Clay minerals play a very central role in this co-evolving system. Life has modified our planet in so many and interconnected ways. Even when considering minerals alone the task of generating a synthetic view of their interaction with life is not easy. Prokaryotes and micro fungi are perhaps ~75% of the biological mass in the planet, of which the majority live in contact with minerals. The question addressed, is: "what do microorganisms do to minerals?". Microorganisms need inorganic nutrients which are, ultimately, stored in minerals. It is reasonable to conclude that microorganisms dissolve or weather minerals in someway in order to release these nutrients. While thinking in this way another question will be rises that "what do microorganisms do to minerals which modifies the inorganic processes, and to what extent are these inorganic processes modified?". Microbes have to adapt to their habitat and change their activity in order to be successful on mineral substrates of different chemistry, fabric, water content, resistance to weathering, etc. This leads to the expression of different genes in different environments, the change of role of certain species between primary producers and scavengers in microbial populations and, eventually, to evolution.

Microbial Structures

Biofilms

Firstly, it is appropriate to consider how micro organisms are in contact with mineral grains. Most frequently, microorganisms generate biofilms, 3-D structures of extracellular polymeric substances (EPS). Biofilms allow microbial communities to attach to surfaces, afford protection from other microbial predators, maintain moisture, control the environment around them, and help microbial cooperation, which includes communication between individuals. Biofilms not only attach to surfaces but also enclose mineral particles.

Symbiotic Structures

Beside biofilms, two other common ways in

ISSN No.:2321-7405

which microbes interact with minerals are through symbiotic activity in lichens and plant roots. In lichens, green algae and/or cyanobacteria are symbiotic with fungi. In this symbiosis, the lichen behaves differently from the other elements (algae, cyanobacteria, fungi). The fungus is the element that anchors the lichen to a solid surface through hyphae known as rhizines. The anchoring to rock, soil or sediment surface means that the lichen penetrates them and contributes to rock disaggregation, while the leaching activity to obtain mineral nutrients contributes to dissolution. However, the coating of the mineral surface is also an effective protection against physical erosion by wind or water, especially in the case of soil and sediments, but also against temperature variations and salt crystallization on rocks. Lichens have also been found to protect against chemical attack in several ways. They limit rainwater penetration in pores, inhibiting dissolution and precipitation processes, and they frequently create a patina (observed typically in monuments) consisting of calcium oxalate, calcium carbonate and biological debris that appears to protect the rock surface from chemical attack. Frequently, biofilms develop in combination with the lichens and the effect of the two on the mineral surface is integrated.

Effect of Clay Minerals on Microorganisms

Clay minerals have small particle size, large surface area and combined hydrophilic and hydrophobic properties, all of which allow the generation of organo-mineral aggregates and biofilm-mineral structures. Montmorillonite has been proven to boost microbial activity where kaolinite failed to do so possibly because of montmorillonite expandability and much greater adsorption capacity that leads to exchange of organic and inorganic species and to pH buffering. The beneficial effect of the covering of bacteria with clay minerals extends to protection against desiccation and UV light during long-range transport in the atmosphere. Such protection is only possible by small particles of great adherence, such as clay minerals. However, adsorption of organic matter on clay minerals typically reduces its availability to microorganisms as compared to dispersed organic matter, and soil and sediment architecture and mineralogy (i.e. clay minerals) may protect organic matter from microorganisms. Microorganisms also require metal nutrients that are taken from minerals, solutions, colloids and decaying organic matter.

Smectite is much more nutrient-rich than kaolinite. Other things being equal, microorganisms living in kaolinite-rich environments will need to be more aggressive, in order to solubilize sufficient nutrients, than in a smectite-rich environment. Obviously, because most environments are not monomineralic, microorganisms can identify the minerals in the system that are most nutrient-rich and leachable, and concentrate their attack on them. In any case, this is a way in which minerals affect microorganisms enormously because microorganisms have to adapt to the inorganic conditions of the environment. In an experimental study, found that the type of mica (biotite or phlogopite) in bacterial cultures controlled how bacteria attacked the mineral. Solubilization of the same amount of Fe required greater production of organic acids for biotite than for phlogopite.

Clay-Mineral Formation Mediated By Microorganisms

It is probably safe to say that clay minerals of microbial origin are typically of variable composition and low crystal order; or rather, that they have a more variable composition and lower crystal order than clay minerals formed by inorganic processes in the same environment. At near-neutral pH, the bacterial cell walls and the EPS have a net negative charge in their surface produced by carboxylic, hydroxyl and phosphoryl groups, so they can attract and retain cation species. They also have localized amino groups charged positively, which allow attachment of silicate anions. Interaction of negatively charged sites on cell walls and anions can also take place through cation bridging. The combination of all these sites on bacterial walls and attachment mechanisms explains how they can be effective nucleation agents for clay minerals. Fiore et al. (2011) carried out experiments lasting up to 322 days with kaolinite saturated solutions in the presence/absence of oxalate and bacteria from peat-moss soil. A white precipitate developed in a

few days. Macroscopic techniques (XRD, Fourier transform infrared spectroscopy – FTIR) could not detect crystalline phases, but high-resolution transmission electron microscopy with microanalysis detected kaolinite. He suggested that kaolinite formed in two steps: (1) precipitation of an alumino silicate gel by the action of oxalate and organic products (EPS, biofilm, metabolites); and (2) crystallization of kaolinite induced by the metabolic activity of bacteria found within the gel.

Recognized ways of mineral weathering induced by microorganisms include the following: (1) acid attack produced by the release of protons, CO_2, carbonic, phosphoric, aliphatic or aromatic acids, and the action of EPS, which have acidic groups (2) exudation of chelating agents, such as oxalic or citric acid, siderophores and EPS, that bind to metals (mainly Fe and Al) and displace the equilibrium of mineral weathering towards further dissolution (3) element oxidation-reduction (mainly Fe, Mn, S), which promotes mineral breakdown and dissolution (4) uptake of dissolved ions by adsorption into cell walls or assimilation, a process which also displaces the chemical reactions towards further dissolution; (5) local modification of the water chemical composition (e.g. concentrating salts) and/or viscosity. These modifications cause the solution to become more aggressive to the mineral surface, favoring cation exchange and penetration of organic molecules into the mineral lattice (6) Increase of pH is less common but has also been reported as a mechanism of feldspar. These mechanisms of chemical attack are sometimes combined with the physical erosion of mineral grains by microbial growth and movements, which fosters mineral weathering by exposing fresh surfaces to chemical attack.

11. GENETICS AND PLANT BREEDING

High throughput Phenotyping: A Revolution towards Precision Breeding

Chaudhary Ankit R.[1] and Sharma Deepak D.[2]

[1,2]Ph.D. Scholar, Department of Genetics and Plant Breeding, Navsari Agricultural University, Navsari, Gujarat

Introduction

As the need for unique characteristics in crop breeding increases, the plant researchers are faced with the challenge of quantitatively assessing the structure and function of greater numbers of plants. Despite the growing use of next-generation sequencing, linkage mapping, SNP genotyping technologies and genome-wide association studies to dissect the genetic architecture of agriculturally important characteristics, but precision phenotyping remains a bottleneck (Zhang *et al.* 2017). Traditional phenotyping is expensive, time-consuming, labour-intensive, low-throughput, and often destructive to plants. High-throughput phenotyping is a way to discover genetic traits that are desired or expressed. These phenotypes can be genetically targeted through genes and environmental conditions to create optimal growth factors (Furbank and Tester, 2011). One of the main goals of high-throughput phenotyping focuses on the genetic gain, by which researchers focus on expanding the knowledge of different genomes and genetic variation. Using high-throughput phenotyping one can lead to an exponential gain in knowledge about the genetics of populations.

What is Plant Phenotyping?

It's a collection of methods and protocols for measuring plant growth, performance, architecture, and composition at various scales. Phenotyping the population is the most laborious and technically challenging part.

What is High throughput phenotyping?

High throughput phenotyping utilises robots, precise environmental control, and remote sensing techniques to analyse plant growth and performance in greenhouses or growth chambers, as well as in the field. High

throughput phenotyping is a multi-disciplinary approach that includes Genetics and Plant Breeding, Bioinformatics, Physiology and Engineering (Zhang *et al*. 2019).

Imaging technology and other types of equipment used for high throughput phenotyping

A wide range of cameras are available for capturing light signals in the visible and infrared spectrums (Visual Inertial System). These cameras measure the morphological and colour properties of the plants by detecting the light in the visible range between 400 and 700 nm. Night imaging is done with infrared (IR) cameras, which detect near-infrared (NIR) light in the range of 700 to 1400 nm. NIR cameras sense near-infrared and short-wave infrared light in a region that is useful for sensing leaf water content. Leaves emit long-wave infrared light in a temperature-dependent manner, which can be detected by using thermal infrared cameras (TIC). Hundreds of spectral bands ranging from 350 nm to 2500 nm can be detected by using hyperspectral cameras.

1. **Scanning by visible light:** Sensing visible wavelengths (400 to 700 nm). It is the most easily accessible sensor and is called VIS (Visual Inertial System). e.g., RGB imaging system. The RGB band sensor captures photos of most of the morphological characteristics of plants, including the entire image of the plant, plant structure, shoot biomass, leaf area, height, and so on. Its measurement is rapid so RGB has various applications.
2. **Far-infrared imaging:** Far-infrared or we can also term it as thermal imaging or thermography. The thermal sensor can detect temperature variations induced by stomatal closure and transpiration. Thermal imaging might be used to assess temperature-related characteristics including stomatal conductance, water content and transpiration rate. At the single plant level, thermography can be used to extract leaf or canopy temperature.
3. **Near-infrared imaging (NIR):** NIR cameras monitor water content and its movement in leaves and soil. They utilize light in the near-infrared region (700–1400 nm) of the spectrum. Plant green areas have the highest rates of reflection between 700-1300 nm NIR wavelengths. NIR above 1300 nm is also reflected by leaves but at a comparatively lesser rate. More the presence of chlorophyll more will be reflectance in the NIR range. These processes cause the scattering of wavelengths within the leaf mesophyll.
4. **Fluorescence imaging:** Fluorescence refers to the light signals produced when radiation of shorter wavelengths is absorbed. Fluorescence imaging is a technique that is used to assess plant health, photosynthesis, biotic and abiotic stress responses and chlorophyll content. UV light produces two forms of fluorescence: red to far-red fluorescence and blue to green fluorescence, which is the basis for multicolour fluorescence imaging. Based on this fluorescence, various ratios are estimated and used as an indicator of stress.
5. **Hyperspectral imaging:** Its capacity to collect pictures in high resolution and a narrow spatial range allows it to distinguish between different stress reactions. In comparison to traditional multispectral sensors, hyperspectral sensors consist of hundreds of thousands of bands per pixel. Band selection is difficult for imaging because of the narrow and numerous bands. These sensors are light weighted and comparatively less expensive; therefore, they are often used for airborne applications on Drones. Due to its narrow range of spectral reflectance, it may be used to determine soil coverage status, photosynthetic rates and level of phytochemicals like nitrogen, cellulose, and lignin.
6. **Magnetic resonance imaging** (MRI)**:** Plant roots are studied via magnetic resonance imaging. To obtain pictures of roots, MRI employs a magnetic field and radio waves. Magnetic resonance imaging allows the 3D geometry of roots to be viewed just as if the plant was growing in

the soil. Some researchers discovered that higher water content changes occurred when the greatest root densities were observed using MRI imaging.

7. **Mini plant photosynthesis meter:** The plant emits a very weak optical signal called chlorophyll fluorescence, which is used to make the measurement. It is invisible, yet the equipment picks it up and measures it correctly. The instrument shows if the crop is stressed due to excess light or water shortage and even if the crop is suffering from herbicide treatment because herbicides are photosynthesis inhibitors.
8. **Infrared plant thermometer:** Used for monitoring evapotranspiration rates in crops and in the observation of daily crop temperatures and it is related to plant water stress. Lower temperatures will be associated with the genotypes that have a higher transpiration rate. The measurement of leaf temperature is also used to identify water stress, which causes stomatal closure.

Different setups used for high throughput phenotyping for integrated management of field-based phenotyping

1. **Phenonet:** Variables like soil temperature, canopy temperature, soil moisture, incoming solar radiation can be efficiently measured by using this smart sensor network.
2. **Phenomobile:** A vehicle that travels across the field of plants and takes data from three rows of plants at the same time.
3. **Plant Scan:** It will help in the analysis of plant morphology by combining a range of digital imaging technologies**.**
4. **The blimp:** It can carry both digital colour and infrared cameras that can operate from 10 to 80 meters above the ground.
5. **The Cropatron:** It will provide controlled conditions to the field, allowing scientists to investigate how climate change affects crops.
6. **Phenotower:** It takes infrared thermography and colour images of field plots from a height of 16 meters above the crop canopy.

Conclusion

Current phenotyping is largely extensive hence the need for an intensive approach. Existing methods for high-throughput field phenotyping gives promising results that can be used to develop phenotyping platforms that are both time and cost-efficient. This might be beneficial for precision breeding and assisting breeding programmes by monitoring important known characteristics or identifying new ones. Combining high-throughput phenotyping technology with large-scale QTL analysis not only substantially enhanced our understanding of the plant dynamic development process but also offered a new strategy to the breeders for optimizing plant architecture towards ideotype breeding.

References

Furbank, R. T. and Tester, M. (2011). *Trends Plant Science,* **16**: 635–644.

Honsdorf, N., March, T. J., Berger, B., Tester, M. and Pillen, K. (2014). *Plos one,* **9**(5): e97047.

Thomas, C. L., Graham, L. S., Hayden, R., Meacham, M. C., Neugebauer, K., Nightingale, M., Dupuy, L. X., Hammond, J. P., White, P. J. and M. R. Broadley (2016). *Annals of Botany,* 118: 655–665.

Vishal, M. K., Tamboli, D., Patil, A., Saluja, R., Banerjee, B., Sethi, A., Raju, D., Kumar, S., Sahoo, R. N., Chinnusamy and Adinarayana, A. (2020). Published as a conference paper at ICLR.

Zhang, X., Huang, C., Di Wu, Qiao, F., Li, W., Duan, L., Wang, K., Xiao, Y., Chen, G., Liu, Q., Xiong, K., Yang, W. and Yan, W. (2017). *Plant Physiology,* 173: 1554–1564.

Zhang, Y., Zhao, C., Du. J., Guo, X., Wen, W., Gu, S. (2019). *Frontiers in Plant Science*, **10**: 714.

ISSN No.:2321-7405

12. PLANT PATHOLOGY

Fall Armyworm: An Invasive Pest

[1]Patel Apurvkumar M. and [2]Sharma Deepak D.

[1]Department of Plant Pathology, [2]Department of Genetics and Plant Breeding,Navsari Agricultural University, Navsari, Gujarat.

Introduction

The fall armyworm (FAW), (*Spodoptera frugiperda*) belongs to the order Lepidoptera and the family Noctuidae originated from tropical and subtropical regions of America. In Latin, the word *frugiperda* means "lost fruit". Thus pest leads to severe loss in major crops like maize of about 6.2 billion, hinders the life of about 200 million people in Africa and overall loss due to pest in all staple crops was about $ 13,383m (Anon., 2017a). Sharanabasappa and Kalleshwaraswamy reported the pest for the first time in India during May 2018 in maize fields in Karnataka (Anon., 2018a). then it was observed in the month of august in Telangana and Tamil Nadu and Telangana. In Gujarat, The pest was first time reported in Ankalv village in Anand from a field of sweet corn on 20th September 2018 (Sisodiya *et al.,* 2019).

FAW is having huge host range of 100 species feeds on the reproductive parts, stems and leaves, (Anon., 2017a) damaging most of the important field and vegetable crops *viz.,* maize, rice, sorghum, sugarcane, pearl millet, cotton, tomato, cabbage, beet, onion, potato and other crops like peanut, soybean, alfalfa, and pasture grasses.

FAW has a complete life cycle of 30 days (summer) and 60 days (spring and autumn). Larva has dome shaped eggs with a diameter of 0.4mm diameter laid in 100-200 batches with 1000eggs/female fecundity. Cannibalism is also observed in the larval stage. The larva goes through six instars are Pale green with a dark head in the early instar and whereas four tubercles on the 8th abdominal segment are present in the late instar larvae in a square manner and dark head with a pale with inverted Y-shape marking on the dark head. Pupa found deep into the soil 2 to 8 cm is shiny reddish brown with cremasters present in pair for a period of 7 to 13 days. Adult moths are nocturnal with a 32 to 40 mm wing span and can fly up to a speed of 100 km per night. Males are smaller than females having brown forewings with triangular white spots at the tip.

Nature of Damage

Feeding of young larva creates a characteristic "windowing" effect or a line of identical "shot" holes on leaves and ragged leaf edges. Frass like moist sawdust was observed near the funnel. Mature caterpillar damages the reproductive parts like tassels, kernels and burrows into cobs in maize. In cotton, the first few instars "skeletonize" leaves and fruiting structures like bracts, squares and bolls are damaged by the older instars in the same manner as bollworms. The incidence of FAW on maize crops was ranged between 9.0 and 62.5% (Shylesha *et al.,* 2018).

Management

Cultural control: Deep ploughing, collection and destruction of egg masses, crop rotation, resistant varieties, early planting and neem cake application @ 250 kg/ha to reduce the adult emergence from pupae (Anon, 2018a). Maize crop powercore containing the *Bt* protein Cry1A105, Cry2Ab2 and Cry1F showed maximum resistance against FAW damage (Burtet *et al.*, 2017).

Monitoring of pest: Traps baited with Scenturion lures, the Trece and Scentry 2 lures ranked second in the number of moths captured and Hercone lure captured the fewest number of moths (Hall *et al.*, 2005).

Biological control: Several eggs (*Trichogramma* sp. & *Telenomus* sp.), larval (*Chelonous* sp. & *Cotesia* sp.) and pupal parasitoids are effective for FAW management. The maximum number of FAW larvae parasitized by *Chelonus insularis* under different locations (Cruz *et al*., 2010). FAW larvae parasitized by *Habrobracon hebetor* up to 7 % larvae parasitized (Anon., 2018b). NPV

infected larvae were found during the survey, more NPV infected larvae were found and collected at Kanisa village of Anand districts (Raghunandan *et al.*, 2019).

Botanicals: The hatching of recently laid eggs of FAW reduced up to 11.30% by using 1% piperine extract. Hydroalcoholic extract obtained from the bark of Mulaterio, *Calycophyllum spruceanum*) has the highest ovicidal activity against eggs of FAW in the Amazon region (Santos *et al.*, 2016).

Chemical control: Application of spinosad 45 SC @ 50 ml/ha reduced the infestation of FAW up to 1.2 ± 1.2 % after the 11th day of application followed by methomyl @ 600 ml/ha in maize crop Cruz *et al.* (2010). Hardke *et al.* (2011) evaluated different insecticides and found that chlorantraniliprole 18.5 SC @ 0.10 kg a. i./ha and cyantraniliprole @ 0.09 kg a. i./ha have maximum (100 %) mortality of FAW feed on sorghum grains. Spinoteram @ 12 g a.i. /ha found most effective against FAW in maize crop (Burtet *et al.*, 2017). FAW fed on Si-treated rice plants through soil application exhibited lower larval weight, male and female longevity and viability of eggs.

Conclusion

Fall armyworm is rapidly getting status of globally invasive pest in maize growing regions of the world including India. There is a big threat to other crops also. The pest can be effectively managed with host plant resistance (*Bt* varieties), behavioral, mechanical, biological and chemical control. Strict foreign and domestic quarantine measures should be enforced at the country level and state level to prevent further spread. Area wide survey and monitoring of fall armyworm is a must to know the current status of this pest in the region**.** Need to develop resistant variety against the fall armyworm and Innovative and effective approaches for management should be initiated

References

Anonymous (2017a). Fall Armyworm: Impacts and Implications for Africa, Evidence Note (2) (CABI).

Anonymous (2018a). PEST ALERT (ICAR-NBAIR).

Anonymous (2018b). SDAU'S special efforts to combat menace of *Spodoptera frugiperda* in maize, 22-25.

Burtet, L. M., Bernardi, O., Melo, A. A., Pes, M. P., Strahl, T. T., and Guedes, J. V. (2017). Managing fall armyworm, *Spodoptera frugiperda* with Bt maize and insecticides in southern Brazil. *Pest Manag. Sci.*, **73**(12), 2569-2577.

Cruz, I., Maria, D. C., Silva, R. B. and John, E. F. (2010). *Rev. Bras. Milho. Sorgo.*, **9**(2), 107-122.

Hall, D. G., Meagher, R., Nagoshi, R. and Irey, M. (2005). Proceeding ISSCT, Vol. 25.

Hardke, J. T., Temple, J. H., Leonard, B. R., and Jackson, R. E. (2011). Laboratory toxicity and field efficacy of selected insecticides against fall armyworm. *Fla. Entomol.*, 272-278.

Raghunandan, B. L., Patel, N. M., Dave, H. J. and Mehta, D. M. (2019). Natural occurrence of nucleopolyhedrovirus infecting fall armyworm, *Spodoptera frugiperda* in Gujarat, India. *J. Entomol. Zool. Stud.,* **7**(2), 1040-1043.

Santos D., A. C. V., de Almeida, W. A., Fernandes, C. C., and de Sousa, A. H. (2016). Hydroalcoholic plant extracts from the southwest Amazon for the alternative control of fall armyworms. *IDESIA (Chile)*, **34**(4), 63-67.

Shylesha, A. N., Jalali, S. K., Gupta, A., Varshney, R., Venkatesan, T., Shetty, P. and Raghavendra, A. (2018). Studies on new invasive pest *Spodoptera frugiperda* and its natural enemies. *J. Biol. Control.,* **32**(3), 145-151.

Sisodiya, D. B., Raghunandan, B. L., Bhatt, N. A., Verma, H. S., Shewale, C. P., Timbadiya, B. G. and Borad, P. K. (2018). The fall armyworm, *Spodoptera frugiperda*; first report of new invasive pest in maize fields of Gujarat, India. *J. Entomol. Zool. Stud.*, **6**(5), 2089-2091.

13. MCQS

This section, in the magazine has been specially introduced with the intention that the students and readers, who are planning to appear for the competitive exams, may get benefit. As the readers are aware that the exams are held by various Government departments and recruiters every year and the agriculture and allied subjects remain key subjects in some exams which are related to agriculture stream. We hope the students and readers will certainly like this and we invite the subscribers to send MCQs for publication in the magazine. We are, this time, concentrating on seed science and are providing 20 questions on the subject. The answers shall be provided in the next issue now onwards.

****

1. Vigour index was given by
   a) Roberts
   b) Moore
   c) Isley
   d) Abdul Baki& Anderson
2. Exhaustion test for vigour determination was given by
   a) Moore
   b) Simek
   c) Germ
   d) Khan
3. X-ray test for vigor determination was given by
   a) Ellies
   b) Simek
   c) Gustefsson
   d) Both b & c
4. Brick gravel test for vigor estimation was given by
   a) Hiltner
   b) Hussain
   c) Both a & b
   d) Germ
5. The paper piercing technique as vigour test was given by
   a) Khan
   b) Ching
   c) Fritz
   d) Maguire
6. Emasculation technique in cotton was given by
   a) Doak, 1934
   b) Malnassy, 1971
   c) Harman, 1990
   d) Taylor, 1988
7. The accelerated aging test for seed vigour detection was given by
   a) Isley, 1950
   b) Delouche, 1965
   c) Maguire, 1962
   d) Simek, 1970
8. Cold test for seed vigour estimation was given by
   a) Jianhua, 1996
   b) Germ, 1970
   c) Isley, 1950
   d) Mc Donald, 1996
9. The speed of germination for seed vigour determination was given by
   a) Shull, 1914
   b) Perry, 1971
   c) Williams, 1997
   d) Kotowski, 1926
10. The formula for the speed of germination was given by
    a) Maguire, 1962
    b) Ching, 1973
    c) Leopad, 1980
    d) Kaul, 1988
11. Saturated salt accelerated aging test for vigor assessment was given by
    a) Khan, 1990
    b) Perry, 1971
    c) Callan, 1990
    d) Jianhua&McDonalds, 1996
12. The international year of seed, declared by UN was

a) 1941
b) 1951
c) 1961
d) 1971

13. Central seed testing laboratory was established in National seed research and training centre during
a) 2003
b) 2006
c) 2009
d) 2012

14. The essential commodities act was established during
a) 1935
b) 1945
c) 1955
d) 1965

15. PPV & FRA was formulated during
a) 2000
b) 2001
c) 2002
d) 2003

16. The biological diversity act was passed during
a) 2000
b) 2002
c) 2003
d) 2004

17. New seed bill was passed during
a) 2001
b) 2002
c) 2003
d) 2004

18. Plant, fruits and seed order was enacted in
a) 1965
b) 1975
c) 1989
d) 1995

19. All India seed growers, merchants and nursery man's association was formed during
a) 1932
b) 1942
c) 1952
d) 1962

20. Seed multiplication team review was passed during
a) 1961
b) 1971
c) 1981
d) 1991

21. First sorghum hybrid was released during
a) 1961
b) 1964
c) 1962
d) 1984

14. ENTOMOLOGY

Combating Mosquitoes in Green Way

D Saicharan

Department of Entomology, Professor Jayashankar Telangana State Agricultural University, Rajendranagar, Hyderabad-500030, Telangana, India

Introduction

Mosquitoes are one the deadliest insect in the world. Their ability to carry and spread diseases to human's cause millions of deaths every year (WHO, 2005). Several mosquito species belonging to the genera *Anopheles*, *Culex* and *Aedes* acts as vectors of many pathogenic organisms causing diseases like Malaria, Filariasis, Japanese Encephalitis, Dengue fever, yellow fever etc. A total of 404 species under 50 genera have been recorded in India (Tyagi *et al.*, 2015). Every year, about 300–500 million people of the world are estimated to be affected by malaria, and this dreadful disease threatens about 2.4 billion of the world's population with a death rate of about 1.1–2.7 million (WHO, 2005).

Vector control strategies have traditionally

focused on killing mosquitoes using a variety of insecticides. As insecticide resistance is now widespread in a number of mosquito species, there is a growing need for safe novel, cheap, and reliable mosquito control strategies (Benelli, 2015). The evolution of insecticide resistance in mosquitoes is threatening the effectiveness and sustainability of malaria control programs in various parts of the world. Biological methods provide promising alternatives to chemical control. They include natural organisms that kill mosquitoes, plant-based insecticides, releasing mosquitoes that are either sterile or unable to transmit disease as well as creating protective barriers against them.

Taxonomic position of mosquito: Kingdom-Animalia, Phylum-Arthropoda, Class-Insecta, Order-Diptera, Superfamily-Culicoidea, Family-Culicidae, Genera-*Anopheles*, *Aedes*, *Culex*, *Mansonia etc...*

Biology and life cycle

Life cycle is temperature-dependent from 1 to 20 days. There are four distinct stages in its life cycle: Egg: 2-3 days, larva: 8-9 days, pupa: 1-2 days, and adult 10 days. Adult is active and terrestrial, while larvae and pupae are aquatic and occur only in water.

Green Methods to Combat Mosquitoes

Biological Methods	
Role of pathogens	
i) Entomopathogenic bacteria	*Bacillus thuringiensis* (Bt) *Bacillus sphaericus* *Wolbachia*
ii) Entomopathogenic fungi	*bassiana* *Metarhizium anisopliae* *Lagenidium* Oomycetes (Watermolds) *Pythium* *Coelomomyces* *Conidiobolus*
Role of predators in mosquito control.	
Dipteran predators	*Toxorhynchites* spp. known as the "elephant mosquito" or "mosquito eater", is a large, cosmopolitan genus of mosquitoes that does not consume blood (Rawlins *et al*., 1991).
Coleopteran predators	Families Dytiscidae and Hydrophilidae have received attention as mosquito larvae predators. *Laccophilus, Agabus* and *Rhantus* were reported as potential biological control agents of mosquitoes (Aditya *et al*., 2006).
Hemipteran predators	Belostomatidae, Nepidae and Notonectidae are the most important families of predaceous Hemipteran bugs.
Odonatan predators	Odonata larvae are voracious and important predators of mosquito larvae in freshwater ecosystems.
Larvivorous fishes	*Gambusia* and *Poecilia* (Poeciliidae) have been introduced in more than 60 countries for mosquito control purposes.
Frogs and toads	Tadpoles, with various life-history characteristics, actively prey upon the eggs of *Ae. aegypti*.
Crustacean predators	*Cyclops vernalis*, *Megacyclops formosanus*, have been reported as active predators of mosquito young instars (Marten *et al*., 1989).
Role of botanical insecticides in mosquito control	
Lantana (*Lantanacamara* L.)	Lantana oil and crude extract are used as natural fumigants against many insects and mosquitoes.
Marigold (*Tagetes patula* Linn.)	The chemical constituents of *Tagetes* are β-karyophyllene, terpenes, hydrocarbons, alcohols, ethers, aldehydes, ketones, esters, carotenoids, flavonoids and thiophenes. They have insect repellent, antiseptic, diuretic, blood purifier and also cancer treatments.
Periwinkle (*Catharanthus roseus* L.)	Its leaves constitute two secondary metabolites viz. vincristine and vinblastine that has shown larvicidal activity against *culex* spp.

Agnimantha (***Clerodendrum phlomidis***)	*C. phlomidis* contains secondary metabolites like tannins, alkaloids, polyphenols, terpenoids, and essential oils etc.... that has shown larvicidal activity against mosquitoes.
Botanical formulations used for mosquito control	Neo-Innova® isa repellent that has a prolonged action. "NEO-PART®" (Prolonged Action Release Technology) is a formulation with 40% Citriodiol®. ME 750: *Smyrnium olusatrum* has isofuranodiene and essential oils with larvicidal activity.
PHYSICAL METHODS	
Mosquito net	These nets are considered as more protective than coils and other repellents because their use does not cause any health problem.
Mosquito traps	These traps copy the various mosquito attractants such as body heat and exhaled carbon dioxide. They are powered by electricity so their use is safe.
MECHANICAL METHODS	
Electric mosquito zipper	This device works by using the ultraviolet light and then killing of mosquito occurs when mosquito interact with the lethal charge of electric charge.
Mosquito Magnet	Its principle based on copying of mammal's properties such as giving off heat, moisture and carbon dioxide. When mosquito comes close to the device it drew in and suddenly dies.

Conclusion

Eco-friendly strategies for mosquito-control are needed to reduce the prolonged application of insecticides that is currently used as the primary method for mosquito control. Safe and sustainable methods using bioagents, predators, insect sterile techniques, physical and mechanical methods should be developed to target various mosquitos' species in such a way that it is available to common man. Need based production of biocontrol formultaions in the form of tablets, capsules, icy granules etc. should be popularized.

References

Aditya, G., Ash, A., Saha, G. K. 2006. Predatory activity of *Rhantussikkimensis* and larvae of *Toxorhynchitessplendens* on mosquito larvae in Darjeeling, India. *J. VectorBorne Dis*. 43(2): 66-72.

Benelli, G. 2015. Research in mosquito control: Current challenges for a brighter future. *Parasitol. Res*.114(8): pp. 2801–2805.

Marten, G. G., Astaiza, R., Suarez, M. F., Monje, C., and Reid, J. W. 1989. Natural control of larval *Anopheles albimanus* (Diptera: Culicidae) by the Predator *Mesocyclops* (Copepoda: Cyclopoida). *J. Med. Entomol*. 26: 624-627.

Rawlins, S. C., Clark, G. G., and Martinez, R. 1991. Effects of single introduction of *Toxorhynchitesmoctezuma* upon *Aedes aegypti* on a Caribbean Island. *J. Am. Mosq. Control. Assoc*. 7: 7-10.

Tyagi, B. K., Munirathinam, A., and Venkatesh, A. 2015. A catalogue of Indian mosquitoes. *Intl. J. Mosquito Res*: 2 (2): 50-97.

WHO (World Health Organization). 2005. Communicable Disease Tool Kit. World Health Organization, WHO/CDS/2005.26, Sudan.

15. SOIL SCIENCE

Phloem Restricted Trypanosomatid: An Emerging Microscopic Pathogen of Tropical Region

Patel, Kailash

Ph. D Student, Department of Plant Pathology, College of Agriculture, SKRAU, Bikaner-334 006, Rajasthan.

ISSN No.:2321-7405

Introduction

The phloem restricted trypanosomatids are a flagellate protozoan commonly called as *Phytomonas* which are grouped under the phylum *Euglenozoa*. They differ from other protozoan members in genomic, mitochondrial and cytological organization and have more characters of animal. Strong evidences support that some flagellate protozoa cause disease in plants although their pathogenicity could not yet be determined via Koch's postulates similar to phytoplasma and some RLO's. The presence of flagellate protozoa (= flagellates) in the latex - bearing cells (laticifers) of the laticiferous plant was first observed by Lafont in Mauritius in 1909 in *Euphorbia*. Implication of flagellate protozoa as etiological agents in plant disease was discovered by Stahel in 1931. The plant parasitizing protozoa were placed under a separate genus *Phytomonas* and the species described by Lafont was named as *Phytomonas davidi*. The new genus *Phytomonas* was suggested by Donovan in 1909.

Scientific Classification of *Phytomonas*

Kingdom: Protozoa Phylum: Euglenozoa Class: Kinetoplastea
Order: Kinetoplastida Family: Trypanosomatidae Gemus: *Phytomonas*

General Characteristics of *Phytomonas*

- They have a definite long, oval or spherical body of size ranges between 5 x 250µm size.
- Vic Kerman, 1976 defined *Phytomonas* as flagellates with digenetic life cycle in plants and insects, retaining the promastigote form throughout (anterior end terminating in a flagellum which is free from the cell body).
- The genus *Phytomonas* reside in the phloem sieve tubes of non-lactiferous plant like coconut, oil palms, red ginger and coffee. Most of the lactiferous inhabiting *Phytomonas* are not considered to be pathogenic except *P.francai* which causes empty root in cassava.
- They can be grown on specialized culture media. The phloem inhabiting *Phytomonas* was first grown in media containing cultured insect cell for generations and then grown on cell free media.
- The plant-infecting *Phytomonas* seem to be transmitted by root graft and by insects of the families *Pentatomidae, Lygaeidae* and *Coreidae*.
- *Phytomonas elmassiani* (on milk weed), *P. brancrofti* (on ficus), *P. leptovasorum* (on coffee), *P. francai* (on cassava) and *P. staheli* (on coconut and oil palm) are some of the parasitic protozoa reported respectively from plants belonging to Asclepiadaceae, *Moraceae*, *Rubiaceae, Euphorbiaceae* and *Palmaceae*.

Mechanisms of infection caused by *Phytomonas*

The actual mechanism by which the protozoa cause disease in plant is not clear. *P. francai,* a laticifer inhabiting protozoa produces enzyme to degrade pectin and cellulose in the laticifer ducts of root and result in empty root disease with poor development of root system and a general chlorosis in cassava plants. However, the non-laticifer or phloem inhabiting *Phytomonas* block the transport of photosynthates to roots and cause phloem necrosis in coffee, hart rot disease in coconut and the Marchitez suppressive (sudden wilt or wither) in oil palm.

Some of the economically important diseases caused by Phloem Restricted Trypanosomatid (*Phytomonas*)*:*

1. **Phloem necrosis of coffee: *Phytomonas leptovasorum:*** Symptoms: Infected trees show sparse yellowing and dropping of leaves. At the end, only the young top leaves remain on bare branches. Roots show die back and the tree dies in the diseased palms, the roots and trunk exhibit multiple divisions of cambial cells and production of a zone of smaller and shorter (abnormal) phloem vessels next to the wood cylinder. The bark is firmly attached to the wood and cannot be separated from it. Trees wilt and die within 3 to 6 weeks during dry season. It

can be transmitted through root grafts but not through green branch or leaf grafts. Pentatomid insects of the genus *Lincus* also transmit the disease.

2. **Heart rot/ Lethal yellowing or bronze leaf wilt of Coconut**: ***Phytomonas staheli***:
   Symptoms: Include yellowing and browning of the tips of the older leaves that subsequently spread to the younger leaves. Recently opened inflorescence become black, unripen nuts fall off and roots begin to rot. Petioles of older leaves may break and spear becomes necrotic. At this stage apical region of the crown rots and emits foul odour. Diseased trees will die within few months of appearance of the external symptom. Pentatomid insects of the genus *Lincus* and *Ochlerus* transmit the disease.
3. **Sudden wilt or Marchitez sopresiva in Oil palm:** ***Phytomonas staheli:***
   Symptoms: It includes browning of tips of the older leaves, which subsequently spread to the younger leaves and eventually become ashy gray. The plant growth slowdown, fruit bunches discolour, rot or falloff and the whole tree die within a few weeks due to rotting and deterioration of root tips and root system. They occur widely in the phloem sieve elements of roots, leaves and inflorescences of infected trees. Pentatomid insects of the genus *Lincus* and *Ochlerus* transmit the disease.
4. **Wilt and decay of red ginger:** ***Phytomonas staheli:***
   Symptoms: It includes browning of tips of the older leaves, which subsequently spread to the younger leaves and eventually become ashy gray. The plant growth slowdown and the whole plant die within a few weeks due to rotting and decaying of rhizomes.
5. **Empty root of Cassava:** ***Phytomonas francai:*** Symptoms:Diseased plants have poor root system and small slender roots with no starch. The above aerial parts of the plants exhibit general chlorosis and decline. Diseased plants contain numerous flagellate protozoa in the laticifer ducts but not in the phloem. It can be transmitted through stem grafts. Pentatomid insects of the genus *Lincus* also transmit the disease.

References

Agrios, G. N. 2008. *Plant pathology*, 5th Revised Ed., Academic Press Publishers, New York. pp 694-695.

Alice, D., Jeyalakshmi, C., and Krishnamoorthy, A.S. 2019. *Fundamentals of Phytopathology*. ISBN: 978-93-84909-21-5. pp 168-171.

Bhattacharyya, U. K. 2014. *Plant pathology at a glance*, 2nd Revised Ed., Kalyani Publishers, New Delhi, India. pp 191.

*****

16. AGRICULTURE

Sensors in Agriculture

C.Sharmila Rahale

Assistant Professor (SS&AC), Department of Nano Science & Technology,TNAU, Coimbatore

Rapid growth in society, weather change, decreased rainfall, and demand for excess food to sustain billions of people globally are placing a lot of influence on farming. That provides negative impacts on traditional farming practices. We are here come with smart sensors in agriculture. The current situation wants farming to become more “smart” by using modern and intelligent technologies. To find the solutions for the best utilization of resources, meeting the global population’s ever-increasing consumption needs. Smart sensors in agriculture provide data that helps farmers monitor and optimize their crops and keep updated with changing environmental and ecosystem factors. A smart agriculture sensors helps the animal Identification, heat detection, and health monitoring, And helps to separate and treat sick cows while locating and tracking their herd. Smart sensors in agriculture, farmers can understand their crops and their productivity, sustain resources, and

can prevent or control the crops from environmental impact or disaster.

Sensors used in agriculture for smart farming are known agriculture sensors. They provide data that helps farmers to monitor and optimize crops with environmental conditions and challenges. These sensors in agriculture installed and fixed in weather stations, drones, and robots used in the agriculture industry. They can be controlled by mobile apps precisely, which develops for this purpose. These sensors are based on wireless connectivity; they can be controlled directly using wifi or through cellular towers with the help of mobile phone applications.

Types of Sensors used in Agriculture

There are many types of sensors are used in agriculture. They are,

Location Sensors

Location-based sensors help farmers get greater insights on the cultivable land by increasing angles of examination of specific sections of the plot and unlock greater value. GPS based sensors, GIS-based sensors, and manned and unmanned aerial devices like drones and satellite imagery help get a 3-dimensional analysis of the land and the composition of soil in the cultivated region.

Optical Sensors

Optical sensors are used in agriculture to understand the properties of the soil and crop by the analysis of the amount of reflected light on the growing parts of the crop in real-time. Optical sensors tell the analysis tools to increase the dosage of nitrogen for weaker and unhealthy plants and regulate the dosage of nitrogen for the healthy ones. Optical sensors are also used to study the crop vigour by including the biomass of the soil and Nitrogen to other gases ratio in the soil as variables. This helps farmers regulate the moisture levels in the air and soil and prevent damp conditions. (Damp conditions accelerate the rate of growth for bacteria and moss).

Electro-Chemical Sensors

Monitoring the pH level of the soil is essential for sustainable and eco-friendly farming while maximizing revenue. Electrochemical sensors are used to monitor and analyse the soil quality and take measures to alter the pH level or continue practices to maintain the current level for the next phases in the lifecycle of a crop. Electrochemical sensors are used in both outdoor farms and greenhouse-based farming establishments. Electrochemical sensors are mainly used to monitor the levels of Phosphorous, potassium, Calcium, Sodium, Nitrogen, Copper, and Iron.

Mechanical Sensors

Mechanical sensors are used to measure the resistance offered by the soil by applying resistive forces. This is mainly carried out with load cells or strain gauges. Mechanical sensors are used to determine the amount of force that roots are exerting to absorb water and this data is used to optimize the tilling methodologies and optimizing the inflow of water. This data is also used in the early stages of the life cycle of the crop to determine the right amount of pressure that is exerted by the tractor to offer maximum yield on a long duration.

Dielectric Soil Moisture Sensors

Dielectric soil moisture sensors are used to monitor the moisture levels of the soil to help optimize methods of irrigation management. This helps the farmer better understand the nature of the soil, its capacity to hold moisture, understand the median and mean of the evaporation rate and also get a detailed insight on the root zone of the crop. Water potential sensors and tensiometer sensors are the two prominently used di-electric soil moisture sensors used in precision farming.

Air Flow Sensors

Airflow sensors are used to record the number of gaseous substances present in the soil at a particular landscape after irrigation or to get an overview of the land that is to be cultivated before the seeding process. It determines the optimum pressure required to pump air to aerate the soil and make it more fertile. It is also used to determine the properties of the soil, its compaction, moisture-holding capacity, and more.

Advantages of Sensors in Agriculture

There are many advantages of Agriculture Sensors,

- They are easy to operate and use and easy to maintain.
- Sensors are cheaper in price and best in quality.

- They can used for measuring pollution and global warming.
- These sensors equipped with wireless chips so that they can be controlled remotely.

Labour shortages and the need for food to feed an increasing global population, agricultural robots and technologies now commonly used by farmers. The vision and mission of machine education now allow robots and sensors to see and train surroundings, and of the cheaper costs of smart sensors, they used for more than a year. New innovative sensing technology allows farmers to monitor their fields' pest groups remotely and take immediate action to protect their crops, using online cloud services and a dashboard.

References

Ali, M. A., Mondal, K., Wang, Y., Jiang, H., Mahal, N. K., Castellano, M. J.,. and Dong, L. (2017). In situ integration of graphene foam–titanium nitride based bio-scaffolds and microfluidic structures for soil nutrient sensors. *Lab on a Chip*, *17*(2), 274-285.

Horak, J., Dincer, C., Bakirci, H., and Urban, G. (2014). Sensitive, rapid and quantitative detection of substance P in serum samples using an integrated microfluidic immunochip. *Biosensors and Bioelectronics*, *58*, 186-192.

Khater, M., de la Escosura-Muñiz, A., and Merkoçi, A. (2017). Biosensors for plant pathogen detection. *Biosensors and Bioelectronics*, *93*, 72-86.

Tang, W., Fan, K., Zhou, J., Wu, J., and Ji, F. (2015). Unmodified screen-printed silver electrode for facile detection of organophosphorus pesticide. *Ionics*, *21*(2), 587-592.

*****

Dear Readers

We have received, in the past, some complaints from the readers that they did not receive the hard copies of the magazine for few months in which their articles were published specially from January 2022 onward.

We have done our best to find out the solution and contacted the postal department too. We have also sent the hard copies separately to some of the subscribers but since we did not have the number of copies needed (at par with the complaints received) so we could not dispatch the magazines to all separately. Therefore, we decided, looking to the need and demand of the subscribers, to reconsider those articles once again and republish the same in the coming issues. We are doing this for all the articles received after November 2021 onwards till August 2022. The number of articles every month to be considered has not been fixed yet we shall include those articles one by one.

It is therefore, requested all those who have not received hard copies to keep the track of their articles once again as the same would be there in the magazine in any issue coming down the line.

It is further requested all concerned to pleae contribute articles in the magazine Readers Shelf and get their article published in the same. The articles, as you are aware should be informative and knowledge spreading. They should relate to the Agriculture and allied subjects.

*****

Answers to MCQs of previous issue

Q.No.	Answer	Q.No.	Answer	Q.No.	Answer
1	a	2	c	3	a
4	c	5	a	6	c
7	b	8	c	9	b
10	a	11	b	12	c
13	b	14	a	15	c
16	c	17	a	18	a
19	a	20	b	21	b

Subscription form

☐NEW ENROLLMENT		☐INDIVIDUAL (12 ISSUES)	Rs. 500.00
☐RENEWAL	[Subscription No.]	☐INSTITUTIONAL (12 ISSUES)	Rs. 900.00
SUBSCRIBE FROM	Click here to enter a date. TO Click here to enter a date.		
	Date: Click here to enter a date.		

Please clearly mention new enrollment / renewal (mention subscription no.)

Please Enroll / Renew me for Readers Shelf (12 ISSUES) at following Address:

ADDRESS		
TITLE:	[First Name][Middle Name][Last Name]	
ADDRESS	[Address]	
CITY	[City]	
DISTRICT	[District]	
STATE	[State]	[Pin Code]

COMMUNICATION DETAILS			
STD CODE	[STD Code]	PHONE NO.	[Phone No.]
MOBILE NO.	[Mobile No.]	ALTERNATIVE MOBILE	[Mobile No.
EMAIL ID	[Primary email ID]		
ALTERNATIVE EMAIL ID	[Secondly email ID]		

I am enclosing herewith annual subscription for Readers Shelf by Demand Draft / NEFT

PAYMENT DETAILS			
DEMAND DRAFT NO.	[DD No.]	DATE OF ISSUE	[DD Date]
ISSUING BANK	[Issue Bank Name]		
ONLINE TRANSFER TRANSACTION NO.	[Bank Transaction No.]	DATE	[Transaction Date]

Please send your DD in favour of J. V. PUBLISHING HOUSE, Payable at JODHPUR

Authorized Signature
With seal

Subscription Department

J. V. PUBLISHING HOUSE

Plot No. 15, Gajendra Nagar, Near Old FCI Godown, Shobhawaton Ki Dhani, Pal Road, JodhpurPhone: 94141 28105 E.Mail: m_vyas@outlook.comWebsite: www.readersshelf.com

J. V. Publishing House
Plot No. 15, Gajendra Nagar, Near Old FCI Godown,
Shobhawaton Ki Dhani, Pal Road, Jodhpur
Phone: 0291-2742287, 0291-2742141
E. Mail: m_vyas@sify.com, Website: readersshelf.com

March, 2023

SUBJECT / TITLES	AUTHOR		PRICE
A Handbook of Agri-Business (PB)	Gaur, S.C.		990.00
A Handbook of Extension Education (PB)	De, Dipak		300.00
A Handbook of Soil, Fertilizer and Manure (2nd Ed.) (PB)	Vyas, S.P.		450.00
A Textbook of Extension Education	Barman, U.		350.00
A Textbook of Fungi, Bacteria and Viruses (3rd Ed.)	Dube, H.C.		250.00
A Textbook of Genetics	Purohit, S.S.		450.00
A Textbook of Manures, Fertilizers and Agro-chemicals	Vyas, S.P.		450.00
A Textbook of Plant Biotechnology	Purohit, S.S.		450.00
A Textbook of Plant Breeding	Purohit, S.S.		350.00
A Textbook of Production Technology of Fruit Crops	Prasad, S.		550.00
A Textbook of Production Technology of Spices and Plantation Crops	Prasad, S.		350.00
A Textbook of Production Technology of Vegetable and Flower	Prasad, S.		550.00
A Textbook of Seed Science and Technology: Principles and Practices	Vananangumdi, K.		450.00
Agrometeorology: At a Glance	Sahu, D.D.		175.00
Agronomy (PB)	Panda, S.C.		990.00
Agros Dictionary of Plant Sciences	Vanangamudi, K.		295.00
Analytical Chemistry (PB)	Sudhalakshmi C.		250.00
Analytical Chemistry For Agriculture (PB)	Rathinasamy A.		350.00
An Introcution to Agricultural Chemistry	Jothimani, S		225.00
Breeding of Field Crops (PB)	Bhardwaj, D.N.		750.00
Cropping System and Sustainable Agriculture	Panda, S.C.		750.00
Extension Education and Rural Development (PB)	Govind, S.		450.00
Farming System: Concepts and Approaches	Jayanthi, C.		350.00
Fundamentals of Plant Pathology (PB)	Pathak, V.N.		350.00
Integrated Insect Pest Management (PB)	Rao, Venugopal		595.00
International Economics (PB)	Singh, D.P.		595.00
Manual for Organic Farming (PB)	Gosh Hajra, N.		550.00
Modern Plant Pathology (IInd Edition) (PB)	Dube, H.C.		500.00
Modern Weed Management (3rd Ed.) (PB)	Gupta, O.P.		550.00
Nutrient Management and Fertilizer Technology (PB)	Pandian		350.00
Organic Farming: Components and Management (PB)	Gehlot, D.		450.00
Post-Harvest Management of Horticultural Crops (PB)	Saraswathy, S.		495.00
Principles and Practices of Agronomy (2nd Ed.) (PB)	Balasubrananiyan, P.		450.00
Principles of Horticulture (2nd Ed.) (PB)	Prasad, S.		450.00
Principles of Plant Pathology (PB)	Jagtap G.P.		450.00
Production Technology of Spices (PB)	Shakila, A.		300.00
Seed Physiology and Biochemistry: Seed Development and Maturation	Vanangamudi, K.		450.00
Sericulture Industry: An Overview	Savithri, G.		250.00
Soil Fertility and Nutrient Management	Panda, S.C.		450.00
Soil Science-Objectives for SAU Entrance. JRF,SRF, NET & ARS	TupakiLokya		250.00
Techniques and Management of Field Crop Production (PB)	Rathore, P.S.		450.00
Weed Management Principles and Practices (3rd Ed.) (PB)	Gupta, O.P.		300.00
Glimpses in Seed Science and Technology	Vinothini, Tamilarasanetc		225.00

The rates are subject to change