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From the Director General's Desk

Dr. N. Sathyanarayana, Director General - NIPHM

Excessive reliance on chemical fertilizer is causing widespread ecological imbalances and directly affecting the soil health necessitating the need for promoting sustainable agricultural practices. NIPHM is promoting the adoption of bio-intensive approach for plant health management employing bio-fertilizers and bio-pesticides. The soil microbiota enhances and mediates fluxes of nutrients from the inert soil matrix to the plant. The plants provides the energy to the biotic soil component whose activities, in turn, are crucial for the formation of physical structures and chemical balances within the soil matrix that permit and encourage the growth of roots. Among the multitude of soil organisms one type stands out because of its ability to form a bridge between plant and soil is Arbuscular Mycorrhizal fungi (AM fungi). AM is a symbiotic association between a fungus and the roots of a plant and creates mycorrhizal networks through underground hyphal networks in soil by connecting individual plants together and transfer water, phosphorous, nitrogen and other minerals and nutrients benefitting the plant host. The Genus Glomus which belongs to Glomeromycetes fungi is a largest and diverse arbuscular mycorrhizal fungi (AMF) and all species form symbiotic relationships (mycorrhizas) with plant roots. Glomus species such as *Glomus intraradices, G. faciculatum* are found in nearly all terrestrial habitats, including arable land, deserts, grasslands, tropical forests. Several positive effects on plants such as higher growth rate increased uptake of carbon, nitrogen, Zinc, Cu, and other essential nutrients by plants have been reported due to mycorrhizal networks. AM associated plants also exhibit improved resistance to both biotic and abiotic stress. The use of mycorrhizal biofertilizer also helps to improve higher branching of plant roots, and the mycorrhizal hyphae grow from the root to soil enabling the plant roots to contact with wider area of soil surface. The symbiosis has a sustainable net benefit to both partners. These benefit can be physiological, nutritional, ecological or any combination of these processes. Commercially important benefits that can be derived from the use of AM fungi are increase in plant growth and yield, improved crop uniformity, reduction in phosphorus and trace metal fertilizers requirements, reduced crop losses due to biotic and abiotic stresses. All these benefits translate into increased profits for farmer.

There have been marked advances in this field during the last few decades. Scientific research in this field involves multidisciplinary approaches to understand adaptation of mycorrhizae to the rhizosphere, mechanism of root colonization, effect on plant physiology and plant growth, biofertilization, plant resistance, biocontrol of plant pathogens.

NIPHM is promoting sustainable agriculture practices through various capacity building programmes. NIPHM has also developed a new training programme on Rhizosphere Engineering and management for sustainable agriculture under which use of mycorrhiza and other soil bio-inoculants such as Rhizobacteria that promote plant growth are covered to improve the soil fertility in sustainable manner. Rhizosphere engineering may ultimately reduce the reliance on agrochemicals by replacing their functions with beneficial microbes. NIPHM is also promoting on-farm production of mycorrhiza with a low cost technology for soil health improvement through its master training programmes as well as in three days farmers training programme.

I hope that extension functionaries of central and state Governments, Scientists of ICAR, SAUs and farmers will take advantage of Rhizosphere engineering programme to equip themselves with skills to popularize the simple and low cost mass production techniques of mycorrhiza.

(N Sathyanarayana)
Director General

Theme Article

Rhizosphere Engineering for Plant Health Management: Strategy for Sustainable Agriculture.

S. K. Sain and O.P. Sharma

During the past four decades, we have witnessed doubling of human population and a concurrent doubling of food production. Improved grain production to meet the food demand of an increasing population has been highly dependent on chemical fertilizer & pesticide inputs based on the assumed notion of 'high input, high output'. This resulted in over use of chemical fertilizers but ignored the biological potential of rhizosphere for efficient mobilization and acquisition of soil nutrients as well as reducing the plant health problems. However, the status of agriculture today is more complex than earliar due to the increased demand for food production while protecting environment and conserving natural resources in the coming decades. Thus, achieving high nutrient use efficiency and high crop productivity with minimum insect-pest damage has become a challenge with increased demand for food, depletion of natural resources, and deterioration of environmental conditions 'Using less produce more' is becoming a promising characteristic for sustainable agriculture.

Plant life on earth is sustained by a small volume of soil surrounding roots, called the rhizosphere. Rhizosphere probably represents one of the most dynamic habitat on earth with rich biodiversity and certainly is the most important zone impacting the quality and quantity of the terrestrial food resources. Rhizosphere management strategies lay emphasis on maximizing the efficiency of root and rhizosphere processes in nutrient mobilization, acquisition, and use by crops rather than depending solely on excessive application of chemical fertilizers in intensive farming systems. Rhizosphere can be defined as the zone of soil around roots that is influenced by plant roots, associated micro biota and soil constituents. The below ground activity of plants (like rhizosphere effects) and its exploration are important factors regulating intra- and inter-specific competition. Below ground and rhizosphere research is being conducted for several decades, rhizosphere processes and management remains untapped in intensive cropping systems. The developing root-soil interface creates dynamic micro environment where microorganisms, roots and soil components interact. This complex interaction provides multiple beneficial plant life & health in turn the yield levels.

Soil fertility as a limiting factor for plant health:

Soil fertility is the most important limiting factor for crop production in most parts of India. Many of the farmers are not getting regular soil testing reports done for soil health management. Poor soil structure and soil texture results in low water holding capacity where nutrient contents and nutrient retention are low, thus causing a low inherent fertility status for agricultural production.

Imbalance crop fertigation can affect susceptibility of plants to insect pests by altering plant tissue nutrient levels. Research shows that the ability of a crop plant to resist or tolerate insect pests and diseases is tied to optimal physical, chemical and mainly biological properties of soils. Soils with high organic matter and active soil biology generally exhibit good soil fertility. Crops grown in such soils generally exhibit lower abundance of several insect herbivores, that may be attributed to lower nitrogen content in organic farming crops. On the other hand, farming practices, such as excessive use of inorganic fertilizers, can cause nutrient imbalances and lower pest resistance. In order to meet the nutrient requirement of agriculture in India, there is a need of 64.5 million tonnes (mt) of $N + P_2O_5 + K_2O$ in 2014-15 which is going to be 74.7 million tonnes during 2017-18. This will not only put pressure on sustainable agriculture but also increase the cost of cultivation and insect-pest pressure.

Soil fertility:

For sustainable agriculture all available nutrient sources like farm yard manure, compost, vermicompost, green manuring, biofetilizers including mycorrhiza, etc. have to be made use in an integrated manner. In addition, integrated use of mineral, organics and recyclable wastes are accepted as the most appropriate strategy for sustaining higher crop yields, minimizing soil fertility depletion and value-added disposal of what are traditionally labelled as “wastes”. Dependence on chemical fertilizers for future agricultural growth would mean further loss in soil quality, possibilities of water contamination and unsustainable burden on the fiscal system. The Government of India has been trying to promote an improved practice involving use of biofertilizers along with fertilizers. These inputs have multiple beneficial impacts on the soil and can be relatively cheap and convenient for use.

Rhizosphere engineering & plant health management

The rhizosphere is known to be a hot spot of microbial activities with a high microbial diversity. The efficiency of rhizosphere processes is highly dependent on inherent soil fertility and the status of soil nutrient supply, which is controlled by the input of external nutrients. It is well known that root growth and expansion can be greatly constrained when the available soil nutrient supply is extremely low. The efficiency of root and rhizosphere processes can be enhanced with increasing intensity of soil nutrient supply. Experiments have shown that rhizosphere management is an effective approach to increase both nutrient use efficiency and crop productivity for sustainable crop production. In cropping systems, the rhizospheres can overlay each other and form a huge continuum with development of root systems in the whole root zone, where root/rhizosphere interactions occur among plants, soils, microorganisms and even between different plant species in intercropping systems. Hence, manipulation or engineering the rhizosphere can play an important role in soil borne diseases, nutrient and pest management.

Role of Rhizosphere engineering for soil borne disease management:

There are several soil borne pathogens which cause serious diseases in crop plant like the genus *Phytophthora, Rhizoctonia, Botrytis, Alternaria, Verticillium, Colletotrichum, Fusarium, Sclerotium, Pythium, Scalerotinia, Macrophomina* etc. There are different options for managing these soil borne pathogens. With proper amount and appropriate use of fertilizers (N, P_2O_5, K_2O) these pathogens can be managed upto certain extent. However, by rhizosphere engineering these pathogens can be managed effectively. Moreover, non chemical methods like application of organic manures, biofertilizers, biopesticides (biocontrol agents & plant growth promoting rhizobacteria), green manuring, crop rotation, etc are also helpful in reducing the soil borne diseases that may be attributed to a lower nitrogen content in organically farmed crops and the beneficial microbial population because optimum level of organic carbon. On the other hand, farming practices, such as excessive use of inorganic fertilizers, can cause nutrient imbalances and lower pest resistance.

The efficiency of rhizosphere in terms of improved nutrient availability can be fully exploited by: (1) manipulating root growth i.e. root development and size, root system architecture, and distribution); (2) regulating rhizosphere processes i.e. rhizosphere acidification, organic anion and acid phosphatase exudation, localized application of nutrients, rhizosphere interactions, and use of efficient crop genotypes); and (3) optimizing root zone management to synchronize root growth and soil nutrient supply with demand of nutrients in cropping systems.

Non chemical methods: Non chemical cultural practices like crop rotations, companion planting, tillage which increases soil aeration for the benefit of microbial in soil and ultimately reduces the pathogen inoculum and thus reduces the diseases. Moreover, in situ ploughing of crop residues to provide biomass for growth of microorganisms, green manuring, incorporation of organic carbon (composting & vermicompost) enhances the soil health by increasing the beneficial microbial population in the soil by providing the source of energy and results in reduction in soil borne diseases.

Biological methods: In a healthy rhizosphere the population of beneficial microbes will be generally at higher level. These beneficial microbial biopesticides act through rhizosphere competition, antibiosis, mycoparasitism against soil borne and foliar phytopathogenic fungi, bacteria, nematodes and sometimes their efficacy on soil borne fungal disease is higher than fungicides. Additionally, application of biopesticides like *Trichoderma, Pseudomonas, Bacillus* etc. in the soils rich in organic carbon certainly have the better results compared to the organic carbon deficit soils. Moreover, the multiplication of plant growth promoting rhizobacteria (PGPR) in carbon rich soil can further help improve better crop health and subsequently reduces the disease either through competition, antibiosis, induces resistance or through all the mechanisms. The application of biofertilizers like *Rhizobium*, Mycorrhiza, *Azotobacter Azospirillum etc.* alone or in combination with biopesticides also improves plant growth and reduces the diseases. There have been several reports that combined soil application of these biofertilizers with biopesticides provides better results in term of soil borne plant disease management. There are several groups of beneficial rhizosphere microorganisms such as nodule forming rhizobacteria, PGPR, beneficial fungus like *Trichoderma*, mycorrhiza, etc. which often act synergistically in combination. Their effects are mediated through a variety of mechanisms like interaction with phytopathogens, production of compounds like vitamins or plant hormones that directly stimulate plant growth.

The beneficial rhizosphere organisms are generally classified into two broad groups based on their primary effects, i.e., (i) microorganisms with direct effects on plant growth promotion [plant growth promoting microorganisms (PGPM)] and (ii) biological control agents (BCA) that indirectly assist with plant productivity through the control of plant pathogens.

(i) Plant growth promoting microorganisms (PGPM)

Among plant growth promoting rhizobacteria (PGPR), *Pseudomonas fluorescence,* nitrogen fixing bacteria like *Rhozibium, Azotobactor, Azospirillum* etc. are found in almost all the soil conditions associated with roots, soil and plant debris or organic matter. It acts through rhizosphere competition, antibiosis and induces resistance to protect crops against several soil borne and foliar plant pathogenic fungi, bacteria. The rhizobacteria also stimulate plant growth, enhance germination, plant survival, growth of roots & shoots, induced resistance and postharvest shelf life. *Pseudomonas* spp. are well recognized as Phosphorous Solubilizing Bacteria (PSB) which also enhance the availability of mineral phosphorous to plants. To ensure that quality biopesticides are available to the farmers, NIPHM is popularizing an easy, low cost and simple on farm production technology for mass production of biopesticides which could be easily adopted by farmers.

The details of low cost *Pseudomonas* production technique is given in NIPHM newsletter *"Plant Health" Vol.4 (3) p 5-6* : September, 2014.

(ii) Biocontrol agents:

Among these, *Trichoderma* species are known to occur in all agroecosystems, commonly associated with root, soil and soil organic matter. *Trichoderma* is well recognized as biological agent to control several soil borne and foliar plant pathogens act through rhizosphere competition, antibiosis, mycoparasitism agents against plant pathogenic fungi, bacteria, nematodes, enhance germination, enhance nutrient uptake, stimulate plant growth, and induces resistance to biotic and abiotic stress in treated plants. *Trichoderma* species can be multiplied at farm level by farmers with the simple and low cost technique as detailed in the NIPHM Newsletter *"Plant Health" Vol.4 (2) p 3-4*, June, 2014

In rhizosphere engineering the soil health plays a paramount role in plant health. In most soils minerals represent around 45% of the total volume, water and air about 25% each, and organic matter from 0.1% to 5%. There are many different types of creatures that live on or in the soil. Each has a role to play. These organisms will work for the farmer's benefit if we simply manage for their survival. Consequently we may refer to them as soil livestock. While there is a great variety of organisms that contribute to soil fertility, earthworms, arthropods, and the various microorganisms merit particular attention. Incorporating organic carbon enhances the activities of macro & microorganisms in the soil.

Role of Rhizosphere engineering for nutrient management

Farmers influence the rhizosphere of their crops every time they plough or irrigate the field or apply fertilizers, use crop rotation, mulching green manuring, composting. These operations can alter the chemical properties of rhizosphere and influence the growth and composition of microbial communities. More prolonged changes in the rhizosphere that persist throughout the growth cycle can be generated with plant breeding and biotechnology. Selecting plants with favourable rhizosphere characteristics and introgression of these traits into elite breeding lines can lead to more permanent changes. This approach relies on being able to identify characters that are useful, heritable and easily detected; all of which are difficult when dealing with belowground traits.

The rhizosphere can be manipulated or engineered with agronomic practices, plant selection, and soil inoculation or with biotechnology. Common practices such as soil tillage, fertilizer application or even irrigation can alter the chemistry of the plant-soil interface by changing aeration, root function or microbial communities. Plants with favorable root traits that improve performance can be selected by breeders. These traits could include exudates that increase nutrient accessibility, minimize stress or that encourage the persistence of beneficial micro-organisms.

Soil microorganisms are paramount in the biogeochemical cycling of both inorganic and organic nutrients in the soil and in the maintenance of soil quality. Soil–plant–microbe interactions are complex and there are many ways in which the outcomes can influence plant health. Since the soil seems inert and dead material but it is quite alive as it consists of a variety of soil organisms in a large number realizing the concept of living soil. Earthworms thrive where there is no-tillage–generally, the less tillage, the better earthworm survival. Worm numbers can be reduced by as much as 90% by deep and frequent tillage. Moreover, the cultural activities like irrigation, application of organic fertilizers, use of crop rotation, mulching, green manuring, composting, companion planting etc. have the potential to make soil environment favourable for replenishing these beneficial microorganisms. Thus, the below mentioned steps should be followed to enhance microbial activities and keep soil live: 1. enhance organic matter, 2. avoid excessive tillage, 3. manage pests and nutrients efficiently, 4. prevent soil compaction and water stagnation, 5. keep the ground covered with plant materials / mulches and 6. adopt diversified cropping systems.

The significance of rhizosphere microorganisms, especially mycorrhizal fungi and bacteria, in polluted soils can be enormous, since they are able to increase the tolerance of plants against abiotic stress, stimulate plant growth and contribute in this way to an accelerated remediation of disturbed soils. The majority of higher plant species is known to have association with mycorrhizal fungi, which can increase the tolerance of plants against abiotic stress, e.g. by an improved nutrient supply or by detoxification of pollutants. Co-inoculation of plants with mycorrhizal fungi and rhizosphere bacteria is a very promising biotechnological approach for the promotion of plant growth and soil remediation. Rhizosphere exploration in soil nutrient resources and root-induced rhizosphere processes plays an important role in controlling nutrient transformation, efficient nutrient acquisition and use, and thus crop productivity.

Among the various soil microorganisms, Mycorrhiza play fundamental roles to benefit plant health and soil physicochemical properties. The beneficial fungus that establishes a symbiotic relationship with the roots of plants is called Mycorrhiza. More than 80 per cent plant species are dependent on the mycorrhizal association. Mycorrhizal fungi grow through the soil by means of hyphae. The extremely filamentous hypha explore every crack and cranny between soil particles to extract water, nutrients and organic matter, and provide all of this to the plant through the roots. The fungi also protect the roots from pathogens by literally creating very specific solutions/protective shield/induced resistance to ward of predators, either physically, or chemically. For this invaluable service, the plant 'pays' the fungi some of the foods it has converted from the energy of the sun. This mutualistic relationship between plant roots and mycorrhizal fungi is an essential link between plants and their soil environment. Rhizosphere bacteria can strongly promote the growth of plants solely and in interaction with mycorrhizal fungi. Regardless of the cause, i.e., drought, high salt, parasites, negative organisms, etc., mycorrhiza have evolved to protect their food source - the plant. If the plant life cycle is finished, the mycorrhiza starts production of copious amounts of spores to carry forward next generation.

Role of Rhizosphere engineering for pest management

Soils with good rhizosphere engineering practices have high organic matter and active soil biology generally exhibit good soil fertility as well as beneficial microbial population (biofertilizers, PGPR & biopesticides). Several soil health management option are known to reduce the insect-pests in different crops like crop rotation with leguminous and cereal crops to reduce soil borne insect-pest, green manuring for enhancing the soil organic carbon and further reducing the soil insect-pest problems, mulching with organic carbon and green mulches to reduce the insect pest and their spread, etc.

Seed treatment and Bio-priming

In addition to managing soil health, seed treatment and biopriming also plays an important role in seed borne and soil borne disease management at the first and soil health management at later stage. Bio-priming is a new technique of seed treatment that integrates biological (inoculation of seed with beneficial organism to protect seed) and physiological aspects (seed hydration) of disease control. It is used as an alternative method for controlling many seed- and soil borne pathogens. It is an ecological approach and has potential advantages over simple seed coating with biopesticides. Seed priming often results in more rapid and uniform seedling emergence and may be useful under adverse soil conditions. Biopriming is potentially prominent to induce profound changes in plant characteristics and to encourage more uniform seed germination and plant's growth associated with fungi and bacteria coatings. It improves tolerance to both abiotic and biotic stresses.

Entomopathogenic nematodes (EPN)

Other soil organisms which play an important role in biological control of soil borne insects are entomopathogenic nematodes. The nematodes are associated with insects that cause disease to them is referred to as entomopathogenic nematodes (EPN). Among 30 families of nematodes which are known to parasitize insects and nematodes, 7 families viz., *Mermethidae, Allantonematidae, Neotylenchidae, Sphaerularidae, Rhabditidae, Steinernematidae* and *Heterorhabditidae* possess a definite potential of causing mortality to insects. *Steinernematidae* and *Heterorhabditidae* contain most efficient EPNs and are of prime importance as far as biological control of insects is concerned. Nematodes are being applied successfully against soil inhabiting insects (as soil application) as well as above-ground insects (foliar spray) in cryptic. They possess many attributes such as wide host spectrum, active host seeking killing the host within 48 h, easy mass production, long-term efficacy, easy application, compatibility with most chemicals, and are environmentally safe. However, the pathogenicity, host searching behaviour, and survivability of different nematode species are varied making them suitable in biological control programs. The details of mass production of EPN is given in NIPHM newsletter *"Plant Health" Vol.5 (1) p 2-6* : 2015.

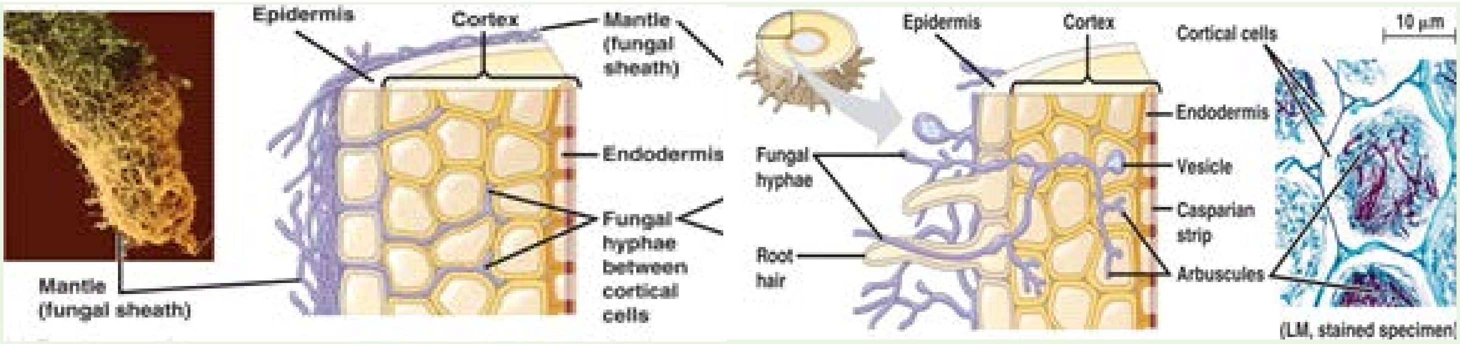
On-farm production of Mycorrhiza

Types of mycorrhiza

There are mainly two types of Mycorrhizae viz.

(a) Ectomycorrhizae: The mantle of the fungal mycelium ensheathes the root. Fungal hyphae extend from the mantle into the soil, absorbing water and minerals, especially phosphate. Hyphae also extend into the extracellular spaces of the root cortex, providing extensive surface area for nutrient exchange between the fungus and its host plant.

(b) Endomycorrhizae or Vesicular Arbuscular Mycorrhizae (VAM): No mantle forms around the root, but microscopic fungal hyphae extend into the root. Within the root cortex, the fungus makes extensive contact with the plant through branching of hyphae that form arbuscules, providing an enormous surface area for nutrient swapping. The hyphae penetrate the cell walls, but not the plasma membranes, of cells within the cortex.



Ectomycorrihiza (A) and endomycorrhiza (B)

Advantages of Mycorrhiza application

- Increased uptake of water, Phosphorous, Nitrogen, Zinc, Cu, and other essential nutrients by plants thus reduces requirement for chemical fertilizers
- Induce resistance against plant pathogens and produce growth promoting substances
- They contribute to carbon storage in soil by altering the quality and quantity of soil organic matter.
- Significant amounts of carbon transfer through fungus mycelia connecting different plant species reducing competition between plants and contribute to the stability and diversity of ecosystems.
- Mycorrhizal hyphae are conduits which help to prevent nutrient losses from the soil, especially at times when roots are inactive and contribute to soil structure.
- Mycorrhizal hyphae and fruiting bodies are important as food sources and habitats for invertebrates.
- Enhance plant yield with reduced input cost and are environment friendly - no harmful effect on users and on soil or plants.

On-farm Mycorrhizae Mass Multiplication Techniques.

The techniques of mass multiplication of symbiotic mycorrhizae are as simple that trained farmers can produce at farm level. Therefore, it should be popularized for Sustainable Agriculture. Different methods are reported to multiply the Mycorrhizae. Here, a simple method is mentioned which can be easily adopted by farmers;

Materials Required: Sterilized soil, Clay or plastic pots, Maize / sorghum /ragi / rice or any other suitable crop seeds, VAM starter inoculants.

Method: the following steps should be followed sequentially;

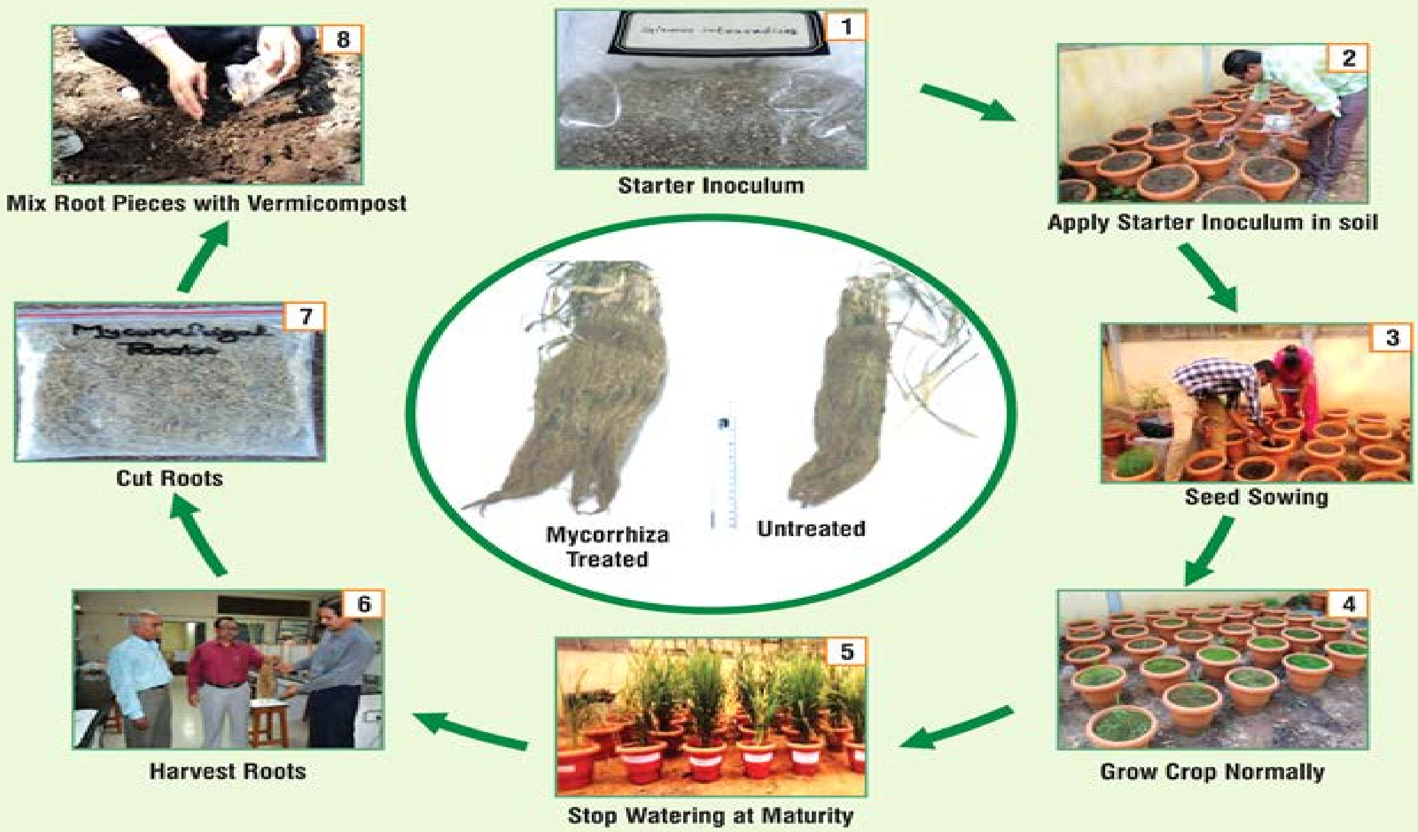
1. Take required quantity of soil from own field to fill up the pots. Sterilize soil to minimize the presence of other fungus, pathogens in soil by heating for 2-4 hours using a big metal pan or by drying under intense heat of the sun for 2-3 days.
2. After cooling, place the sterilized soil in thoroughly cleaned and dry pots or trays. For large scale production polythene bags, trough lined with plastic sheet may be used.

3. Place a pinch of root starter inoculants in the pot and then cover with a thin layer of soil.
4. Sow 3-5 seeds in each pot at such a depth that seedling roots should come in contact with inoculum.
5. Grow the plants for three months under normal conditions.
6. Protect the plants from pest and diseases using biocontrol agents or biopesticides.
7. Do not use chemical fertilizer/ fungicide in pots/ seedbed where Mycorrhizae is being applied. If necessary apply fertilizer after 15 days of sowing.
8. Stop watering the plants after 3 months and cut the upper part of plants or stalks when they are completely dried. Allow the soil in the pot to dry further.
9. Remove the roots along with adhering soil from the pots and dry in shade.

10. Cut the roots finely and save some root inoculants for future use. Mix the fine cut roots with the soil from the pot to produce VAM soil inoculants.
11. Store the root and soil inoculants in sealed plastic bags in cool dry place.

Mycorrhiza application: Application of mycorrhiza is easy and requires no special equipment. The goal is to create physical contact between the mycorrhizal inoculant and the plant root. Mycorrhizal inoculant can be sprinkled onto roots during transplanting, mixed into seed beds, blended into potting soil, "watered in" via existing irrigation systems, applied as a root dip gel or probed into the root zone of existing plants. The method of application depends upon the conditions and needs of the farmers. Farmers can use finely cut roots produced with this method by mixing it with soil or compost material and spreading in main field. Properly produced 1 to 2 kg roots will be sufficient for application in one acre area.

Application Rates: It depends on the quality of inoculum i.e. quantity of the active spores/ hyphae present in the product. Generally, a material containing 100 IP (Infective Propagules) per gram is recommended to apply @ 3 to 4 kg per acre.



On farm Mycorrhiza production method

Special Event: Income Enhancement through Establishment of Eco-friendly IPM Model Villages at Tamil Nadu

Department of Agriculture, Tamil Nadu in collaboration with NIPHM has taken an initiative by through a project on "income enhancement through establishment of eco friendly IPM model villages". Under this initiative NIPHM has organized 7 training programmes of 3 days duration and trained 276 farmers from 10 districts of TamilNadu viz. Arialur Ariyalur, Trichy, Namakkal, Dharmapuri, Dindigul, Karur, Krishnagiri, Thoothukudi, Perambalur and Vellore.

Farmers were trained in AESA in conjunction with Ecological Engineering for Pest management through on-farm production of biocontrol agents and microbial biopesticides. The programmes farmers were also provided hands-on training in on-farm mass production techniques of host insect Corcyra, parasitoids such as

Trichogramma, Chelonus, Bracon, Goniozus, Chrysoperla, Reduviid, Spiders, Coccinellids and mass production of microbial biopesticides such as *Trichoderma, Metarhizium, Verticillium, Beauveria, Nomuraea, Paecilomyces, Pseudomonas, Bacillus* and (iv) Entomopathogenic nematodes. These techniques can easily be adopted with minimal facilities at low cost at farmer's doorstep.

Special Event: Regional Plant Health System Analysis (R-PHSA) (1st to 15th June)

The R-PHSA programme aims in creation of a pool of experts to analyse Plant Health Systems to safeguard native agricultural biosecurity and to build SPS capacity to gain market access. It is designed to enable officials working with the NPPOs of South Asian and African Countries and actively engaged in the area of Plant Biosecurity. The International trade of plants and plant products has witnessed several fold increase in the post WTO era. A number of International Agreements/Treaties/Conventions have emerged in the past decade to harmonize various factors/ issues associated with International Trade. The developing countries need to understand the complexities and implications of PHS of a country and the SPS Measures. The Programme gives the opportunity to review the existing National Regulations, evaluate the gaps and to identify appropriate systems that need to be followed to enhance agriculture production, safeguard native agro-ecosystems from invasive pests and promote exports.

The course was attended by 13 International participants representing Nepal, Sri Lanka, Bangladesh, Kenya, Bhutan and Ghana. 19 participants from Andhra Pradesh, Kerala, Chhattisgarh, Rajasthan, Maharashtra, Uttar Pradesh, Gujarat and Himachal Pradesh were also participated. Experts from USDA Dr. Parul Patel, Dr. John Crowe from USDA were involved in the programme. Dr. Dave Nowell and Dr. Ana of IPPC, Rome with an implicit arrangement by NIPHM-USDA could deliver some of the training sessions through video-conference.

The Course was thematically divided into three areas *viz.* (i) Sustainable Agricultural Production, (ii) Biosecurity and (iii) Market Access and various topics related to those themes were covered with an emphasis on regional harmonization in areas like Pest Risk Analysis, Pest Surveillance and Emergency preparedness in managing the pest risks and to gain market access as well.

Off Campus PGDPHM: Efforts of Agricultural Officers in Enhancing Organic Farming in Kerala: On-farm production of Biopesticides

Mr. Georgekutty Mathew, AO. Krishibhavan Eruvessy has initiated the in-house production unit of *Trichoderma* and trained his wife and daughter. He has been successful in production of *Trichoderma* and utilized this biopesticides for his own kitchen garden vegetables, research trials and distributed to the farmers for managing the soil borne diseases of black pepper, coconut, vegetables.

Smt. Asha Raj, AO, organized the On-farm production of Trichoderma (OFPT) training at Krishibhavan Vattiyoorkvu in which 62 farmers trained. The trained Farmers Self Help Group (FSHG) produced 60 kg *Trichoderma* and utilized by mixing in 6 tonnes of enriched manure. The members of FSHG are very satisfied and enthusiastic about the activity. Dr. K Satyagopal IAS, Director General NIPHM visited On-farm *Trichoderma* production unit, Ecological Engineering demonstration filed of vegetable cowpea at Vattiyoorkavu Krishibhavan and interacted with the farmers.

Jidesh.C.V. has organized two training cum awareness programme at Azhikode, Kannur and 256 farmers participated. Out of it 20 farmers were provided intensive hands on training and 3 women farmers groups comprising 10 in each SHGs have initiated On-farm *Trichoderma* production units at Azhikode Panchayath, Kannur Dist. Kerala. These 3 units are now started functioning.

Joseph John Therattil, has organized two training programmes on on-farm production of *Trichoderma* at Krishibhavan Azhikode, Kannur, in which 65 farmers were trained. Out of which 20 members of a SHG which is registered under charitable societies act had produced 2 tons of *Trichoderma* enriched bio manure and utilized as medium for pro tray method of vegetable seedling production and for basal application. This SHG produced 80,000 vegetable seedlings and distributed among farmers.

Similarly, Muralidhara Menon at Porathissery; Sherin at Eruvessy Panchayath; Dr. Jomy Jacob, at Kadakampally, Trivandrum; Smt. Girija at Nediyiruppu, Malappuram District & Talakulathur Kozhikode Dist.; Mr. Asha Nath, at Pattambi, Palakad Dist. Smt. Betzy at Rajakumari, Idukki Dist.; Sujith PG, at Methala Kodungallur Thrissur District; Mr. Krishnakumar PG at Nagalassery Palakkad; Regy V.j at Puramattom have organized the farmers training programmes 'on-farm production of Trichoderma in their respective service areas and trained farmers and members of SHGs. The farmers and SHGS have started production of Trichoderma for their own consumption. Among a total of 873 farmers trained, about 230 farmers have started on-farm production units.

Ecological Engineering for Pest Management (EE for PM)

Ecological Engineering for Pest Management is emerging as a new paradigm in insect- pest management. NIPHM is promoting Ecological Engineering for Pest Management in conjunction with AESA based Plant Health Management through various PHM training programmes. The trained officers under the off-campus PGDPHM programme for Kerala are now making efforts in implementing the Ecological Engineering for Pest Management in conjunction with AESA at farmer's fields in Kerala. Jidesh. C.V. A.O. has organized demonstration of AESA & Ecologically Engineering for Pest Management in 1 hectare vegetable field at Chal, Azhikode Panchayath, Kannur Dist. in which 25 farmers actively participated. After educating around 250 farmers on AESA, ecological engineering for pest management, use of biopesticides, fruitfly traps etc. nearly 60 hectares of vegetable cultivation areas has been established as "Safe to eat vegetable zone".

Smt. Betzy has demonstrated EE for PM in vegetable & cardamom fields at Rajakumari, Idukki Dist, and now it is being practiced in vegetable farmers' fields covering 2 hectare area through vegetable development programme of Department of Agriculture Kerala. Demonstration is also being maintained in an area of 25 cents of Holy Queens Upper Primary School, and Primary Health Centre at Rajakumary. Teachers, PH Staff members, students, parents are actively participating in this effort.

Similarly, EE for PM was demonstrated by Smt. Girija M. at Nediyiruppu (Malappuram Dist.) in paddy field, Smt. Asha Raj, in cowpea field at Krishibhavan, Vattiyoorkvu and Mr. Joseph John Therattil in cowpea field at Anakkara Palakkad.

Awareness on organic farming through the use fo AESA and Ecological Engineering for Pest Management, and use of biocontrol agents and microbial biopesticides, fruit flyr traps etc is also being created through vrious mediaa, news papers and magazines.

Capacity Building

Quarantine Pest Detection and Identification (8th to 28th April)

This programme aims to create a pool of experts in detection and diagnosis of pests of quarantine significance. The programme is designed to update the knowledge of participants in advances in detection and diagnosis apart from developing hands on skills on various detection and diagnostic methods. 8 participants from Bangladesh and 9 from Indian States of Bihar, Assam, New Delhi and Jammu & Kashmir attended the training. A number of background topics like plant quarantine regulations, exim procedures for plants and planting material, impact of introduced pests etc. were also covered in addition to diagnostics in quarantine pests and seed health testing. Hands-on training on dry seed examination, incubation methods, serological and nucleic acid based methods was imparted.

Stored Grain Pest Management for OSCSC officials - Off-campus (15th to 18th April)

This programme was tailor made to suit training needs of management and quality control personnel of Orissa State Civil Supplies Corporation Limited, Bhubaneshwar, Orissa (OSCSC). State Civil Supplies Corporations are the important players in the Food Security programme of Government of India. These Corporations store the food grains for varying periods of time and the stocks are moved as per the requirement. OSCSC felt the need to train their personnel through NIPHM in scientific storage especially when there are reports of Khapra Beetle seriously damaging food grains in some of the areas of Orissa. A four day power packed programme was delivered in Off-campus mode at Bhubaneshwar in which 76 personnel were trained in scientific storage, importance of sanitation, detection, identification & behaviour of stored grain pests. Surveillance, monitoring and reporting protocols were discussed and skill development in safe and scientific fumigation procedure for AlP Fumigation was done with a view to empower the personnel involved in resistance management and systems approach for pest management.

Capacity Building

Brainstorming Workshop on Post-Harvest Pests in Peanuts (5th June)

A brain storming workshop on peanut storage protocol was facilitated on the request of Agricultural and Processed Food Products Export Development Authority (APEDA) on the backdrop of continued rejection of large consignments of peanuts especially by Vietnam. The workshop aimed to map the current status of peanut post-harvest pest management and to identify the potential improvement areas thereby attempting for pest exclusion from export consignments of peanut. A number of experts and invited guests put together their expertise on 5.6.2015 to analyse the situation and to mitigate the problem. The variety and richness of discussions at the Workshop made it possible to pool together the insights, observations, experiences and proposals for actions. The workshop participants identified a number of general and specific issues; such as need of SOP, applied research, extending GAPS for storage, use of systems approach, challenges pertaining to lures etc. Specific action points discussed included corrective measures to be taken at harvesting, processing and storage along the production and supply chain. The management plan for peanut bruchid, *Caryedon serratus* was specially emphasized due to non-compliances received on its interception in export consignments of peanut.

Phytosanitary Treatments -MBr& ALP (16th to 30th June)

The increased trade in agricultural products is almost always accompanied by the potential risk of an inadvertent entry of quarantine pests to countries or regions. Quarantine pests can seriously disrupt trade of agricultural products. The trading partners though negotiate various phytosanitary measures and employ them; the phytosanitary treatments often serve as one stop solution at the end point of export. Fumigation with Methyl Bromide and Aluminium Phosphide are the treatments that are very effective and generally accepted to mitigate risk of international movement of pests. However, the phytosanitary treatments are mostly outsourced by the NPPOs and as such, the treatment providers have a very important role to play. The appropriate and adequate training and skill development of treatment providers, therefore, is mandatory.

NIPHM conducts regular training courses in this area and is one of the notified Institutes under Insecticides Rules, 1971 Chapter III -10, (3a) (iii) for imparting training

for commercial pest control operators on fumigation using Methyl bromide and Phosphine. Twenty one private industry participants from Tamil Nadu, Maharashtra, Karnataka, Andhra Pradesh, Rajasthan, Gujarat and Telangana States were trained in this batch of training. The course deliberated on important aspects of fumigants and fumigation and hands on skill development was undertaken in areas of scientific fumigation and safety.

"Orientation programme in "On- Farm Production of Biocontrol Agents and Microbial Biopesticides to Promote AESA based Plant Health Management in conjunction with Ecological Engineering for Pest Management and Agricultural Extension Services" (13 to 22 April and 1 to 10 June)

A joint training programme between NIPHM & MANAGE was launched to train the extension Officers from State and Centre Govt. and for those who are undergoing the PGDAEM programme of MANAGE. Two joint programmes were organized to impart skills in on-farm production of BCAs and microbial biopesticides to promote AESA based Plant Health Management in conjunction with Ecological Engineering for Pest Management and Agricultural Extension Services". A total of 31 officials were provided hands-on experiences in production of biocontrol agents viz. *Trichogramma, Chelonus, Goniozus, Bracon*, *Reduviids, Spiders* and *Trichoderma, Pseudomonas,* Entomopathogenic fungi and Entomopathogenic Nematodes (EPN), Vesicular Arbuscular Mycorrhiza (VAM) and vermicomposting and fruit fly traps. The participants were given knowledge in implementing effective extension services.

Production Protocol for Bio control agent and Quality Analysis & Quality Management of Microbial bio-pesticides (8 to 28 May, 5 to 25 June)

Two modular training programmes were organized on production protocol for biocontrol agent and quality analysis & quality management of microbial bio-pesticides to create a pool of master trainers with enhanced skills in the area of production of superior BCAs and their quality management. Participants were trained in laboratory and on-farm production of biocontrol agents and microbial biopesticides viz. *Trichogramma, Chelonus, Goniozus, Bracon*, *Reduviids, Spiders* and *Trichoderma, Pseudomonas,*

Capacity Building

Entomopathogenic fungi and Entomopathogenic Nematodes (EPN), Vesicular Arbuscular Mycorrhiza (VAM). Additionally they were imparted hands-on experiences in the techniques & methods required for registration and quality management of microbial biopesticides.

Production Protocol for Biocontrol Agents (5 to 15 June)

NIPHM has developed simple methodologies with the available low cost inputs for the mass production of biocontrol agents and microbial biopesticides at farm level. The participants were imparted skills and hands-on-practices in laboratory and on-farm production of biocontrol agents Parasitoids viz., *Trichogramma, Chelonus, Goniozus, Bracon* and predators such as *Reduviids, Spiders* and microbial biopesticides such as *Trichoderma, Pseudomonas,* Entomopathogenic fungi and Entomopathogenic Nematodes (EPN), Vesicular Arbuscular Mycorrhiza (VAM) and vermicomposting and fruit fly traps. Alumni


On-farm production of biocontrol agents and microbial biopesticides to promote AESA based plant health management in conjunction with Ecological Engineering for pest management" : RKVY-Project (Meghalaya) (13 to 18 May)

This training programme was organized under collaborative RKVY project between Meghalaya Govt. & NIPHM on "Adoption of Agro-ecosystem Analysis based Biointensive Pest Management Strategies and Promotion of Decentralized Biocontrol Agents and Biopesticides Production Centres through Farmer SHGs in Meghalaya. The aim of the programme is to create a pool of master trainers in on-farm production of biocontrol agents and microbial biopesticides to promote AESA based plant health management in conjunction with Ecological Engineering for Pest Management with enhanced skills in on-farm production of biocontrol agents and microbial biopesticides. 12 officers were trained in on-farm production of parasitoids viz., *Trichogramma, Chelonus, Goniozus, Bracon* and predators such as *Reduviids, Spiders* and microbial Biopesticides such as *Trichoderma, Pseudomonas,* Entomopathogenic fungi and Entomopathogenic Nematodes (EPN), & biofertilizers including VAM and vermicomposting, fruit fly traps.


Appropriate Pesticide Application Techniques and Farm Level Storage Structures (23 – 30 April)

Appropriate pesticide application techniques (PATs) and equipment selected for applying pesticides are vital to the success to pest control operations. This complex process requires a high level of knowledge and understanding, practical skills, well maintained and calibrated equipment, and probably most importantly a desire or will to protect the environment. The main purpose of PAT is to achieve maximum efficacy with minimum side effects on non – target organisms. The knowledge on farm level storage structures enhances the farmers to safely store the produce and also can sell it when there is a better market price.

The participants gained knowledge on use of high volume, low volume and ultra – low volume spraying techniques, nozzle selection, and calibration of the equipment, storage problems of food grains at commercial / farm level. The participants learnt the importance of suitable equipment selection and operation of the equipment, selection of suitable nozzles and calibration of the sprayers.

Safe and Judicious Use of Chemical Fertilizers and Chemical Pesticides (17 – 24 July)

Pesticides are poisonous substances and harmful to living organisms, therefore their use must be very judicious. The application techniques ideally should be target oriented so that safety to the non – targets and the environment is ensured. Spray drift and the risks associated with the application of pesticides in agriculture are attracting increasing attention. In this regard, safe use of chemical fertilizers and chemical pesticides, appropriate

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Pesticide Formulation Analysis (PFA)

The Pesticides are one of the important agricultural inputs for plant protection and about 45,000 MT of technical grade pesticides are being used indifferent forms and formulations on an average in India per annum. The Departments of Agriculture, Government of India as well as State Governments have established Pesticide Testing Laboratories for monitoring the quality of the pesticides available in the markets through their respective enforcement wing for the welfare of the farming community besides statutory post registration verification of the pesticides under the Insecticides Act 1968. The analysts working in these Laboratories must possess skills in analysing the quality of pesticides. Further, under rule 21(b) of insecticide rules, training in analysis of pesticides for quality control is mandatory for analyst working in pesticide testing laboratories. The Pesticide Formulation Analysis (PFA) courses are being conducted by NIPHM, to meet this statutory requirement and to build the capacity of the pesticide Analysts of the Government Laboratories.

A training programme on Quality control analysis of pesticides was organized from 07. 04.2015 to 11.06.2015 and 12 participants were trained. The participants were introduced to the concepts on pesticide management, various sections and rules of insecticide act 1968 & rules 1971, procedures of implementation during enforcement, pesticide formulations and their physico-chemical properties, principles of volumetric analysis and different type of titrations, volumetric and instrumental methods of analysis for quality control of pesticides. The participants were also trained in operation and maintenance of UV-Vis & FTIR spectrophotometers, gas chromatographs & liquid chromatographs. They were given hands on experience in analysing pesticides using the modern analytical instruments as per the latest Bureau of Indian Standards (BIS) and Registration Committee (RC) approved methods of analysis. Further, the participants were given training on laboratory quality system management and internal audit as per ISO/IEC 17025-2005 which is an integral part of the PFA program.

Laboratory Quality System Management and Internal Audit as per ISO/IEC 17025-2005:

There is a great demand for the harmonisation in analytical practices and data generated/reported by the quality control laboratories as per the good laboratory practices, which are well documented and traceable. To ensure this, there must be a good Laboratory Quality System Management in every laboratory and a regular audit in place for consistent quality assurance.

The National Accreditation Board for Testing & Calibration has brought out guidelines in the form of ISO 17025-2005 and gives accreditation to the laboratories which fulfils and demonstrates the capabilities as per the standard. The Government of India made it mandatory for the all the Pesticide Testing Laboratories to follow ISO 17025-2005 and get accreditation from NABL. To build the capacity of the pesticide analysts working in Pesticide Testing Laboratories, NPHM conducts training program on "Laboratory Quality System Management and Internal Audit as per ISO/IEC 17025-2005".

A training program was conducted from 18-23 May, 2015 and 26 officials (incl. 3 private participants) were trained on procedures of Internal Audit and Quality Management of the Laboratories to enable them to obtain accreditation by the NABL.

Method validation in Pesticide Formulation Analysis and Measurement of Uncertainty:

Method validation and Measurement of Uncertainty are important elements in ensuring the quality assurance in any laboratory particularly for obtaining accreditation from NABL. NIPHM conducts the training program on these aspects regularly for the benefit of the analysts. A training program was conducted from 17-22 June, 2015 and 20 officials were trained. The participants were learned skills in the principles & techniques of method validation. They were introduced to terminologies used in the measurement of uncertainty, identification and measurement of uncertainty, practical exercises in measurement of uncertainty in the analysis. The participants were also provided opportunity to gain hands on experience in method validation using different sample matrices.

Training Program on Quality Analysis and Quality Management of Microbial Bio Pesticides:

Pursuant to the major policy shift and advocacy for use of Microbial Bio Pesticides for plant protection in an attempt to reduce the use of synthetic pesticides for cost effectiveness and safety to the environment, the production and supply of Microbial Bio Pesticides is slowly picking up in our country and there is a need to have qualified microbiologists / analysts to monitor the quality of such products. Two training programs were organized during 19-28 May, 2015 and 16-25 June, 2015 to meet the requirement of Quality Analysis. The participants were also introduced to the principles of Quality Control of Microbiological Pesticides and provided hands on experience in testing the microbial bio-products for CFU, Bio assay and physic-chemical properties.

Around the World

Cassava Mealybug: A looming threat to Indian Cassava

The Cassava mealybug (*Phenacoccus manihoti* Matile-Ferrero, 1977) (Hemiptera: Pseudococcidae) is native to South American Continent and is considered as one of the highly invasive pest in the introduced areas. Cassava is the preferred host and it can also infest Citrus, Tomato, Sweet potato, Soybean, Croton, Euphorbia etc. These are economically important crops and provide sustainable livelihood for many farmers. Sago and Starch Industry are directly dependent on Cassava production. Cassava mealybug is considered as one of the important threat to Cassava-growing countries. Storage root yield losses of 84% have been reported. The pest is transported to new areas through import of infested Cassava or other planting materials such as Euphorbia, Citrus, Croton etc., and fresh produce. The damage severity is greater in the dry than in the wet season. India is free from this Cassava mealybug.

Existing Regulations: Import of seeds / stem cuttings of Cassava are prohibited from Africa and South America due to various devastating pests of concern and stem cuttings can be imported for research purpose from other countries as per the conditions stipulated in Plant Quarantine Order, 2003. Euphorbia plants for propagation are permitted from South Africa with declaration for freedom from Cassava mealybug. All known host plants of this pest must be inspected at ports of entry by Plant Quarantine Officials, as well as during post entry quarantine.

Life cycle: *Phenacoccus manihoti* reproduces by parthenogenetic oviparity. The life cycle consists of an egg and four instar stages with the fourth being the adult mealybug. The lower thermal threshold is 14.7°C, an optimal temperature of about 28°C, no development above 35°C. Each individual can lay about 500 eggs in an average life span of 20 days. The average development period of egg to adult lasts for about 33 days. The most favoured sites for oviposition are terminal shoot tips, lower leaf surfaces and leaf petioles. The eggs hatch into crawlers and the insect moults thrice in its development to a fourth instar. Except for crawlers, all instars prefer the lower surfaces of fully expanded leaves from where they move sluggishly to the stems and shoot tips.

Monitoring: The pest is highly invasive, India shares the border with many countries and there is a need to monitor for the pest in Cassava growing areas in India Many of the devastating sucking pests such as Papaya mealybug, Cotton mealybug etc., found their entry due to lack of awareness among stakeholders and are still causing havoc to domestic production and hampering the export market.

Cassava mealybug on Cassava leaves

Second, Third and Fourth Instar

Adult females

Alumni Forum

Awareness among farmers through in-service PGDPHM student, Kerala:

Mr. Asok, P.I., Agriculture Officer, Vizhinjam, Trivandrum, Kerala, an in-service student of PGDPHM (2014-16 batch) was trained in preparation of low-cost bottle trap and lures for fruit fly control. He has taken initiative to popularize the use of low-cost bottle trap and lure among the farmers in fruits and vegetable fields in Vizhinjam. The demonstration has drawn attention of many farmers due to the trapping of huge numbers of fruit flies in the snake gourd field and more farmers are interested to adopt the low-cost bottle trap. He is very happy to note the positive and enthusiastic response from the farmers and looking forward to take up the popularization for better control of fruit flies.

Ms. Resmi, M.V., Agriculture Officer, Vedekkancherry, Palakkad, Kerala and Ms. Maya, AO Kerala in-service students of PGDPHM (2014-16 batch) were also trained in preparation of low-cost bottle trap and lures for fruit fly control. They have promoted the concept and encouraged Self Help Group to setup a unit to prepare the bottle traps and lures.

Awareness among the farmers through KVK, Rajouri, SKUAS, Jammu & Kashmir:

Similarly, Dr. Arvind, Scientist, KVK, Rajouri, SKUAS, Jammu and Kashmir got trained at NIPHM and is popularing the low-cost bottle trap and lure concept among the vegetable farmers in Rajouri, Jammu & Kashmir by placing few traps as demonstration.

वर्ष 2015-16 हेतु राजभाषा कार्यान्यवन समिति की पहली बैठक

दिनांक 10-04-2015 को डॉ.के.सत्यगोपाल, भा.प्र.से., महानिदेशक, रावस्वाप्रसं (एनआईपीएचएम) की अध्यक्षता में राजभाषा हिन्दी के प्रगामी प्रयोग से संबंधित जनवरी-मार्च, 2015 तक की तिमाही प्रगति रिपोर्ट की समीक्षा हेतु राजभाषा कार्यान्यवन समिति(राकास) की बैठक आयोजित की गई। उक्त बैठक में महानिदेशक ने राजभाषा हिन्दी की तिमाही प्रगति रिपोर्ट एवं इसके उत्तरोत्तर उपयोग की समीक्षा की एवं धारा 3(3) के तहत् द्विभाषी (अंग्रेजी-हिन्दी) में दस्तावेजों को जारी किये जाने की अनुपालन को सुनिश्चित करने के निदेश दिए। तिमाही के दौरान रावस्वाप्रसं द्वारा वनस्पति स्वास्थ्य से संबंधित संकलित शब्दावली की समीक्षा हेतु दिनांक 06-05-2015 को इंजी. शंकर, संयुक्त निदेशक (पीएचई) एवं प्रभारी रजिस्ट्रार, रावस्वाप्रसं की अध्यक्षता में विभिन्न संस्थानों से आमंत्रित हिन्दी अधिकारियों / हिन्दी विशेषज्ञों के साथ बैठक आयोजित की गई। उक्त बैठक में डॉ. जे. रेणुका, सहायक निदेशक (राजभाषा), राष्ट्रीय कृषि अनुसन्धान प्रबन्ध अकादमी (नारम), डॉ. महेश कुमार, हिन्दी अधिकारी (तकनीकी), भारतीय कदन्न अनुसंधान, हैदराबाद एवं डॉ. के. श्रीवल्ली, हिन्दी अनुवादक, मैनेज, हैदराबाद ने शब्दावली की समीक्षा की। साथ ही उन्होंने शब्दावली के संवर्धन हेतु कृषि एवं वनस्पति स्वास्थ्य से जुड़े कई शब्दों को शामिल करने हेतु सुझाव भी दिये।

तिमाही के दौरान एनआईपीएचएम की वेबसाइट के मुख्यपृष्ठ को हिन्दी में तैयार करने एवं वार्षिक प्रतिवेदन 2013-14 एवं प्रभागों के विभिन्न गतिविधियों को उक्त वेबसाइट पर अपलोड करने का कार्य किया गया।

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