Readers Shelf

VOLUME NO: 18	ISSUE NO: 05	February, 2022
No. of Pages in this issue		40 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 Arpita, Jodhpur
Printed by: Manish Kumar, Manak Offset,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. AGRONOMY

Doubling the Farmers Income - A Way for Sustainable Growth

S.V. Varshini[1] and S.P. Sangeetha[2]

[1]Senior Research Fellow & [2]Assistant Professor (Agronomy),Department of agronomy, Tamil Nadu Agricultural University, Coimbatore.

Agriculture is the mainstay of the Indian economy because of its high share in employment and livelihood creation. Agriculture in India engages nearly 119 million of farmers and 144 million landless labourers (Census 2011). In India about 80 percent of the farmers comes under the small and marginal category (Agriculture Census, 2012) and the average size of land holding is 1.15 ha. It will decrease even more in upcoming years due to land fragmentation, industrialization and urbanization which are discourage farmers in farming activity. (Bhattacharyya et al., 2018). Based on the estimates, the real income grew at the compounded rate of 3.94 per cent per annum during 2004-05 to 2011-12 which is the fastest when compared to previous two decades. It took 18 years for the income to double as income grew at the rate of 3.94 per cent (Chand et al., 2015). At present the population of India gets increased in a drastic way. To feed the entire human population and to improve the standard of the farmers need to adopt new interventions and initiatives with improved technologies which attracts the young educated generation towards agriculture.

Productivity of Major Crops Across Various Districts in the State

Crop	State average (kg/ha)	Highest (kg/ha)	lowest (kg/ha)
Rice	3532	3969(West Godavari)	1687 (Visakhapatnam)
Jowar	2435	6884 (Guntur)	304 (Anantapur)
Bajra	1366	2674 (SPS Nellore)	587 (Anantapur)
Maize	6390	7691 (Prakasam)	2731(Visakhapatnam)
Red gram	503	1558 (Guntur)	129 (Anantapur)
Bengal gram	1144	2303 (Guntur)	568 (Anantapur)
Ground nut	564	4538 (Guntur)	306 (Anantapur)
Sunflower	803	1125 (SPS Nellore)	334 (Anantapur)
Castor	575	1432 (Guntur)	440 (Prakasam)
Sugarcane	71847	116794 (Kurnool)	48330(Visakhapatnam)
Cotton	570	886 (Guntur)	239 (Anantapur)

(CMFRI, 2020)

From the above information we can clearly understand that, there is wide gap between crop production and productivity this can be reduced by adopting innovative and new technology for crop production.

Reason for Low Income of the Farmers

- Low resources availability
- Lack of marketing infrastructure
- High amount of post harvest losses
- Limited scope of farm mechanization
- Imbalance and more use of chemical fertilizer and pesticides
- Natural calamities
- Low productivity
- Higher production cost

ISSN No.:2321-7405

- Lack of awareness among the farmers about new innovation and technology

Specific Strategies for Doubling Farmers' Income

Market Management

The markeing management may be one of the strategies for doubling farmers' income. It inclues Agricultural price policy, post-harvest management, contract farming, establishment of terminal market, national agriculture market and farmer producer organization.

Agricultural Input Management

Climate smart agriculture, risk management, bridging yield gap, use of biotechnology for enhancing yield, enhancing income by improving yield of crops, integrated farming system, increase in cropping intensity and agricultural productivity, easy availability of improved quality seed, soil test based nutrient management, water and weed management and crop insurance.

Reference

Bhattacharyya S., Burman R. R., Sharma J. P., Padaria R. N., Paul S. and Singh A. K. 2018. Model villages led rural development: A review of conceptual framework and development indicators. Journal of Community Mobilization and Sustainable Development 13(3): 513-26.

Chand, Ramesh, Saxena R. and Rana S. (2015): Estimates and Analysis of Farm Income in India, 1983-84 to 2011-12, Economic and Political Weekly, May 30, 32.

CMFRI K. (2020). State Specific Strategies for Doubling Farmers Income-2022.

2. 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 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

ISSN No.:2321-7405

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.

3. HORTICULTURE: SPICES

Ginger Based Cropping System

Dharini Chittaragi

Ph.D Scholar, Dept. of Spices and Plantation crops, HC and RI, TNAU, Coimbatore, Tamilnadu, India

India is the largest producer and exporter of dry ginger in the world. Cultivation – Kerala, Karnataka, Sikkim, Himachal Pradesh, Meghalaya, Assam and Northeastern states. Ginger is long duration crop. Indian ginger is having high esteem in the global market (lemon-like flavour). Kerala is the leading producer of ginger (70%) in India. Finest quality ginger- Kerala (congenial climate & rich earthy soil). Ginger is used as food, flavouring and medicinal products.

Climate and Soil Requirements

- warm and humid
- Well-distributed showers during the growing period
- Ideal temperature – 19- 28° C
- Soil temperature – 25 - 26° C (sprouting)
- Soil – sandy loam and clay loam, virgin forest soil (ideal)
- pH- 6 to 6.5 and RH- 70 to 90%
- The best time for planting ginger on the West Coast of India is during the first fortnight of May with the receipt of pre-monsoon showers.
- Under irrigated conditions, it can be planted well in advance during the middle of February or early March.

Mulching

- The first mulching is done at the time of planting with green leaves @ 10-12 tonnes/ha.
- Mulching is to be repeated @ 7.5 tonnes /ha at 45 and 90 days after planting, immediately after weeding, application of fertilizers and earthing up.

- The leaves of Daincha,chilaune (*Schima wallichii*), Banmara (Eupatorium),utis (*Alnus nepalensis*) preferred to NE region

Advantages

- Done with green leaves/organic wastes is essential to prevent soil splashing and erosion of soil due to heavy rain
- It also adds organic matter to the soil, checks weed emergence and conserves moisture during the latter part of the cropping season

Cropping Systems Followed in Ginger

Ginger as Intercrop

Among the different cropping systems like multiple cropping, intercropping, relay cropping, succession cropping, intercropping is the most suitable practice to stabilize the production. Intercropping is the growing of two or more crops/varieties simultaneously on the same area of land. The crops may or may not be sown or harvested at the same time. The most important advantage of intercropping is that it is more efficient and productive than sole cropping due to its higher combined yield. The risk due to weeds, disease, pests and climatic factors are reduced in the intercropping. Ginger is successfully grown as an intercrop in coconut, areca nut, coffee, litchi, mango, and orange plantation. Ginger is also grown in intercrop in apple, pear, young citrus orchard and forest plantations.

Ginger-Vegetables

Very short duration vegetables and other crops can be efficiently taken up in the field of ginger for better utilization of growth resources.

Ginger-Legumes

Legumes play a wide role in contributing to food security, income generation, and maintenance the of environment for millions of small-scale farmers. Apart from being a major source of dietary protein and oil, legumes are known to biologically fix atmospheric nitrogen (N) in symbiosis with *Rhizobium* bacteria. The fixed N can at least partly reduce the N fertilizer requirement of the main field crop in rotation. Thus it becomes an affordable source of N for resource-poor farmers. In most farming systems, legumes are usually intercropped with cereals and other field crops to improve land productivity. This practice is believed to provide the farmer with several options for returns from land and labour, and often increases efficiency with which scarce resources are used. It also reduces dependence upon a single crop that is susceptible to environmental and economic fluctuations.

In most ginger/ grain legumes intercrop smallholder farmers do not adopt any definite crop spatial arrangement or even definite crop population. The result is that while most farmers intercrop ginger with a very high population of grain legumes resulting in acute crop competition for available growth resources, low crop yield and quick soil nutrient improvement, others intercrop ginger at very low grain legume populations leading to inadequate utilization of growth resources. In any cropping system, however, the geometry and population of individual plants have an important role on the growth and yield of the crops as they have a regulatory or compensation capacity over resource availability.

Ginger-Tamarind

Tamarind (*Tamarindus indica* L) is one of the most important multipurpose domestic tree species grown commercially in the dry zone of Karnataka. Intercropping in a perennial plantation is one of the major forms of multiple cropping for increasing production and profit in available land. In intercropping system, productivity is improved either by efficient interception of available solar energy or by having a crop of greater radiation use efficiency

References

Anil Kumar., Ranjan Kumar Singh., Neena Bharti., and Gopal Krishna.2018. Performance and Profitability Study of Different Ginger Based Cropping System in Bokaro District of Jharkhand *Int.J.Curr.Microbiol.AppSci*. Special Issue-7: 2934-2939.

Kumar, R.D., Sreenivasulu, G.B., Prashanth, S.J., Jayaprakashnarayan, R.P., Nataraj S.K., and Hegde. N.K. 2010. Performance of ginger in tamarind plantation (as intercrop) compared to sole cropping (Ginger). *Int. J. Agric. Sci.,* 6 (1): 193-195

Nwaogu, E.N. and Muogbo, P.C. 2015. Effect

ISSN No.:2321-7405

of ginger- grain legume cropping system and spatial arrangement on soil fertility management and yield of intercropped ginger in the guinea savanna of Nigeria. *Int. Res. J. Agric. Sci. Soil Sci.* 5(1):1-7.

Nybe,E.V, Mini Raj and Peter,K.V. 2007. *Spices*, New India publishing agency, New delhi.311p.

Shanmugavelu,K.G.,Kumar,N.,and Peter, K.V.2002. *Production Technology of Spices and Plantation Crops*. Agrobios (India). 546p.

4. AGROFORESTRY

Recent and Advanced Sampling Methods for Forest Inventory Process

[1]Yogesh Kumar and [2]Aditya Pratap Singh

[1]Department of Silviculture and Agroforestry, College of Forestry, Navsari Agricultural University, Navsari-396450, Gujarat, (India),[2]Department of Genetics and Plant Breeding, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur-741252, West Bengal (India)

Abstract

Forest areas are not as readily accessible as compared to crop fields. Data collection is hence tedious and difficult. Remote sensing tools and techniques have opened ways to collect, store and interpret forest data for research and developments. High throughput sampling methods not only save time and capital, but also increase precision and accuracy and hence reduced error chances in systematic research. LiDAR seems to be such promising technology. With advancement in this regard, forest inventory would become more feasible and robust.

Introduction

Detailed and timely information on forests is a requirement of traditional forest management, forest certification and assessment of forest biodiversity. This increased demand for information together with the intent to reduce costs, requires higher efficiency of forest data acquisition. Various technologies for acquiring spatial forest resource data have been developed in recent years. Field- level investigation has been enhanced by global satellite positioning systems (GPS), automatic measuring devices, field computers and wireless data transfer, and modern remote sensing is now able to provide cost-efficient spatial digital data that are more accurate than ever before.

Evolution of Different Remote Sensing Technologies:

- **Digital Aerial Photos:** Aerial photos have traditionally been the most common source of remote sensing imagery for use in forest inventories. As a result of technological advances, the interpretation of aerial photographs has evolved from analogue imagery to digital devices and applications. Even analogue aerial photos can be digitalized by scanning, else; the photos can be taken directly with digital cameras. Digital aerial photos can be adjusted to the desired coordinate system, digital elevation model may help considering the effects of terrain elevation. The result of such a modification/correction, an orthophoto, is spatially almost as accurate as an ordinary map with highly scalable images. Digital orthophotos are being used mostly as background images in forestry mapping and Geographic Information System (GIS) applications, e.g. for on-screen visual interpretation. The next, considerably more demanding step will be to utilize the imagery in fully automatic computerized interpretation.
- **Spectrometer Imagery:** A spectrometer is a device capable of imaging extremely narrow bands over a broad range of wavelengths. In other words, the device's spectral resolution is high. The visible light and near-infrared wavelength ranges can be imaged by up to 300 bands, and measurements can be taken either on the ground or from

aircraft. The advantages of spectrometer imaging over other remote sensing techniques are (i) the wavelength bands are abundant, and (ii) certain narrow wavelength bands can also be selected. A function of all imaged wavelength bands, or a spectral fingerprint, can also be used to improve accuracy in the interpretation phase. Furthermore, basic information on the spectral properties of the objects deduced is acquired which can be utilized in the interpretation of other remote sensing imagery.

- **High-Resolution Satellite Imagery:** Langley (1975) was one of the first to test imagery from space for forest inventory purposes, since when the technology has vastly improved. The most notable advance in modern satellite remote sensing has been the marked improvement in spatial resolution. The first commercial satellite having a spatial ground resolution < 1 m, IKONOS, was launched in 1999. This had a ground resolution in the panchromatic mode of 0.8 m (nadir point), and the ground resolutions of the 4 bands ranging from 0.45 μm to 0.9 μm in the multiband mode were 3.2 m. A single IKONOS image covered an area of 11 km x 11 km. The American Quick Bird 2 satellite, launched in 2001, had a ground resolution of 0.61 m in the panchromatic mode and 2.44 m in the multiband mode. Modern high-resolution satellite imagery provides a highly attractive alternative to digital aerial photography and can be used in mapping applications, for example, which to date have been carried out in Finland exclusively with aerial photos. In forestry, high-resolution satellite imagery could in principle be used for forest planning purposes, but the high cost of these images has hindered such development up to now.
- **Microwave Radars:** Radar imaging is an active remote sensing technology in which radiation emitted by the device itself is measured. The device emits recurrent microwave pulses of a certain frequency and the receiver in turn measures the radiation reflected from different ground objects. The main advantage of radar imagery is its high temporal resolution, as images can be acquired at practically any time, while optical satellite imagery may be hard to come by in Finland due to the often-cloudy conditions. Radar imagery is thus an interesting alternative for forest mapping, given that its accuracy is sufficient for acquiring detailed plot and compartment information. Microwave satellite images have so far not been able to supply sufficiently detailed information, but they have proved suitable for large-area forest mapping where optical satellite imagery has not been available. Future radar sensors will also be able to produce highly detailed forest imagery. Several sensors having spatial resolutions of 1-3 m are currently being planned, e.g. the TerraSAR sensor, which will have a ground resolution of 1 m, complete polarmetry (polarization = direction of oscillation), stereo imaging and interferometry imaging (phase difference of two separate radar signals). It is planned that TerraSAR images should be available within 5 years. Due to the appropriate resolution and number of imaging channels (several frequencies, polarizations, imaging angles, imaging times), satellite radar imagery will also soon be able to provide valuable detailed information for forestry purposes.
- **Profile Imaging:** Profile imaging is aimed at producing height profiles of objects by imaging the area of interest in parallel flight paths. Since the flight altitude is only 100-200 m, a single flight path covers a relatively narrow strip of terrain, but a 3-dimensional (3D) profile of the imaged area can be obtained by combining several flight-path images. One example of a profiling sensor is

ISSN No.:2321-7405

profiling microwave radar. It has been shown by Hyyppa (1993) that profiling microwave radar is capable of measuring the mean and dominant height of the growing stock in a stand, the basal area, stem volume, crown height, development class and soil type. The main problem has arisen from the low ground width of the images, so that the resulting flight path density in operative use has been so high that imaging costs have soared astronomically.

- **Laser Scanning:** Laser scanning provides more promising remote sensing material than profile imaging. This technique makes it possible to reach even the single-tree level in forest imaging. A laser scanner emits an infrared laser pulse, and each image row consists of a 3D point cloud representing near-adjacent ground elements. The x, y and z coordinates are derived for each measurement, and both 3D terrain and crown models can be derived by analysing the measurements, so that the difference between these models provides a height model for the growing stock. The main advantage of this technology compared with optical remote sensing is that the physical dimensions of the imaged objects can be measured directly (Hyyppa and Inkinen 1999).

LIDAR

Lidar is also called a 'laser radar', 'laser scanner', 'laser profiler', 'range finder', or 'laser ranger'. Recently, it has been used as a novel active sensing tool for 3D measurement of plant shapes and canopy structures. Lidar can accurately measure the distance between the sensor and a target based on the elapsed time between the emission and return of laser pulses (the 'time of flight' method) or based on trigonometry (the 'optical probe' or 'light section' methods). The accuracies of airborne and ground-based lidar systems are typically ;0.1–1 m and ;0.05–10 cm respectively, so lidar can replace conventional passive methods for 3D measurement.

How LiDAR Works?

Lidar systems send out thousands or even hundred of thousands of laser light pulses every second. The acronym "laser" stands for "light amplification by stimulated emission of radiation." A laser generates a stream of high energy photons in narrow range of wavelengths. Most terrestrial lidar systems operate in near-infrared portion of the spectrum. These light pulses then strike and reflect off of the surfaces on the earth. The lidar system measures the time it takes for the light pulse to return. These times are recorded and then converted to distances based on the following formula:

$$D = r*t/2$$

D = the distance from the sensor to the target

r = rate of speed (speed of light = $3x10^8$ m/s)

t = time it takes for the pulse to return

Note: the time is divided by 2 because the light must travel to the object and back to the sensor

The above formula tells us the distance from the sensor to the target, also known as the range. With knowledge of the position (X,Y,Z) of the lidar system sensor and the angle of the laser, the precise 3-dimensional coordinates (X,Y,Z) of the objects on the ground can be calculated. This is done with **Direct Georeferencing**. The integrated Global Positioning System (GSP), Inertial Measurement Unit (IMU) and onboard computer on the lidar system allow for the direct georeferencing of the points.

Conclusion

With the increased demand of high throughput data recording for forestry research, significant tools have been developed to meet the needs. Remote sensing tools and techniques have evolved and with the development of advance sensors, voluminous data can be captured and stored for further use. Of all the tools, LiDAR's data are a valid source of information for estimating and spatially predicting forest structural diversity and gains relevance for its potential role in characterizing forest ecosystems. The maps of structural diversity may be utilized not only for planning management strategies related to biodiversity, but also for primary hypotheses pertaining to silvicultural management systems since tree diameter and height are basic data for assessing the commercial value of timbers.

References:

Beyene, S.M., Hussin, Y.A., Kloosterman, H.E. and Ismail, M.H. (2020). Forest Inventory and Aboveground Biomass Estimation with Terrestrial LiDAR in the Tropical Forest of Malaysia, *Canadian Journal of Remote Sensing*. **46**(2): 130-145.

Holopainen, M. and Kallivorita, J. (2009). Modern Data Acquisition for Forest Inventories. In Kangas, A. and M. Maltamo (eds.), *Forest Inventory – Methodology and Applications* (pp. 343–362).

http://gsp.humboldt.edu/OLM/Courses/GSP_216_Online/lesson7-1/components.html

http://gsp.humboldt.edu/OLM/Courses/GSP_216_Online/lesson71/overview.html#:~:text=There%20are%20three%20main%20types,archeology%20sites%20and%20rock%20formations.

Hyyppa, J. (1993). Development and feasibility of airborne ranging radar for forest assessment. Helsinki University of Technology, Laboratory of Space Technology, 112 pp. ISBN 951-22-1888-7.

Langley, P.G. (1975). Multistage variable probability sampling. PhD Dissertation, Berkeley, CA, University of California, 101 p. Dissertation thesis 75-22538.

Mura, M., McRoberts, R.E., Chirici, G. and Marchetti, M. (2015). Estimating and mapping forest structural diversity using airborne laser scanning data. *Remote Sensing of Environment.* 170: 133–142.

Silva, Carlos & Klauberg, Carine & Mohan, Mikey & Bright, Benjamin. (2018). LiDAR Analysis in R and rLiDAR for Forestry Applications.

5. AGRICULTURAL EXTENSION

Indigenous Technical Knowledge in Agriculture: An Overview

Peddi Naga Harsha Vardhan*

Ph.D. Research Scholar, Department of Agricultural Extension,Uttar Banga Krishi Viswavidyalaya, Pundibari, West Bengal-736165.

Introduction

Indigenous Technical Knowledge (ITK) is specifically concerned with actual application of the thinking of the local people in various operations of agriculture and allied areas. Indigenous knowledge is the local knowledge - knowledge that is unique to a given culture or society. Talukdar *et al.*, (2012) stated that ITK's will be helpful in technology blending programme to generate eco-friendly, location specific, economically viable and socially acceptable technologies. The term indigenous technical knowledge is often camouflaged with the belief that is associated with forthcoming happenings and the innovations made by the farmers to solve specific problems. In many cases, traditional knowledge has been orally passed for generations from person to person. Some forms of traditional knowledge are expressed through stories, legends, folklore, rituals, songs, and even laws.. Indigenous knowledge systems (IKS) are being examined by academicians, development planners, and contributors to alternative development approaches. Traditional knowledge (TK), also known as indigenous knowledge (IK) or local knowledge (LK) generally refers to the matured long-standing traditions and practices of certain regional, indigenous, or local communities. It also encompasses the wisdom, knowledge, and teachings of these communities. Moreover, unlike formal scientific knowledge, indigenous knowledge is generally transferred as oral wisdom from one generation to the other, and is seldom, if ever, documented. Combining all forms of knowledge other than the formal ones as 'indigenous knowledge' would lead to its generalization and oversimplification, and may negate the outstanding contribution local knowledge can make to sustainable development. Indigenous people can provide valuable input about the local environment and how to effectively manage its natural resources. Outside interest in indigenous knowledge systems has been fuelled by the recent worldwide ecological crisis and the realization that its causes lie partly in the overexploitation of natural resources based on inappropriate attitudes and technologies.

Indigenous Technical Knowledge in Agriculture

Indigenous knowledge is fundamental to local decision-making regarding daily activities like hunting and gathering, fishing, agriculture, animal husbandry, water conservation, health, etc. In the recent years, the role of IK in a range of sectors is being talked about. It includes intercropping techniques, pest control, crop diversity, and seed varieties in agriculture; plant varieties, and fish breeding techniques in biology; traditional medicine in human healthcare; soil conservation, irrigation, and water conservation in natural resource management; and oral traditions and local languages in education. The realization of IK's contribution to these sectors has led to an increasing interest in it by academicians, and policymakers alike. Many government and non-governmental organizations, as well as international organizations such as the World Bank, International Labor Office, UNESCO and FAO are now appreciating the role IK can play in achieving sustainable development in a country. This interest is also apparent in the policies and programmes of various countries. Scientists now recognize that indigenous people have managed the environments in which they have lived for generations, often without significantly damaging local ecologies. Borthakur and Singh (2012) suggested that the appropriate coalition between the traditional and modern knowledge and technology systems has immense potential to benefit the society. Many feel that indigenous knowledge can thus provide a powerful basis from which alternative ways of managing resources can be developed. Indigenous knowledge technologies and know-how have an advantage over Science in that they rely on locally available skills and materials and are thus often more cost-effective than introducing exotic technologies from outside sources. Pokhrel and Laskar (2020) revealed that indigenous technologies are of low cost, easily available and have no deleterious effects on agro-ecosystem. By considering the cost effectiveness, availability and eco-friendly nature of the technologies these can be included in the present day integrated pest management (IPM) programme particularly for the farming communities. Purkait *et al.*, (2018) study revealed that the fish farmers are discern ITKs as more widely accepted among the rural farmers because of its cost-effectiveness, local availability of materials, less complexity in preparation, compatibility to social and cultural habitats and economic viability.

The following are some of the features of indigenous knowledge, which have relevance to conservation and sustainable development:

- **Locally appropriate:** Indigenous knowledge represents a way of life that has evolved with the local environment, so it is specifically adapted to the requirements of local conditions.
- **Restraint in resource exploitation:** Production is for subsistence needs only; only what is needed for immediate survival is taken from the environment.
- **Diversified production systems:** There is no overexploitation of a single resource; risk is often spread out by utilizing a number of subsistence strategies.

- **Respect for nature:** The land is considered sacred, humans are dependent on nature for survival, and all species are interconnected.
- **Flexible:** Indigenous knowledge is able to adapt to new conditions and incorporate outside knowledge.
- **Social responsibility:** There are strong family and community ties, and with them feelings of obligation and responsibility to preserve the land for future generations.

Conclusion

The Indigenous Technical Knowledge (ITK) is socially desirable, economically affordable, and sustainable, involves minimum risk and focus on efficient utilization of ecofriendly resources.The indigenous technologies are low cost, easily available and have no deleterious effects on agro-ecosystem. The technologies are practiced by the farming communities. It is also an established fact that the indigenous knowledge varies from region to region and community to community. Considering the cost effectiveness, availability and eco-friendly nature the technologies these may be included in the present day farming. Because the materials that are used in these technologies are available locally and are also socially accepted hence, the indigenous technical knowledge's may not be the only option but may be accommodated as one of the most viable as well as effective tools in farming.

Reference

Anwesha, B. and Pardeep, S. 2012. Indigenous Technical Knowledge (ITK) and their Role in Sustainable Grassroots Innovations: An Illustration in Indian Context. Proceedings of International Conference on Innovation & Research in Technology for Sustainable Development. 38-42.

Puran, P. and Nripendra, L. 2020. Indigenous technical knowledge (ITK) based pest management practices for Boro paddy in Northern parts of West Bengal. Journal *of Entomology and Zoology Studies* ; 8**(2)**: 494-98.

Soumyadip, P., Sutanu, K., Anandamoy, M. and Subir, K. P. 2018. Indigenous Technical Knowledge in Fisheries of South 24 Parganas District of West Bengal, India. *Int.J.Curr.Microbiol.App.Sci.* 7**(02)**: 2793-2797.

Talukdar, R.K. Barman, S. and Hussain, A. 2012. Documentation and perceived rationale of Indigenous Technical Knowledge (ITK) utilized in Boro rice cultivation by farmers of Kamrup District of Assam. *J. Acad. Indus. Res.* 1**(7)**:412-18.

6. SEED SCIENCE AND TECHNOLOGY

Seed Vault - ' The Noah's ARK of Plant Diversity'

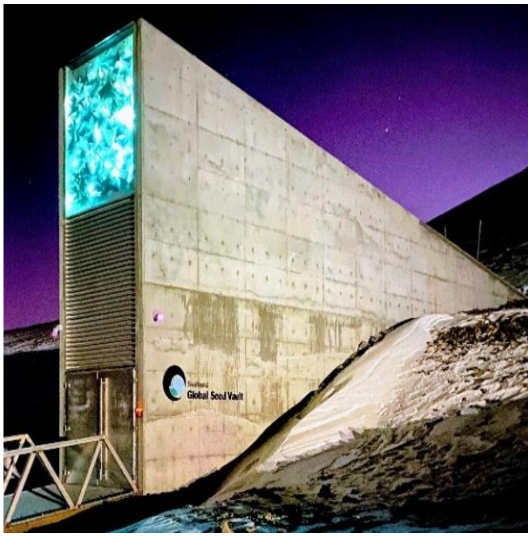
Akhila Jabeen P A[1], Ebeenezar S[2]

[1,2]*SRM College of Agricultural Sciences, SRM Institute of Science and Technology, Chengalpattu, 603 201, Tamil Nadu, India*

Introduction

The Svalbard Global Seed Vault is a gene bank containing secure backup for the world's crop diversity, on the Norwegian Island of Spitsbergen in the remote Arctic Svalbard archipelago. It provides long term storage of seeds conserved from around the world. The Seed Vault aims to provide backup in any loss of diversity, by natural disasters, equipment failures, mismanagement, or accidents. When there is a natural disaster or civil war that destroy the cropping, the seed vault provides backup for the seeds in the country. Seed vault provided backup when Philippines national seed bank was damaged by flooding. Seed Vault is considered to be a backup for the worlds 1750 seed banks and storehouses of agriculture. The same method as in South India, where seeds are stored in the temple's top pillars, to use in great disaster. Svalbard is the ideal place for a seed vault due to its low temperature, remote and calm location with public services. The vault is owned by the Norwegian government and maintained with the agreement - Tripartite agreement; among the Norwegian Government, Crop Trust and Nordic Genetic Resource Centre (NordGen).

ISSN No.:2321-7405

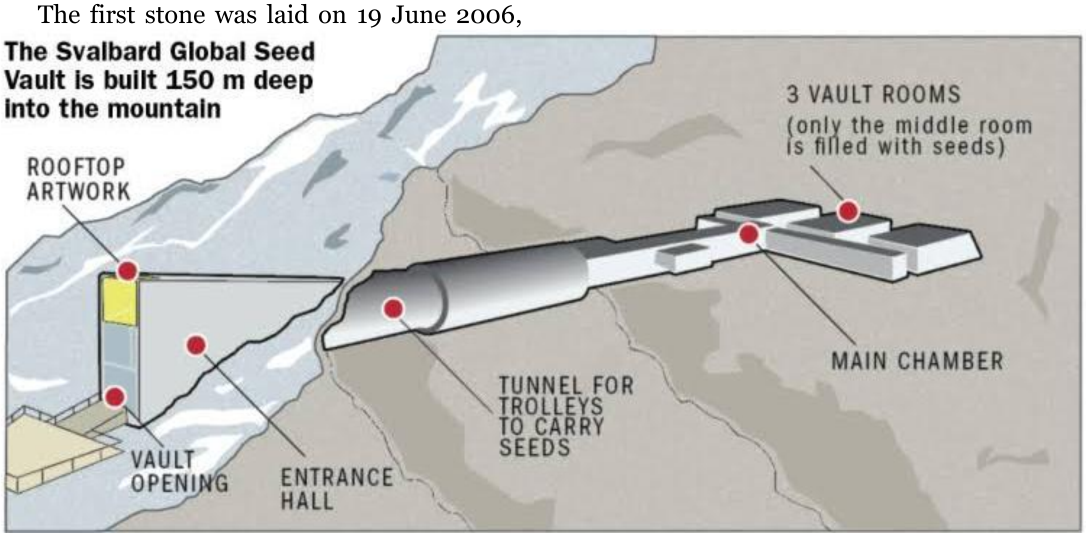


History of Seed Vault

From 1984, the NordGen; the Nordic Gene Bank stored germplasm in the abandoned coal mine. The International Treaty on Plant Genetic Resources for Food and Agriculture was adopted in 2001, CGIAR and conservationists started the ideology of seed vault hence approached the Norwegian government. The seed vault officially opened on 26 February 2008, with the first seed sample arrived in January 2008.

Construction of Seed Vault

The first stone was laid on 19 June 2006, by Norway, Sweden, Finland, Denmark and Ireland prime ministers. Its 200 meters inside a sandstone mountain on Spitsbergen Island and employs major security systems. It contains *Perpetual Repercussion* by Norwegian artist Dyveke Sanne, marking the entrance of the vault from the distance. The vault entrance is made of reflective stainless steel, mirrors and prisms; which reflects polar light in the summer season. During winter, a network of 200 refibre optical cables gives greenish turquoise and white light.



Storage OF Seeds

Seeds are stored in sealed three-ply foil packages and then placed into plastic containers on metal shelving racks. Storage rooms maintained at -18°C. Low temperature and limited access to oxygen ensures low metabolic activity and delay seed ageing hence a longer period of storage. Low temperature is maintained even when there is no electric supply by the permafrost surrounding the facility which maintains a low temperature.

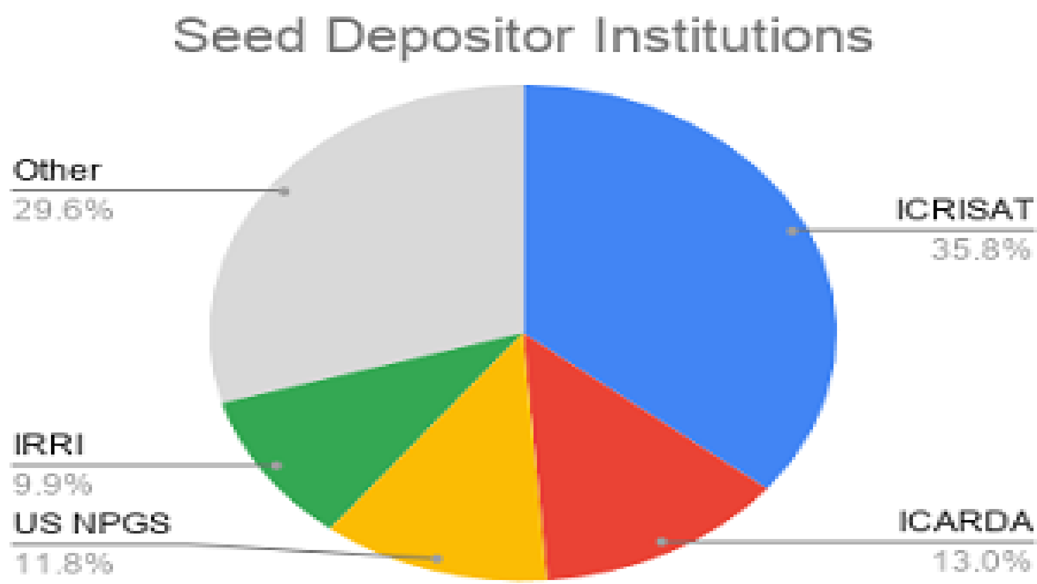
Five percent of the seeds in the vault, about 18000 samples with 500 seeds each. As part of the vaults first anniversary more than 90000 food crop seed samples were placed into storage, bringing, the total number of seed samples to 400000. Among the new seeds are 32 varieties of potatoes from Ireland national gene bank and 20000 new samples from the US Agricultural Research Service. Seed vault contains about 70,000 different varieties of barely, 1,50,000 samples of rice and 1,40,000 samples of wheat

Seed Contributors

About 76 different institutions are contributing to the seed vault. 37 institutions gather seeds from multiple countries and the Center for Genetic Resources, Netherlands gathers from all 7 continents including Antarctica.

Major Seed Contributors:

- ICRISAT (International Crop Research Institute for the Semi-Arid tropics)
- ICARDA (International Centre for Agricultural Research in Dry Areas)
- IRRI (International Rice Research Institute)



References

Marte Qvenild, 2008, Svalbard Global Seed Vault: a 'Noah's Ark' for the world's seeds, Development in practice, pages 110-116

Asmund Asdal and Luigi Guarino, 2018, The Svalbard Global Seed Vault: 10 Years—1 million Samples, Bio preservation and biobanking Vol 16, No 5.

F. William Engdahl, 2007, "Doomsday Seed Vault" in the Arctic, Global Research

ISSN No.:2321-7405

7. AGRICULTURAL CHEMISTRY

Bioethanol Production from Banana Pseudostem

[1]Dr Nagalakshmi RM*, [2]Dr R Sangeetha Vishnu Prabha and [3].Dr K Shamini

[1]Sethu Baskara College of Agriculture and research foundation, Karaikudi, TamilNadu
[2]Pushkaram College of Agriculture, Pudukottai TamilNadu, [3]TamilNadu Agricultural university Coimbatore,TamilNadu

Introduction

The Energy Information Administration (EIA) recently forecasted that global energy consumption is expected to increase almost 50 percent by 2050. Energy consumption is very high in India because of the energy requirements of energy-intensive manufacturing. Due to population and economic growth, energy-related carbon dioxide emissions are expected to increase at an average rate of 0.6 percent per annum. Global energy demand and available energy is progressing in opposite directions. To meet the energy crisis and to combat the environmental pollution, biofuels are environmentally friendly alternatives.

Bioethanol is nowadays increasingly used as an alternative liquid biofuel for transportation in high and medium income countries. The current increased worldwide ethanol demand in transportation sector will lead to the expansion of fuel ethanol production. In India, sugarcane molasses is the major resource for bioethanol production and inconsistency of raw material supply holds the major hinderance in bioethanol production. Drastic fluctuation in pricing of sugar cane farming and sugar milling resulted in farmers shifting from sugarcane cultivation other crops and the role of sugarcane in bioethanol is constantly decreasing.

Bioethanol from banana pseudostem

Banana is the most important fruit crop in the world. Global banana cultivation generates about 250 million tons of fresh lignocellulosic biomass residues. Using post-harvest wastes like residual banana pseudostem as a feedstock for ethanol production could be an effective alternative. Banana pseudostem are non-food biomass resources and therefore do not compete with human food supply. Cellulosic ethanol has been envisaged to be produced by fermentation of simple sugars from enzymatically hydrolyzed plant biomass (Hossain et al., 2011). Banana widely is a widely cultivated fruit crop throughout the world. It exhibits typical ploidy variation than any other fruit crop. This diversity gives the opportunity to exploit the genetic variation of banana in identifying potential genotypes suitable for bioethanol production. Screening wide range of banana genotypes may result in identification of potential genotypes for bioethanol production. Identification of genotypes with high yield and bioethanol efficiency will aid the farmers to get additional income.

Saccharomyces cerevisiae is the most commonly used fungus of the incipient lignocellulosic biofuel industry due to its robustness, stress-tolerance compared to bacteria and other fermenting microbes. Number of different strains of *Saccharomyces cerevisiae* is available in nature (Brooks et al., 2008). Selection and use of a potential strain will increase the yield of ethanol. The utilization of molecular methods enables rapid and precise identification of the *Saccharomyces cerevisiae* strain level (Mohammed and Reddy, 1986). Bioethanol is usually prepared by various methods. Manipulations in the pretreatment, enzymes used and microbe used results in marked increase or decrease in ethanol yield. Pretreatment includes acidification (H_2SO_4) alkalisation (NaOH) or high temperature. The enzymes used also varies viz., cellulase, amylase or zylase can be used. The efficiency of the pretreatment and enzymes used varies with the chemical nature of the biowaste. So, an optimised protocol with suitable pretreatment, correct enzyme and microorganism can give maximum. The pseudostem can be used for ethanol production but still there remains some waste after ethanol production. That waste can further be converted to biofertilizers. As the waste mass have undergone a series of pretreatments for ethanol production, it need be treated well for further degradation.

Decomposition wastes after ethanol production

Earthworms are efficient decomposers. It acts as voracious feeder, modifying composition of organic waste, gradually reducing its organic carbon and C:N ratio and retains more nutrients (nitrogen, potassium, phosphorus, calcium). Earthworm increases the surface area of any material and makes it more favorable for the activity of microbiota for further decomposition. Earthworms have the ability to consume various types of organic wastes such as livestock excreta, cattle dung, oil palm waste, agricultural residue, sewage sludge and other agro-industrial refuse. Earthworms accelerates the bioconversion process by two to five times as compared to traditional composting, thereby hastens the conversion of wastes into valuable biofertilizer. Earthworm-microbe interaction makes the degradation faster. So, an optimised protocol will increase the ethanol yield which helps the farmer to get more profit and the biofuel production helps to reduce the energy crisis and environmental pollution. The end product of ethanol production is further converted to biofertilizer which increases the soil nutrition.

References

Brooks AA. Ethanol production potential of local yeast strains isolated from ripe banana peels. African Journal of Biotechnology. 2008; 7:3749-3752.

Hossain ABMS, Ahmed SA, Ahmed MA, Faris MAA, Annuar M, Hadeel Norah H. Bioethanol Fuel Production from Rotten Banana as a Environmental Waste Management and Sustainable. Energy. 2011; 5:586-598.

Mohamed MA, Reddy CA. Direct Fermentation of Potato Starch to Ethanol by cocultures of Aspergillus niger and Saccharomyces cerevisiae. Applied and environmental microbiology. 1986; 52:1055-1059.

*****

8. AGRICULTURAL SCIENCES

Plant Products and Anti Viral Principles

Sudha, A.

Assistant Professor (Plant Pathology),Department of Millets, Tamil Nadu Agricultural University, Coimbatore

Preparation of Plant Extracts, Neem Oil and NSKE

Plants virtually are nature's chemical factories, providing man with practically unlimited sources of chemicals for possible use as botanical pesticides. These plant products are found to have fungicidal, bactericidal or antiviral principles. Out of 2,000 plant species possessing pesticidal properties, 346 have fungicidal properties, 92 have bactericidal properties and 90 have antiviral principles. Among the plant products neem derivatives are reported to be effective in controlling several diseases. Others include *Mahua* (Iluppai), Pungam (*Karanj*).

Neem Products

The tree (*Azadirachta indica*) contains several active principles in various parts. The important active principles present in neem products are azadirachtin, Nimbidin, Nimbinene, Nimbidic acid and Azadirone. Among the various neem products, neem seed kernel extract, neem oil, neem cake and neem cake extract are widely used as they are safe to ecofriendly populations.

Neem Seed Kernel Extract 5% (NSKE)

Neem seed kernel is powdered. Twenty five kg of powdered neem seed kernel is taken in a gunny bag and tied. It is soaked in 100 litres of water for 8 hours. The gunny bag is shaked thoroughly to get the extract and the filtrate was taken. The volume of the filtrate was made 500 litres using water. To this extract 500 ml of sticker like Teepol or Triton AE or 500 g of Khadi soap is mixed. The neem seed kernel extract thus obtained is ready for spraying. It is used to control the green leaf hopper (GLH), the insect vector of Rice Tungro Virus (RTV). Foliar sprays of 5% NSKE at 15 days interval effectively control the vector and reduce the spread of RTV. Foliar spray of NSKE at the time of panicle emergence reduces the sheath rot disease (*Acrocylindrium oryzae)* in rice. In blackgram and greengram two sprays NSKE 5% at 15 days interval controls powdery mildew (*Eryspihe polygoni).*

Neem Oil 3%

In plant disease management, neem oil 3% foliar spray is used. Here Teepol (1ml / litre of water) is mixed first with water to have emulsion and then the neem oil is added. The final solution will be milky white in colour. To get 3% solution 30 ml of neem oil is added to 1 litre of water. For one hectare, 15 litres of neem oil is required to mix in 500 litres of water.

Neem oil 3% is used to control green leaf hopper, the vector of RTV, for which three sprays are given at 15 days interval. For the control of whitefly vector of yellow mosaic in blackgram and greengram neem oil 3% spray is done. Sheath rot of rice is controlled with neem oil 3% when it is sprayed at the time fo panicle initiation. Rice blast is also controlled by neem oil 3%. Rust of groundnut (*Puccinia arachidis*) and powdery mildew of blackgram (*E.polygoni*) are controlled by two sprays with neem oil 3% at 15 days intervals.

Neem Cake

Neem cake obtained after extraction of oil is used in the control of soil-borne diseases. Neem cake is powdered and directly applied to the field before last ploughing for sowing. Soil application of 150 kg of neem cake per hectare as basal dressing reduces sheath blight (*Rhizoctonia solani*) and blast. In cotton, pre-emergence, post-emergence and damping off disease (*Rhizoctonia solani*) reduced by soil application of neem cake at 2.5 and 5.0 tonnes / ha respectively. Soil application of neem cake controlled root rot of blackgram and sesame (150 kg/ha), chickpea wilt (*Fusarium solani*), basal stem rot of coconut (*Ganoderma lucidum* 5 kg/ha), betelvine foot rot and leaf rot (*Phytophthora capsici*) and crossandra wilt (*Fusarium solani*).

Neem Cake Extract 10%

Neem cake is powdered. Fifty kilogram of neem cake is taken in a gunny bag and is soaked in 500 litres of water for a period of 8 hrs. The gunny bag is removed after a thorough shaking. To the extract, 500 ml of sticker (Teepol or Trition AE) is added and mixed well. This extract is used to control citrus canker (*Xanthomonas axonopodis* pv. c*itri*).

Besides the above said preparation, some of the commercially available neem formulations are Bioneem, Biosol, Econeem, Field Marshall, Kemissal, Margocide, Neem Mark, Neemax, Neemazal, Nimbicidine, Neemgold, Neemguard, Neemicide, Neem plus, Nimba, Nimbin, Sunneem, Wellgro, etc.

*****

We invite good, informative and knowledge spreading articles for publication in Readers Shelf. Please contribute your articles.

*****

9. AGRONOMY

Bioeffectors in Agriculture

Elumle Priyanka[1]

[1] *Research scholar, Department of Agronomy, AAU, Jorhat-13, Assam*

Introduction

There is no planet B

We are killing our planet A by polluting ocean, soil and destroying biodiversity which is directly or indirectly affecting our agriculture and it is to be noted we are the last generation who can do something to protect it, As biostimulants can improve crop production and productivity by maintaining soil health, so it is the best option to be adopted under extreme climatic stresses. The huge amount of chemical fertilizers applied to the soil not only destroyed soil health but also started showing harmful effects on climate, human health and other living organisms, biostimulants can overcome such effects by minimizing the usage of chemical fertilizers, improving the metabolic processes and enhancing the enzymatic actions of plant and soil

What are biostimulants?

Du Jardin defines biostimulants as "any substance or microorganism applied to plants with the aim to enhance nutrition efficiency, abiotic stress tolerance, and/or crop quality traits, regardless of its nutrient content" or A biostimulant may be defined as any substance or mixture of substances of natural origin or microorganism which improves the condition of crops without causing adverse side effects

Types of biostimulants

Two categories of biostimulants are natural and synthetic biostimulants. The former are obtained from biological material, and the latter are structurally similar and functionally identical to biological material.

There are many categories of biostimulants such as humic acids, seaweed extracts, liquid manures, beneficial bacteria and fungi

Humic and fulvic acid

It is important and economic to build up soil humus and enhance microbial growth to improve crop growth and productivity. The humus can be derived from leonardite, black peat, dung, compost, soil, sludge, hard coal and sapropel peat. The humic substances can be divided into three components: fulvic, humic and humin. It contains the total nutrients i.e., nitrogen-3.71% phosphorus-0.1% potassium- 6.25% etc

Seaweed extracts

The use of biostimulants along with conventional mineral fertilizers can enhance its effectiveness and improve plant growth. The liquid extracts from seaweed can be applied as a foliar spray. It contains major and minor nutrients, amino acids, vitamins, cytokinins, gibberellins and auxins which promote growth. These compounds may work synergetically at different concentrations.

PGPR

The bacterial biostimulants (Plant growth-promoting rhizobacter) is a major plant biostimulants category that improves plant growth, improves nutrient uptake, protects the plant from biotic and abiotic stresses. It includes *Azotobacter sps, Azospirillium sps, Psuedomonas sps etc.*

AMF

The arbuscular mycorrhizal fungi (AMF) help the plant in the absorption and translocation of nutrients to the site of action.

Benefits

Enhance nutrient efficiency

Most of the nutrients added to the soil get leached, volatilized and fixed with other nutrients and make it unavailable to plants thus it becomes difficult for the plant to absorb the optimum amount of nutrients for its growth. when the plant is applied with biostimulants, it starts absorbing an adequate amount of nutrients from the soil by improving the nutrient uptake capacity of the plant by triggering the metabolic pathways which are required for carrying out photosynthesis and respiration which will also enhance the enzymatic activity and most of the biostimulants such as humic acid, seaweed extracts contains auxin like substances, and the humic acid can interact with metal ions, oxides, hydroxides and forms water-soluble and insoluble complexes.

Enhance soil enzymatic activity

By deep ploughing the soil organic matter is getting oxidized day by day and it is resulting in less availability of organic matter to the soil microbes. Biostimulants can improve organic matter by stimulating soil biological activity. The

ISSN No.:2321-7405

functionalized molecules present in it helps in retaining water, forms soil aggregations and scavenges toxins or harmful metals which will result in favorable environment for soil microbes to carry out their enzymatic activity

Improve production

We need to reduce the use of chemical fertilizers and in the meantime increase production and productivity by maintaining soil and plant health, here the use of biostimulants will help us to achieve both production and sustainability. biostimulants is a promising and eco-friendly innovation that enhances seedling germination, plant growth, vigor, flowering and fruit set overall its production and productivity

Protection from abiotic stress

Now days Plant growth and development is mostly affected by abiotic stresses(drought, salinity, extreme rainfall and temperature).which causes huge losses, when we incorporate biostimulants along with other management systems will ultimately protect the crop from its harmful effects by enhancing its processes at cellular, molecular and physiological levels. The different hormones present in it can induce cell division, cell differentiation, vascular development and increases the nutrient mobilization capacity of plants

Conclusion

The bioactive compounds present in biostimulants will enhance production and productivity of the crop by maintaining soil health and also protect the plants from abiotic stresses by stimulating different metabolic and physiological processes of the plant, thus the usage of chemical fertilizers may be reduced by incorporating biostimulants along with other crop production systems

References

du jardin, (2012).The Science of Plant Biostimulants-A bibiliographic analysis. Ad hoc study Report to the European Commission DG ENTR.2012

Halpern *et.al.*,(2015) The use of biostimulants for enhancing nutrient uptake, Advances in Agronomy, Vol 129 pp.141-174

Calvo *et.al.*,(2014)Agricultural uses of plant biostimulants Plant Soil,383, pp.3-41

10. PLANT PATHOLOGY

Spiroplasma: An emerging Threat to Crops

Ravi Regar[1]

[1]*PhD. Scholar, Department of Plant Pathology, S.K.N. College of agriculture, Jobner, Jaipur.*

Introduction

Spiroplasma was identified in 1971. Spiroplasmas are wall-less prokaryotes. Spiroplasma comes under mollicutes. It has a spiral shape. They grow well at 37°C. The impact of Spiroplasma diseases on agriculture is impressive and, at the present day, no effective curative strategy has been developed. Spiroplasmas are pathogens of agriculturally important plants like corn, citrus etc. It infects the phloem of the affected plant, causing fruit deformities.

Characters of Spiroplasma –

- Lack of cell wall.
- Helical
- Surrounded by a triple-layered unit membrane.
- Fried-egg colony morphology.
- They are mostly found in phloem tissues of plants.
- Cell of Phytoplasma are usually resistant to the antibiotics eg. Penicillin, cephaloridine, which act on cell wall, but sensitive to tetracyeline.
- Transmitted by vector like leaf hopper.

Systematic Position of Mycoplasma

Group	**Prokaryotes**
Class	Mollicutes
Order	Entomoplasmatales
Family	Spiroplasmataceae
Genera	Spiroplasma

Symptoms of Spiroplasma Disease in Plant

1. Stunting.
2. Numerous ear shoot develop
3. Numerous tillers may also develop at the leaf axils and base of the plant, giving if a bushy appearance.
4. On affected trees, fruits become small, crooked.

Important Diseases Caused by Spiroplasma

1. Stubborn *disease* in citrus.
2. Pear decline.
3. Corn stunt.
4. Grape Leaf roll.
5. Periwinkle yellow.

Some Major Plant Diseases Symptoms

Stubborn Disease in Citrus – Causing agent *Spiroplasma citri*. The most common symptoms are different shape of fruits, effect on colour of fruits and fruit drop before maturity.

Figure 1

Grape Leaf Roll – Leaf tissue between the veins turns deep red to purple, with downward curling or cupping of the leaf margins.

Figure 2

Corn Stunt - The most characteristic symptoms of Corn stunt citrus discoloration panicle and twisting and distortion of inflorescence. Leaves – abnormal colours, abnormal forms, necrotic area, yellowed or dead. Witches broom and dwarfing.

Figure 3

Pear Decline - The most characteristic symptoms are Poor shoot and spur growth. Also dieback of shoots, premature reddening and upper rolling of leaves. Reduced leaf and fruit size, and premature leaf drop.

Figure 4

ISSN No.:2321-7405

Common Management Practices for Control of Spiroplasma Caused Diseases

- Rouging of infected plants.
- Adjustment of date in sowing.
- Use of pathogen-free bud and grafting materials.
- Remove replants infected with disease and replant with disease-free trees.
- Vector controls are effective methods for the containment of spiroplasma-associated diseases. Spraying Monocrotophos, Cypermethrin, and demithoate will be effective for vector control.

11. AGRICULTURAL SCIENCE

Major Disease of Cumin and Their Management

Kiran Choudhary

Ph.D Scholar, Department of Plant Pathology, RARI, Durgapura- 302018 , Jaipur, RAJASTHAN

Abstract

Cumin is grown in India besides several other countries. It is an important crop of Rajasthan and Gujarat and some adjoining states. The crop suffers due to wilt (Fusarium oxysporum f.sp. cumini), blight (Aternaria burnsii), powdery mildew (Erysiphe polygoni) and seed borne microorganisms. Some more diseases have been reported but research has not been done. Measures to control the diseases have been identified and recommended

****

Introduction

Cumin (*Cuminum cyminum* L.) belongs to the family *Apiaceae,* chromosome number 2n = 14 locally known as Jeera or Zeera in Hindi and is an annual herb. It is believed to be a native of the Mediterranean and Near Eastern regions. It is mainly cultivated in India, Egypt, Libya, Iran, Pakistan and Mexico (Peter and Nybe, 2002). Nutritional composition of cumin seeds is 17.7% protein, 23.8% fat, 35.5% carbohydrate and 7.7% minerals and essential oil content in seed varies from 2.5 to 4.5% (Pruthi,1996).The seeds of cumin are used for flavouring especially meat casseroles, lentil soup and an ingredient of most curry powders and many savoury spice mixtures. It is stimulant, antispasmodic carminative and also diuretic.

India is the largest producer and consumer of cumin seed in the world and occupied an area of 12.76 lakh hectares with annual production of 9.12 lakh tones, India exported 2.14 lakh tons of cumin worth of Rs 3328 crore during the year 2019- 20 (Anonymous, 2020). The crop is mainly cultivated in Rajasthan and Gujarat, and both the states together contribute more than 90% of total country's cumin production. In Rajasthan, it is cultivated in area 7.79 lakh hectares with annual production of 4.28 lakh tones (Anonymous, 2020).

Major Disease of Cumin :-

- Cumin Wilt
- Blight Of Cumin
- Powdery Mildew Of Cumin
- Damping Off

1. Cumin Wilt :-

Disease symptoms:-Wilt disease is caused by *Fusarium oxysporum* f. sp. *cumini*. At seedling stage and pre flowering stage, the disease produces wilting symptoms. When stem is cut longitudinally brownish discoloration is observed. Mathur and Mathur (1956) reported wilt of cumin from Rajasthan and identified the casual organism to be *Fusarium oxysporum*. On the basis of host specificity, Patel and Prasad (1963) finally named it as *Fusarium oxysporum* f. sp. *cumini*. Disease produces wilting symptoms at seedling and later stage of plant growth. Brownish discolouration of vascular bundles is seen when stem is cut longitudinal.

Favourable condition:-Soil temperature is between 12.5° C and 14° C.

Management :-

- Soil application with *Trichoderma harzanium* @ 2.5 kg/ha .
- Seed treatment with carboxin 37.5% + thiram37.5% WG (75 WG) @ 2 g/kg.
- Soil application with Neem cake @ 5 q/ha.
- Grow resistant vari. –GC-4, RZ-19.

2. Blight of Cumin:-

Disease symptoms:-Cumin blight is the second most important disease caused by *Alternaria burnsii* and together with wilt, could be most damaging. Blight appears in the form of dark brown spots on leaves as well as stems, whereby the stem tips bend downwards. *A. alternata* has been reported to be seed borne and a cause of seedling blight in India. Cloudy weather after flowering increases the incidence of the disease in cumin. As the spread of the disease is very fast, only prophylactic measures are recommended for effective prevention against blight. During winnowing, Seeds become shriveled and are easily blown away. Early sowing of cumin crop gets high intensity of disease and produces the unmarketable seeds.

Favorable conditions:-Disease becomes widespread in wet weather with temperature ranging from 20-32° C accompanied by high humidity and cloudy weather.

Management :-

- Soil application with *Trichoderma harzanium* @ 2.5 kg/ha .
- Seed treatment with Carbendazim 12% + Mencozeb 63% WP @ 0.2%.
- Spray of Mancozeb 75% WP @ 0.2%.
- The combination of tebuconazole (0.1%) + Azadirachtin (0.2%) also effective to manage Alternaria blight of cumin.
- Grow resistant vari.- GC-4.

3. Powdery Mildew of Cumin:-

Disease symptoms:-Powdery mildew of cumin caused by *Erysiphe polygoni* is an important disease. The crop is usually attacked by disease at flowering stage in cloudy weather during February-March. It is a routine practice of farmers to spray fungicides onward from one-month age to maturity of the crop to save seed yield from powdery mildew disease. Gohil et al.,

(1988) reported losses of 19.1 per cent in North Gujarat due to *E. polygoni* in cumin. Powdery mildew disease is destructive disease which may cause complete failure of crop. Cumin crop is usually attacked by this disease in cloudy weather during February-March at flowering stage. Powdery growth on cumin develops first on leaves which later can cover all stems and branches including flowers.

Favourable conditions:- Cool high humid weather (20-25° C) or cloudy weather with high relative humidity (RH) > 80% favours conidial germination and diseas development.

Management

- Spray of propiconazole @ (0.025%) was the most effective fungicide.
- Dusting with sulphur dust at the time of flowering in the month of January and spraying with @ dinocap (0.1%).
- Spray of wettable sulphur @ (0.2%).

4.Damping Off

Disease symptoms:-Damping off disease is soil borne. It occurs in two stages, i.e. the pre-emergence and the post-emergence phase. In the first stage, seeds get rotted and the seedlings are killed just before they reach the soil surface. A soft water-soaked lesion appears near the collar region after seedling emerges out of soil line. The disease is primarily spread by the pathogen via soil, water and secondary spread of conidia via rain splash and wind. Low temperatures below 24° C, high humidity, high soil moisture, high dose of nitrogenous fertilizers and cloudiness for few days are the favourable conditions.

Management

- Damping-off can be avoided by starting seed in light, well-drained, well-prepared soil.
- Avoid overwatering condition in field.

References

Anonymous (2020) Spices - Area, production and export data in India 2019-20. Directorate of Arecanut and Spices Development, Department of Agriculture, Cooperation and Farmers Welfare, Ministry of Agriculture and Farmers Welfare, Government of India, West Hill P.O., Kozhikode, Kerala.

Gohil, V. P., Jani, S. M. and Dange, S. R. S. (1988). Assessment of yield losses due to powdery mildew in North Gujarat. *Indian Phytopath*. 41: 156-157

Peter KV, Nybe EV (2002) Dominating global markets. The Hindu Survey of Indian Agriculture 8799.

Pruthi JS (1996) Spices and Condiment. National Book Trust New Delhi, India 118- 178.

Mathur, B. L. and Mathur, R. L. (1956). Annual report of scheme for research in wilt disease of zeera (*Cuminum cyminum* L.) in Rajasthan. University of Rajasthan Jaipur.

Patel, P. N. and Prasad, N. (1963). Fusarium wilt of cumin (*Cuminum cyminum*) in Gujarat State India. *Plant Dis. Report.* 74:528–531

*****

Readers Shelf, a monthly magazine, which has provided platform to the intellectuals for contributing articles on various subjects related to Agriculture Science and Allied Subjects, Dairy, Poultry Science, Management etc., is pleased to share with all the readers that they can send the articles under fast track system. The process is simple.

The articles under this system are published on priority basis and therefore anyone who is interested to get the article published on priority basis may opt for this system. For further details you may write us on readersshelf@gmail.com .

*****

12. AGROFORESTRY

Salt Affected Soils: Significance and Management for Sustaining Crop Yields

[1]Yogesh Kumar and [2]Aditya Pratap Singh

[1]Department of Silviculture and Agroforestry, College of Forestry, Navsari Agricultural University, Navsari-396450, Gujarat, (India), [2]Department of Genetics and Plant Breeding, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur-741252, West Bengal (India)

Abstract

Among all the factors that deteriorate soil health in terms of its fertility to sustain crop productivity, salinity is a major one. Soil salinity is inherent property of arid and coastal zones but also results from anthropogenic practices. Saline soils pose challenge for cultivation of salt sensitive crops and thus limit the income possibilities of farmers pertaining to such lands. However, interventions in agroforestry systems may lead a way to overcome these challenges to significant levels.

Introduction

Salt-affected soils are present in all the continents and under almost every climatic condition. Their distribution, however, is relatively extensive in the arid and semi-arid regions compared to the humid areas around the globe. The nature and characteristics of these soils are also diverse in the sense that they require specific approaches for their reclamation and management to sustain their productivity. Any long-term solutions for this issue therefore, necessitates understanding of the mode of origin of salt-affected soils. Their classification, keeping in view the physico-chemical characteristics, processes leading to their formation and the likely approaches for their reclamation and successful management are key areas for research.

Classification

In the course of accumulation of knowledge on the nature, properties and plant-soil relationships in salt affected areas, two main groups of these soils have been distinguished (Szabolcs, 1974). These are:

Saline soils - Soils containing sufficient neutral soluble salts tend to adversely affect the growth of most of the crops. The main soluble salts are sodium chloride and sodium sulphate. However, saline soils also contain appreciable quantities of chlorides and sulphates of calcium and magnesium.

Sodic soils- Soils containing sodium salts capable of alkaline hydrolysis, mainly Na_2CO_3 are also referred to as 'Alkali' in some literatures. These two main groups of salt-affected soils differ not only in their chemical characteristics but also in their geographical and geochemical distribution, and their physio-biological properties. The two categories also require varied approaches for their reclamation and agricultural utilization. In nature the various sodium salts do not occur absolutely discretely, but in most cases either the neutral salts or the ones capable of alkaline hydrolysis exercise a dominant role on

ISSN No.:2321-7405

the soil-forming processes and therefore in determining soil properties.

Although the above two categories account for a very large fraction of salt affected soils the world over, there are transitional or borderline formations which are likely to have properties intermediate between those of the two broad categories. Several local terms in different parts of the world are in vogue to designate such soils. Other categories of saltaffected soils which, though less extensive, are commonly met in different parts of the world are.

Acid-sulphate soils- These are soils that have somewhere within a 50 cm depth a pH below 3.5 to 4.0 that is directly or indirectly caused by sulphuric acid formed by the oxidation of pyrite (FeS_2) or, rarely of other reduced sulphur compounds. Potential acid sulphate soils occur in tidal swamps. They have high levels of pyrite, low levels of bases and produce strongly acid sulphate soils when pyrite is oxidized to sulphuric acid after drainage (Pons, 1973). Pyrite formation is favored in brackish and saline mangrove swamps dissected by tidal creeks where deposition and build up of coastal sediments is slow. Apart from high salinity, the productivity of acid sulphate soils is restricted due to such soil factors as iron and aluminium toxicities, deficiency of phosphorus, etc.

Degraded sodic soils- Degraded sodic soils are usually considered to be an advanced stage of soil development resulting from the washing out of salts. The details of the type of soil developed as the leaching proceeds depend on local conditions, particularly soil texture and type of clay present. As a result of the leaching processes there is a tendency for the dispersed clay and organic matter to move down the profile resulting in the formation of a dark, extremely compact layer having a sharply defined upper surface and merging gradually into the subsoil with increasing depth. The darker colour of the compact layer compared with the layer above may be due to its higher clay content since it does not always have a higher content of organic matter. The upper soil layers have a loose porous, laminar structure due to loss of clay and the upper surfaces of this layer may be paler than the lower, possibly because of silica being deposited on them. The clay pan cracks on drying into well defined vertical columns having a rounded top and smooth, shiny, well defined sides. These can be broken into units about 10 cm high and 5 cm across with a flat base. Below this the column breaks into rather smaller units with flat tops and bottoms which on light crushing break into angular fragments.

As the leaching of these desalinized soils proceeds, the upper horizons deepen and often become slightly acidic in reaction and the amorphous silica content increases. As a further stage of development, it has been suggested that the very characteristic clay pan becomes less pronounced, possibly because of washing down of sandy material from the A horizon in the cracks between the structural units.

Management of Salt Affected Soils

When salts more soluble than calcium carbonate and gypsum are present in the soil and affect crop growth and yield of most crops these soils are considered salt affected. Most of these soils have an Electrical Conductivity of more than 4 Ohms/cm. Many of them are classified as Solonchakz. The presence of salts affects the plant uptake of nutrients and the microbiological activity in the soil. Salinity may also affect other soils to a lesser extent and may; lead to recognition of saline phases which also deserve attention when present under salt sensitive crops (spinach, etc.). Methods adopted to remove excess salts from the soil surface and the root zone in saline soils are enlisted as follows-

- To prevent the excessive accumulation of salt in the root zone, irrigation water (or rainfall) must be applied in excess of that needed for the evaporation of the crop. Leaching can be timed to precede the critical growth stages at which stress should be prevented. This can be timed through irrigation during dry seasons. Leaching at times of low evapotranspiration demands is more efficient, for example, at night, during high humidity, in cooler weather or outside the cropping season.
- Leaching is only effective when salty drainage water is discharged through subsurface drains that carry the leached

salts out of the area under reclamation (But one should avoid contaminating other areas under cultivation downstream).

The following techniques or events can help reclaim saline soils:-

- Salt can be leached out of the root zone through good quality irrigation water or by heavy rainfall.
- Creating good surface and internal drainage. The use of tile drains and open ditches in the fields can increase drainage and remove some of the salts.
- Breaking the compacted layers that occur near or at the soil surface.
- Adding organic matter, such as rotted hay or feedlot manure, at 10-15 tons/acre to improve soil porosity.

There are some additional considerations in the reclamation of sodic and saline-sodic soils.:-

- Reclamation of sodic soils is similar to saline soil in leaching the salts out of the root zone, except that gypsum should be added to remove the sodium. The amount of gypsum required depends on the soil texture and ESP.
- Reclamation of these salt-affected soils is a very difficult thing and can take several years.
- Sandy soils in high rainfall regions can be reclaimed more easily than clay soils if rainfall is the only source of reclamation.

Apart from these, other management practices can be followed. They include avoiding excessive fertilization after the leaching of salts process has started, avoiding deep tillage as it might bring salts to the soil surface (forcing a restart of the reclamation process), establishing a cover crop to prevent erosion, and other management practices that will reduce surface evaporation and encourage water movement downward in the soil. Some crops are more salt- tolerant than others and should be considered in these situations.

Salt tolerance in Crop Plants

1. Salt tolerance of cereal crops: Most of the major cereal crops exhibit high tolerance to soil salinity. In this group are sorghum, wheat, triticale, ripe, oats and barley. Only exceptions are corn and rice. All cereals tend to follow the same sensitivity or tolerance pattern in relation to their stage of growth. Seeding or early vegetative stage appears to be the most sensitive. With subsequent stages showing increased tolerance. The phenomenon has been reported for sorghum, wheat, barley, corn and rice. Salt stress can have a significant effect on the developmental process. In the first phase Leaf and spikelet primordial are initiated, leaf growth occurs and tiller buds are produced at the axils of the leaves. High salinity at this time reduces the no. of leaves per cubic the no. of spiklets per spike and no. of tillers per plant.In the Second phase, tillers grow, main stem and tiller culms elongate and the final no. of florets is set. Salinity stress during this phase affects tiller survival and reduces the no. of functional floats /spikelets. This phase ends with anthesis. During the final phase carpet fertilization and grain filling occur during the final phase. At this time, salinity affects seed number and seed size.

   The effect of salinity on spikelet and tiller number established during phase I has a greater influence on final seed yield than the effects exerted on yield components in the latter two phases.

2. Salt tolerance of vegetable crops: Vegetable crops tend to fall into more sensitive salt – tolerant categories. The only notable exceptions are asparagus and red beet under marginal conditions of salinity, the growth of many vegetables is stunted without showing visible injury symptoms. At high salinity levels, some vegetables exhibit pronounced injury symptoms in the later stages of growth. Bean leaves develop a marginal chlorosis-necrosis with an upward cupping of the leaves. Onions have also been shown to develop a leaf necrosis. In addition to growth suppression, some vegetable crops exhibit symptoms of nutritional imbalance of deficiency. Some lettuce cultivars develop calcium – deficiency symptoms when SO_4

level in the soils is too high. Excess calcium may restrict the uptake of potassium which may be a factor in reduced yield of bean and carrot. Vegetable crops produced on saline soil are not of prime market quality. For e.g. smaller fruit size of tomato and pepper sand reduced petiole length of early misshapen potatoes. But in carrots and asparagus, the flavor is enhanced by a measurable increase in sugar content. When grows under saline conditions. Similarly in tomatoes total soluble solids is significantly increased as salt stress is increased.

3. Salt tolerance of fruit trees and vine crops: Most fruit trees are relatively sensitive to salinity. Stone fruits, citrus and avocado have all shown specific sensitivity to foliar accumulations of Cl- and Na-. The accumulation of these ions to harmful levels contributes to the reduction in tree growth and fruit yield. Chloride toxicity in woody plants is more severe and is observed on a wide range of species than Na+ toxicity. The initial symptoms of excess chloride accumulation are leaf tip necrosis developing into marginal necrosis. With citrus, a chlorosis and bronzing of the leaves occur without a well defined necrosis. As Cl^- continues to accumulate, the effects become more severe with premature leaf drop, complete defoliation, twig dieback in extreme cases death of the vine.

   Injury by Na+ can occur of concentration as low as 5 mol m-3 in the soil solution. The injury symptoms are characterized as tip, marginal or interveinal chlorosis. Initially, Na^+ is thought to be retained in sap wood of the ---. With the conversion of sap wood to heartwood, Na+ is released and then translocated to the leaves causing leaf burn. This may explain why stone fruits and grapes appear to be more sensitive to salinity as the plants grow older. With succeeding years, the Cl^- and H^+ accumulate were rapidly in the leaves, causing leaf burn to develop earlier and with severity.

4. Salt tolerance of ornamentals, trees and flowers: A limited number of floricultural plants have been tested for salt tolerance. Chrysanthemum, carnation and stock are considered moderately tolerant to salt stress. Aster, poinsettia, gladiolus, gerbera, amaryllis, and African violet are considered somewhat sensitive. In woody ornamentals and trees, the type of injury is similar to damage recorded for fruits trees and vines.

Conclusion

Soil salinity is becoming a major constraint to crop production. Crop production demands a high input of fertilizers and water, possibly increasing salinity of soil. Fertilization and irrigation management strategies must consider the effects of salinity on crop growth, crop salt tolerance, soil proprieties, and effects on water use efficiency and soil salinity. Drip irrigation and subsurface drip irrigation, compared with other irrigation systems, increase water use efficiency and creates suitable root-zone salinity. Fertigation increases nutrient use efficiency and allows fertilizer application without provoking excessive increases in soil salinity. Salt tolerance of vegetable crops can be enhanced by applying some nutrients (e.g., silicon, humic acid, etc.). Biofertilizers also have the potential to increase salt tolerance of crops and reduce soil salinization.

References

Abrol, I. P., Yadav, J. S. P., & Massoud, F. I. (1988). Salt-affected soils and their management (No. 39). Food & Agriculture Org.

Horneck, D. A., Ellsworth, J. W., Hopkins, B. G., Sullivan, D. M., & Stevens, R. G. (2007). Managing salt-affected soils for crop production.

Szabolcs, I., & Fink, J. (1974). Salt affected soils in Europe (p. 63). The Hague: Martinus Nijhoff.

Gupta, R. K., & Abrol, I. P. (1990). Salt-affected soils: their reclamation and management for crop production. In Advances in soil science (pp. 223-288). Springer, New York, NY.

Hossain, M. S. (2019). Present scenario of global salt affected soils, its management and importance of salinity research. Int. Res. J. Biol. Sci, 1, 1-3.

13. AGRICULTURE

Biofortification of Maize

[1] Dr Nagalakshmi RM*, [2]Dr R Sangeetha Vishnu Prabha[3].Dr K Shamini

[1]Sethu Baskara College of Agriculture and research foundation, Karaikudi, TamilNadu
[2]Pushkaram College of Agriculture, Pudukottai, TamilNadu
[3]TamilNadu Agricultural university Coimbatore TamilNadu

Introduction

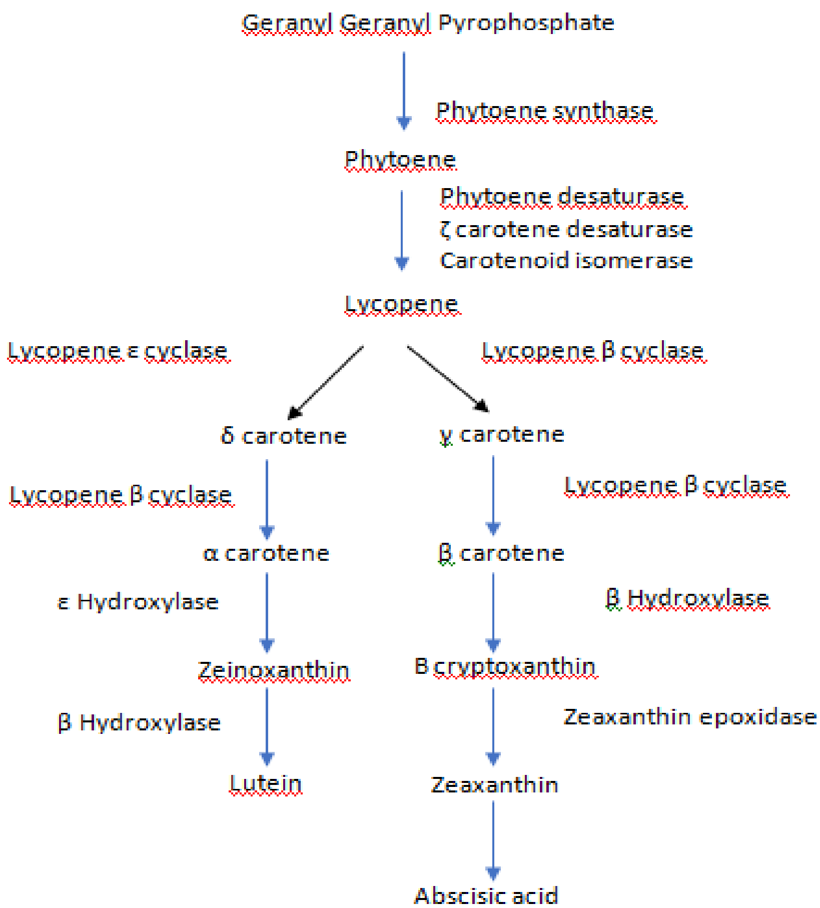
Maize is one of important staple food crop especially for the resource poor population of the world. Maize along with wheat and rice meet out 30% of calorie requirement of the world. (Nuss & Tanumihardjo, 2011). It is an important animal feed all over the world (Tanumihardjo et al., 2019). Maize is a rich source of carbohydrate and low in most of the other essential nutrients. Attempts are being made to increase the concentration of the essential amino acids lysine and tryptophan along with the vitamin A.

QPM

Breeding for increased lysine and tryptophan started with the identification opaque 2 mutant line of maize. The *O2* mutation in maize was first reported by Jones and Singleton in 1920. This specific mutation doubles the lysine content in maize endosperm. Zeins are the most common protein of maize which is poor in lysine and tryptophan. *o2* allele in homozygous recessive condition brings the zein fraction down and increases non zein proteins and thus in turn increases the fraction of lysine and tryptophan in the kernels (Lou et al., 2005). Apart from the nutritional superiority, *o2* allele is associated with many undesirable characters including soft endosperm, increased susceptibility to pest and disease and reduced yield. Soft endosperm is a major problem and makes the kernel opaque and susceptible to pest and disease. Another set of genes called modifier genes have a marked influence on the endosperm strength. The undesirable effect of *o2* allele can be brought down by these modifier genes. Maize lines with o2 allele and modifier genes exhibiting increased lysine and tryptophan and kernel qualities are developed and are quality protein maize (QPM). Lysine and tryptophan content is also influenced by another set of genes called "amino acid modifiers", the role of which is not clearly understood. Marker assisted introgression of *o2* allele led to the development of QPM varieties. Apart from *o2* mutants, many other mutants like *floury2, floury3, opaque6, opaque7, opaque11, opaque16* and *mucronate* also exhibit higher lysine content. Introgression of o2 gene requires specific molecular markers which were identified by ICRISAT i.e., phi 057, phi 112 and UMC 1066. All these markers are genespecific SSR markers located in the short arm of the 7^{th} chromosome. Breeding for QPM lines involves the introgression of o2 allele along with the action of modifier genes. After the identification of molecular markers, marker assisted backcross breeding strategy is used to develop QPM lines. Agronomically superior high yielding lines are selected as recurrent parents and o2 allele is transferred from the mutants (Hossain et al., 2019). QPM varieties and hybrids are released for commercial cultivation in India. Maize lacks an important nutrient, beta carotene. Like QPM varieties, maize varieties rich in beta carotene were also developed.

Beta Carotene

Beta carotene is an important micronutrient deficiency of which leads to blindness, skin diseases and heart diseases particularly among children (WHO,2009). Increasing the beta carotene concentration in a staple food like maize will eradicate hidden hunger among the resource poor population of the world. The beta carotene pathway of maize is influenced by three enzymes encoded by the genes *Psy1, LcyE* and *crtRB1*.



Of these three *crtRB1* has major influence on the beta carotene biosynthesis (Harjes et al., 2009). While breeding for beta carotene biofortified maize lines *crtRB1* is used for selection. Maize has two carotenes (alpha and beta) and three xanthophylls (leutin, zeaxanthin and beta cryptoxanthin). Lutein is the major carotenoid of maize followed by zeaxanthin, β-carotene, β-cryptoxanthin, and α-carotene. Of these carotenoids α-carotene, β-carotene and β-cryptoxanthin are provitamin A carotenoids. Increasing the concentration of β-carotene at the cost of other carotenoids results in vitamin A enhanced maize lines. High beta carotene donor lines were developed by CIMMYT and are used for biofortification breeding programmes. Superior varieties and inbreds are used as recurrent parents and favourable allele of crtRB1 was transferred and biofortified maize lines for beta carotene were developed.

Conclusion

When the staple food crops are biofortified, a regular dietery intake will eradicate malnutrition and hidden hunger. Biofortification is cost effective and long lasting compared to other means to control malnutrition like nutrient supplementing. Furthur research and development of new biofortified varieties is expected in near future.

References

Harjes CE, Rocheford TR, Bai L, Brutnell TP, Kandianis CB, et al. (2008) Natural genetic variation in lycopene epsilon cyclase tapped for maize biofortification. Science 319: 330–333.

Hossain, F., Sarika, K., Muthusamy, V., Zunjare, R. U., & Gupta, H. S. (2019). Quality protein maize for nutritional security. In A. M. I. Qureshi, Z. A. Dar, & S. H. Wani (Eds.), Quality breeding in field crops (pp. 217–237). Springer.

Lou, X., Zhu, J., Zhang, Q., Zang, R., Chen, Y., Yu, Z., & Zhao, Y. (2005). Genetic control of the opaque-2 gene and background polygenes over some kernel traits in maize (Zea mays L.). Genetica, 124, 291– 300.

Nuss, E. T., & Tanumihardjo, S. A. (2011). Quality protein maize for Africa: Closing the protein inadequacy gap in vulnerable populations. Advances in Nutrition, 2, 217–224.

Tanumihardjo, S., McCulley, L., Roh, R., Lopez-Ridaura, S., Palacios-Rojas, N., & Gunaratna, N. (2019). Maize agro-food systems to ensure food and nutrition security in reference to the Sustainable Development Goals. Global Food Security, 25, 100327.

WHO (2009) Global prevalence of vitamin A deficiency in populations at risk 1995–2005. Available: http:// www.who.int/ nutrition/ publications/micronutrients/vitamin_a_deficiency.

14. 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.

- **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.
- **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.
- **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.
- **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.
- **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.
- **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.
- **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.

- **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

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

15. AGRONOMY-WEED SCIENCE

Biological Weed Management - Eco Friendly Way for

ISSN No.:2321-7405

Weed Management

S.P. Sangeetha[2] and S.V. Varshini[1]

[1]*Assistant Professor (Agronomy) &* [2]*Senior Research Fellow, Department of agronomy, Tamil Nadu Agricultural University, Coimbatore.*

Weeds are undesirable plant plays a significant role in different agro-eco-systems which cause direct and indirect losses. Weeds not only cause yield reduction (37 per cent) but also increase cost of cultivation, reduce input use efficiency and loss of potentially productive lands. Generally farmers follow several practices for control of weeds in different crops and cropping systems. In which herbicide application mostly practiced one due to labour shortage. But herbicide applications create soil and water pollution and also develop weed resistance and tolerance due to continuous application of same herbicide year after year. It also creates heavy financial burden to the framers. To overcome these problems, biological control appears pollution free and economic option for weeds control. Biological control of weeds is the deliberate use of natural enemies to reduce the weed population to a tolerable level. Insects, mites, plant pathogens, nematodes, fish, birds, animals, and their toxic products are major weed controlling biotic agents. Among these, insects are one of the important and widely used biological agents.

List of weed species controlled by insects

Weed species	Insects
Salvinia molesta	Cyrtobagous salviniae, Paulinia acuminata
Alternanthera philoxeroides	Agasicles hygrophila
Opuntia spp	Dactylopius ceylonicus, D. opuntiae, D. tomentosus, D. indicus
Lantana camara	Ophiomyia lantanae, Crocidosema lantana
Parthenium hysterophorus	Zygogramma bicolorata
Cyperus rotundus	Bactra verutana, Athesapaeuta cyperi
Orabanche spp.	Phytomyza orobanche

List of microorganisms used in bio herbicides and their target weeds and ecosystems

Microorganism	Target weed Crops	Crops	Commercial product
Colletotrichum gleosporioides	Aeschynomene viriginica	Rice, soybean	Collego
Phytopthora palmivora	Morrenia odorata	Citrus groves	De Vine
Alternaria destruens	Dodders	Cranberry	Smolder
Biopolaris sorghicola	Sorghum halepense		

Bahadur *et al.* (2015)

Factors to be considered in selecting agents

- Agent must target a particular plant species
- It must have high level of predation and parasitism on the host plant and its entire population, must be prolific.
- It must be able to thrive in all habitats and climates where the weed exists and should be able to spread easily and widely
- It should be a strong colonizer
- The overall cost of introducing the agent must be cheaper compared to other control methods
- The technology that will be involved in introducing and managing the agent must be as simple
- It should maintain natural biodiversity.

Advantages

- Biological control can be cost effective in the long term.
- A high degree of specificity of target weed

- No effect on non-target and beneficial plants or man
- Absence of residue build-up in the environment
- Effectiveness for managing herbicide- resistant (HR) weeds populations.

Disadvantages

- Weed must be highly specialized
- Developing suitable and successful system involves huge money.
- It is a slow very process. It takes larger time to develop and work on weed populations.
- Requires government support.

Conclusion

Biological weed management is gaining popularity in the recent times due to its eco friendly nature. Overuse of herbicides affects the crop and soil environments in negative way. This may be reduced by adopting biological weed control methods.

References

Bahadur, S., Verma, S. K., Prasad, S. K., Madane, A. J., Maurya, S. P., Gaurav, V. V., & Sihag, S. K. (2015). Eco-friendly weed management for sustainable crop production-A review. *J Crop Weed*, *11*(1), 181-189.

*****

*****

16. SOIL SCIENCE

Importance of Soil Organic Matter for Sustainable Agriculture

Manimaran G[1] Sivakumar K[2] Gokila B[3] and Ramaswamy V[4]

[1&4] PG Scholar, Department of Soil Science and Agricultural Chemistry, AC& RI, Tamil Nadu Agricultural University- Coimbatore [2]Assistant Professor, Department of Soil Science and Agricultural Chemistry, AC& RI, Tamil Nadu Agricultural University- Coimbatore [3]Research Associate, Department of Soil Science and Agricultural Chemistry, AC& RI, Tamil Nadu Agricultural University- Coimbatore

"Whatever is affixed to the soil belongs to the soil"

Introduction

Soil organic matter (SOM) consist of a complex system of substances, ranging from components of organic residues undergoing decomposition, metabolic products of microbes, products of secondary synthesis and Humic substances. It aids as a soil conditioner, nutrient source, substrate for microbial activity, preserver of the environment and major determinant for sustaining agricultural productivity. Agricultural sustainability is described as a system's capacity to maintain consistent levels of production and quality through time without affecting its economic viability or the natural world SOM has a great importance in soil formation besides, creating physical and physio-chemical conditions optimum for crop growth.

Influence of organic matter:

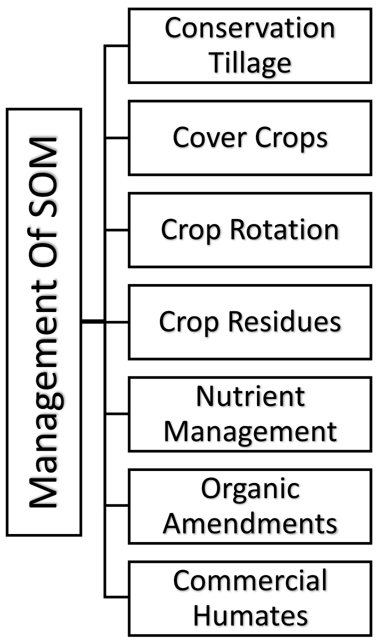
- Humic substances impart dark brown colour to the soil which facilitate warming and helps in better plant growth and yield.
- The physical conditions of the soil like soil structure, porosity, water holding capacity will have improved.
- SOM play as a pool for plant nutrients and prevent leaching which is caused due to large cation exchange capacity [> 300 cmol (p^+) kg^{-1}]
- Formation of clay humus complexes through the interaction of humic substances and clays increase buffering capacity and exchange capacity of the soil
- It will form stable complexes with metals and thereby increase availability to plants and it act as a nutrient source such as N, P, S and micronutrients which

ISSN No.:2321-7405

is important for its metabolism and growth.

- Biodegradation of chemicals (fertilizers, pesticides, fungicides and herbicides) through interaction with organic matter is a vital phenomenon for our ecosystem

Management of SOM for sustainable agriculture:



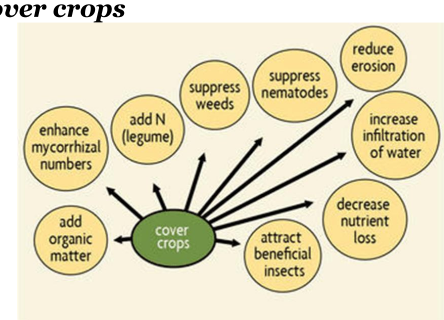
Restoration of soil health through management of soil organic matter (soil organic carbon) is major concern in India because of having diverse agro ecological regions. Variants are due to the effect of climate, landscape, soil type, texture etc., the magnitude of organic and inorganic carbon content has been found to be 9.55 Pg and 4.14 Pg, respectively. The reason may be because of excessive tillage, burning of crop residue, variations in climatic conditions (temperature and rainfall) etc.,

Proper management of soil organic matter is the pivot to sustainable agriculture, which can be attained through scientific agricultural management practices like conservational tillage, crop rotation, land use planning, recycling of crop residues etc.

Conservation Tillage:

Conservation tillage involves reducing the intensity and frequency of ploughing and having crop residues on the soil surface, as mulch. This is an important strategy for enhancing soil organic carbon content. This system contributes less to atmospheric CO_2 than conservational tillage. SOM accumulates more under zero tillage which sustains soil health.

Cover crops



Use of cover crops such as clover and small grains, improve the soil organic carbon content. Rotation of legumes, grasses with food crops is an important strategy to enhance soil organic carbon. These cover crop act as mulch and help in maintaining optimum temperature and moisture in soil and improves soil organic matter content by creating ideal conditions for microbial activity.

Crop Rotation

Crop rotation provides an opportunity to produce more biomass carbon than that is under mono- cropping. Inclusion of green manure crops in rotation, improves the soil organic matter status and microbial carbon. Growing legumes in rotation helps in increasing the productivity, and maintaining ideal C: N ratio and soil organic matter levels.

Crop Residues

Management of crop residues is of importance in improving soil organic matter levels. Crops and cropping system also play an important role in maintaining soil organic carbon stocks because both quantity and quality of crop residues are returned to the soils over a period of time

Nutrient Management

It is impossible to maintain soil organic carbon content in the soil through integrated use of FYM, green manures and other organics with inorganic fertilizers on long term basis. Studies have revealed that the fertility management practices can increase the SOC @ 50 – 150 Kg ha^{-1} yr^{-1}.

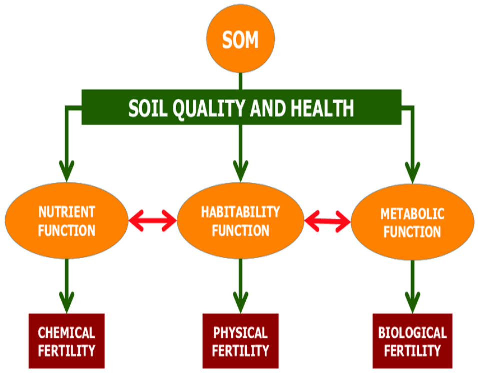
Organic Amendments

Organic amendments such as manure, compost and crop residues are recommended to improve the soil organic carbon status. However, under tropical, subtropical, arid and semi-arid climatic conditions of the country, the organic carbon content is not high due to high temperature. Farm yard manures rich sources of essential elements as well as trace elements.

Commercial Humates:

Keeping in view of the significance of organic matter and humic substances in soil, commercial humates, derived from lignites are being marketed for agricultural purpose in the name of mined lignite. The impact of ammonium humate fertilizers can be seen in normal productive soils rather than in the problem soils. However, because of the high manufacturing cost these commercial products are relatively expensive

Importance of organic matter



Organic manure has a number of advantages with regard to soil quality and health, and it is the most significant and fundamental input in crop production. The organic matter condition of soil has been declining day by day as a result of intensive agriculture. As a result, using organic manure instead of artificial chemical fertiliser to boost soil fertility is a standard practise, and this notion began with crop cultivation. Organic manures were the only source of nutrition required by agricultural plants until the mid-nineteenth century. Organic manure improves soil quality through changing soil physical properties, increasing biological activity (microbe activity), and aiding in the breakdown of organic materials, among other things. Organic manure aids plant uptake of nutrients from the soil, increases nutrient availability in the soil, lowers soil pollution, minimises soil erosion and degradation, improves nutritional security, and alleviates a variety of crop-related issues.

Conclusion

SOM has a significant impact on soil quality and plant health. SOM aids in the provision of nutrients, absorption and retention of moisture in the soil, prevention of soil erosion, and makes the soil simpler to manage and maintain the fertility. SOM management is part of a proactive strategy to crop production that aims to maximise the soil's beneficial chemical, physical, and biological properties. Individual technique for improved SOM management have a variety of consequences on soils and crops, and they contribute to SOM dynamics by achieving one or more of the following goals:

- Increasing the quantity of organic carbon that is introduced to the system
- Adding a greater variety of organic ingredients
- Slowing down the loss of biological matter

The addition of mulch materials, the application of green manures and cover crops, Commercial Humates, Nutrient Management practices and the addition of compost are all powerful combinations of practices to improve the soil and agroecosystem health.

"If you build up the soil with organic material, the plants will do just fine"

Reference

Magdoff F, Weil RR. Soil organic matter management strategies. Soil organic matter in sustainable agriculture. 2004 May 27:45-65.

Jangir, Chetan Kumar, Sandeep Kumar, and Ram Swaroop Meena. "Significance of soil organic matter to soil quality and evaluation of sustainability." Sustainable agriculture. Scientific Publisher, Jodhpur (2019): 357-381.

ISSN No.:2321-7405

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, Jodhpur Phone: 94141 28105 E.Mail: m_vyas@outlook.com Website: 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

February, 2022

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 Agricultural Biochemistry	Purohit, S.S.		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	Tupaki Lokya		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 Scien ce and Technology	Vinothini, Tamilarasan, Nagendra and Bhvyasree		225.00

The rates are subject to change