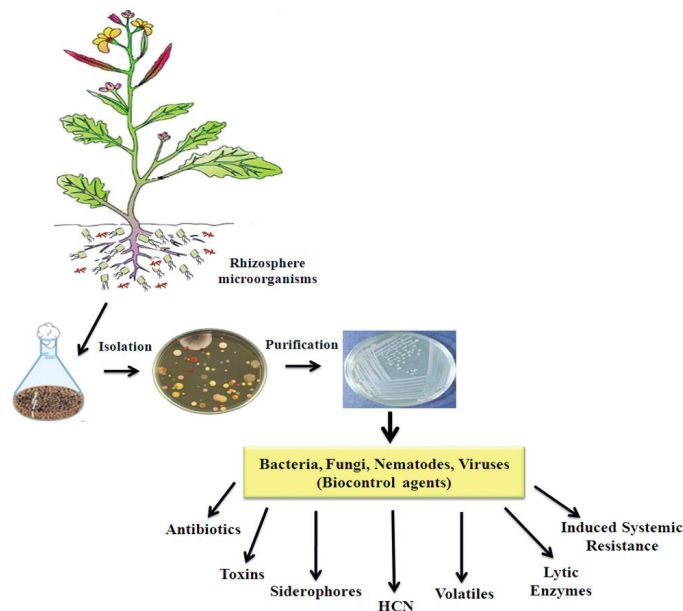
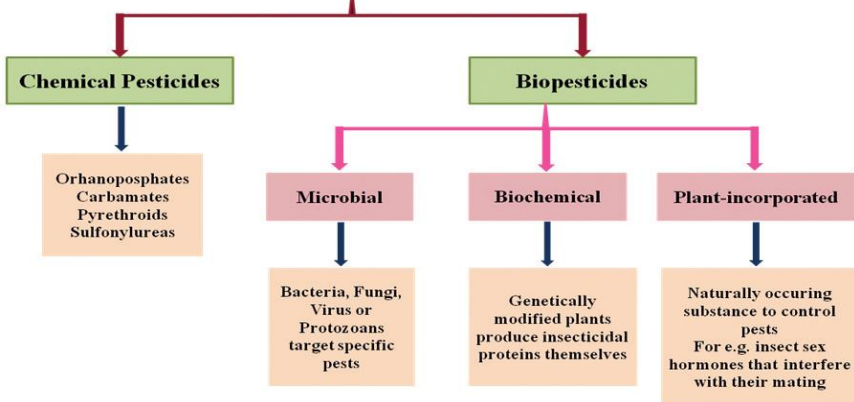




THEME ARTICLE

Types of Pesticides



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From the Director General's Desk

The global biopesticides market is estimated to grow at a rapid rate. Growing demand for natural based pesticides among farmers along with increasing industry competitiveness is driving the business growth. A need to improve the agricultural productivity owing to increasing population and reducing cultivable land is changing the preference towards biopesticides. Tough regulations to reduce the pesticide residue in Agriculture produce, development of resistance in pests against pesticides and environmental pollution due to non-judicious usage of chemical pesticides are the main reasons for shifting our interest from chemical pesticides to biopesticides for effective and sustainable pest management. Various food exporting countries are using biopesticides to meet the consumer expectations in the developed economies. However, global pandemic COVID-19 resulted in disruption of supply chain and low purchasing power of consumers which hampered the biopesticides market.

Microbial biopesticides are the formulations containing microbes as active ingredients. Being economically viable, eco-friendly, and easy to use, microbial biopesticides can create a suitable alternative for synthetic pesticides in crop protection. Increasing pests, diseases, and fungal infections have affected crop yields. To curb these problems, biopesticides obtained from microorganisms and other biological agents play a vital role in minimizing and controlling pest infestations. The most commonly used and CIB & RC approved microbial biopesticides in India to be used against fungal and bacterial diseases are *Trichoderma viride*, *Trichoderma harzianum*, *Trichoderma reesei*, *Ampelomyces quisqualis*, *Pseudomonas fluorescens* and *Bacillus subtilis*.

Microbial bio-pesticides have several advantages over synthetic pesticides notably, cost effectiveness and eco-friendly in nature. The total world production of biopesticides is over 3000 tonne/year, which is increasing at a rapid rate. India has a vast potential for bio-pesticides. However, factors such as lack of awareness & low adoption rate of biopesticides and low shelf-life & inconsistent performance are expected to hinder the growth of this market to a certain extent. An updated representation of the current knowledge on microbial bio-pesticides, their modes of action, commonly used microbial biopesticides, their advantages and disadvantages are discussed in the theme article

वैश्विक जैव पीड़कनाशियों का बाजार तेजी बढ़ने का अनुमान है। उद्योगों में बढ़ती प्रतिस्पर्धा के साथ किसानों के बीच प्राकृतिक आधारित पीड़कनाशियों की बढ़ती मांग से व्यवसाय में वृद्धि हो रही है। बढ़ती जनसंख्या के कारण कृषि उत्पादक में सुधार की आवश्यकता है एवं कृषि योग्य भूमि कम होने से जैवपीड़कनाशियों को महत्व दिया जा रहा है। कृषि उत्पादक में पीड़कनाशी अवशेष को कम करने के लिए सख्य नियम, पीड़क नाशियों के प्रति पीड़कों में प्रतिरोध क्षमता का विकास एवं रासायनिक पीड़क नाशियों के गैर-विवेकपूर्ण इस्तेमाल एवं पर्यावरण के दूषित होने के मुख्य कारणों की वजह से प्रभावी एवं सतत पीड़क प्रबंधन के लिए रासायनिक पीड़कनाशियों की जगह जैव पीड़कनाशियों के इस्तेमाल में हमारी रूचि बढ़ रही है। विभिन्न खाद्य निर्यातक देश विकसित अर्थव्यवस्थाओं में उपभोक्ता अपेक्षाओं को पूरा करने के लिए जैव पीड़कनाशी का उपयोग कर रहे हैं। अतः वैश्विक महामारी कोविड-19 के परिणामस्वरूप आपूर्ति श्रृंखला में व्यवधान एवं उपभोक्ता की क्रय शक्ति में कमी आयी, जिससे जैव पीड़कनाशी बाजार प्रभावित हुई है।

माइक्रोबिअल जैव पीड़क नाशी सक्रिय तत्व के रूप में सम्मिलित माइक्रोबस का सूत्रीकरण है। आर्थिक रूप से व्यवहार्य, पर्यावरण के अनुकूल एवं उपयोग में आसान होने के कारण माइक्रोबिअल फसल संरक्षण में सिंथेटिक पीड़कनाशियों के लिए एक उपयुक्त विकल्प साबित हो सकता है। बढ़ते पीड़कों, प्रकोपों एवं फंगल संक्रमण फसल की पैदावर को प्रभावित किया है। इन समस्याओं पर अंकुश लगाने के लिए सूक्ष्मजीवों एवं अन्य जैविक एजेंटों से प्राप्त जैव पीड़कनाशी पीड़क संक्रमण को कम करने एवं नियंत्रित करने में महत्वपूर्ण भूमिका निभाते हैं। भारत में फंगल एवं बैक्टीरिअल रोगों जैसे: ट्राइकोडर्मा विराइड, ट्राकोडर्मा हर्जियानम, ट्राइकोडर्मा रीसी, एम्पेलोमाइसेस क्विसक्वालिस, सुडोमनास फ्लोरेसेंस एवं बैसिलस सबटिलिस के लिए सबसे अधिक इस्तेमाल किये जाने वाले एवं आरसी अनुमोदित जैव पीड़कनाशियों का उपयोग किया जाना चाहिए।

सिंथेटिक पीड़कनाशियों की तुलना में माइक्रोबिअल जैव-पीड़कनाशी के कई लाभ हैं, विशेष रूप से उचित लागत एवं प्रकृति में पर्यावरण के अनुकूल। जैव पीड़कनाशी का विश्व भर में कुल उत्पादन 3000 टन / प्रति वर्ष है, जिसमें तेजी से वृद्धि हो रही है। भारत में जैव पीड़कनाशी की अपार संभावनाएं हैं। हालांकि, जागरूकता की कमी एवं जैव पीड़कनाशी के कम अपनाये जाने की दर, कम शेल्फलाइफ एवं असंगत प्रदर्शन जैसे कारकों से कुछ हद तक इस बाजार के विकास में बाधा आने की उम्मीद है। माइक्रोबिअल जैव पीड़कनाशियों पर वर्तमान ज्ञान का एक अद्यतन प्रतिनिधित्व, उनकी क्रिया के तरीके, आम तौर पर उपयोग किये जाने वाले माइक्रोबिअल जैव पीड़कनाशियों, उनके फायदे एवं नुकसान के बारे में इस लेख में चर्चा की गई है।

Dr. Saagar

(डॉ. सागर हनुमान सिंह, भा.डा.से.)

महानिदेशक

Microbial biopesticides used in plant disease management: An overview

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Abstract

The estimated potential yield losses caused by plant pathogens is up to 42% globally and most research in plant pathology aims to reduce yield loss in our crops directly or indirectly. Chemicals are being used extensively for management of pests and disease worldwide. However, indiscriminate use of these chemical pesticides may have adverse effect on ecological equilibrium and human health directly or indirectly. Greener approaches for effective management of these diseases are the need of the hour to protect ecology and human health. Biopesticides have an important role in crop protection, although most commonly in combination with other tools including chemical pesticides as part of Bio-intensive integrated disease management. Microbial biopesticides are the products obtained from microorganisms or the formulations of microorganisms itself which are beneficial and can be applied against plant diseases and insect pests responsible to cause damage to agricultural crops year after year. This paper underscores the utility of biocontrol agents composed of microorganisms including bacteria and fungi. Biopesticides have several advantages over their chemical counterparts and are expected to occupy a large share of the market in the coming period.

1. Introduction

The global population is exploding at an exponential rate and is anticipated to reach approximately 9.7 billion by 2050, the largest share of which is in Africa and Asia (United Nations, 2015). This has imposed a large burden on agriculture and its allied sectors in terms of meeting food demands, which requires more inputs for crop production. Anthropogenic activities have affected people's surroundings and have also had negative impacts on the environment and ecosystems, including reductions in agricultural areas due to construction, the explosion of nutrient mining, degradation, and contamination of water resources (resulting in scarcity), aggregation of xenobiotics in the soils, and degeneration and deterioration of the quality, fertility, and efficiency of soil, with implications of soil erosion and climate change. Plant pathogens causing major damages to crop plants include fungi, bacteria, viruses and nematodes. Crop losses are creating a major threat to the food production with about 27 to 42% loss in global food production attributed to plant disease caused by plant pathogens which otherwise would have been doubled if no disease management strategies are applied (Singh, 2016). In order to overcome these challenges and meet the requirements for food and supplies, the productivity and sustainability of agricultural practices should be improved and novel and improved strategies must be found. Enhanced agricultural productivity can be achieved in many ways, such as through increasing crop yield by providing manure and organic-based treatments, including biopesticides, or by limiting yield loss due to extreme environmental conditions [Pathak *et al.*, 2015; Gonclaves *et al.*, 2021,]. Abiotic stress can be largely controlled by the use of bio stimulants and bio effectors (Van *et al.*, 2017). Biopesticides, which are pest management agents based on living microorganisms or natural products, offer a great promise in controlling yield loss without compromising the quality of the product. Different agricultural practices, such as the use of crop rotation, cover crops, disease resistant varieties and

good seed bed preparation have been applied to control pests and diseases. However, such practices are not always sufficient protection from crop losses. Because of this, many certified organic growers turn to biopesticides to insure and/or enhance their abilities to grow and market high-quality produce. Approved organic products for plant disease control include many legally registered biopesticides. Such products have been developed to control numerous plant diseases and to provide useful tools for growers to decrease the incidence and/or severity of plant diseases (Kumar, 2021).

Plant disease control is mainly based on extraneous application of pesticides to improve agriculture productivity. However, only a part of applied pesticides is used for killing of pathogens and pests. Large part of applied pesticides remains either as residual pesticide or gets volatilized or leached resulting in ecological and environmental problems, and human health hazards. The increased consumer demands for safe food have invigorated research on development of safe and eco-friendly biopesticides. The use of microorganisms for biological control of pests is considered as a pragmatic approach which can drastically lessen the adverse outcomes of agrochemicals in soil. Rhizospheric microorganisms isolated from various crops produce different antagonistic compounds and inhibit the growth of various phytopathogens and insect pests. Moreover, in several plants, hormones like salicylic acid, jasmonic acid and ethylene contribute towards induction of both, systemic acquired as well as induced systemic resistance. In this article, antagonistic rhizosphere microorganisms have been explored for control of phytopathogens. Further, recent advances in field of biopesticides using rhizosphere microorganisms under field conditions is discussed for improving crop productivity in sustainable agriculture (Anju and Satyavir, 2019).

Beneficial rhizosphere microorganisms could be exploited to provide sustainable solutions in reducing the application of pesticides for agricultural crop production. Biopesticides offer several advantages including complete biodegradability and water solubility over traditional chemical/ synthesised pesticides. Thus, microorganisms and plant-based biochemicals provide a safe alternative option for plant disease suppression in agriculture system.

Microbial bio pesticides are used primarily as preventative measures, so they may not perform as quickly as some synthetic chemical pesticides. However, biopesticides are generally less toxic to the user and are non-target organisms, making them desirable and sustainable tools for disease management. While their use is not overly complicated, the application of some biopesticides may require a high level of understanding and knowledge of the diseases and pathogens that they are designed to control. As with any disease management program, proper timing and application are essential to ensuring efficacy.

2. Different types of biopesticides used in plant disease control

A biopesticide is defined by the U.S. Environmental Protection Agency (EPA) as a pesticide derived from natural materials. The EPA divides biopesticides into three categories: viz., Biochemical pesticides, Microbial pesticides and Plants containing added genetic material (Figure 1).

A. Biochemical pesticides contain naturally occurring substances that control pests. Substances that control diseases in this category include **potassium bicarbonate, hydrogen dioxide, phosphorous acids, plant extracts, and botanical oils.**

B. Microbial biopesticides contain **microorganisms as the main active ingredient** that function as biological control agents, affecting the pathogen directly or indirectly through the compounds they produce or by stimulating specific plant responses.

C. Plant-incorporated protectants (PIPs) are the least common type of biopesticide. These are pesticidal substances produced by plants that contain **genetic material added to the plant often through genetic engineering.** Biopesticides also exist for the management of weeds, insects, and nematodes. In this article, only commercially available microbial and biochemical biopesticides are discussed.

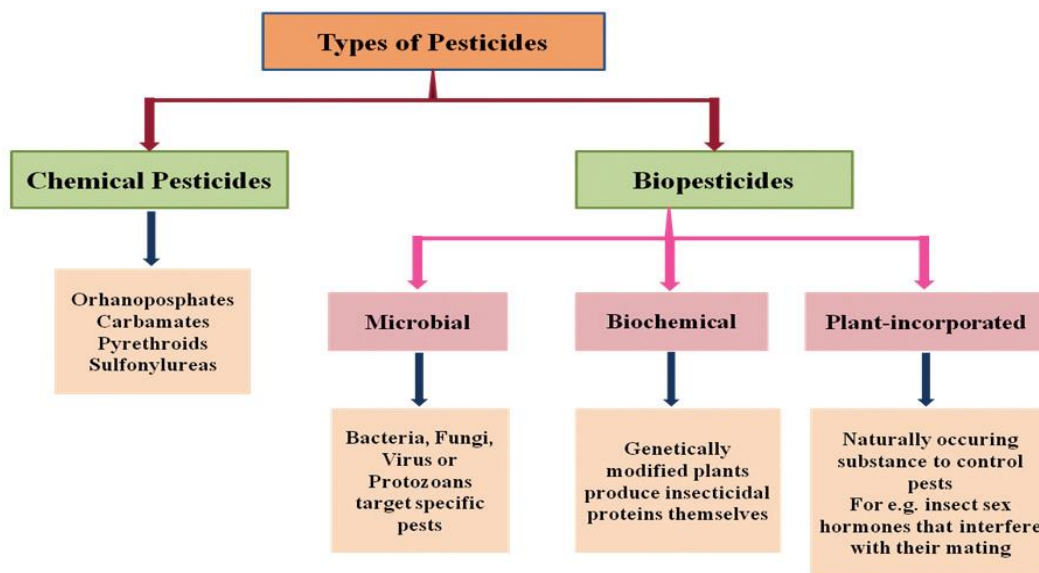


Figure 1. Categories of pesticides used for control of phytopathogens and insect pests.

3. Mode of Action of Microbial Biopesticides

Biopesticides act in a variety of ways on microorganisms depending on their type and nature. A few mechanisms through which biopesticides attack or kill pathogens are given below. The mechanisms of biocontrol agents used in plant disease control are classified broadly into two types viz., direct and indirect. Under the direct mechanisms the microbial pesticides kill plant pathogens by parasitism (parasitizing the hyphae of plant pathogens) or antibiosis (secretion of antibiotics which are harmful to plant pathogens), under indirect mechanisms the microbial pesticides suppress plant pathogens either by competition, and induced systemic resistance (Figure 2).

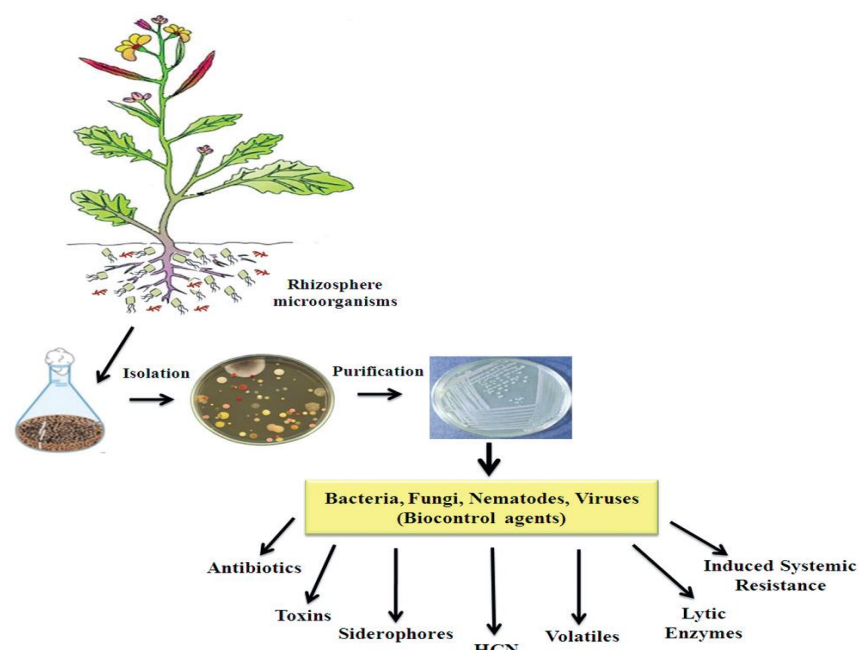


Figure 2. Mechanisms involved in the biological control of plant diseases and insect infestation

Microbial bio pesticides are applied to crops for biological control of plant pathogens where they act via a range of modes of action. Some microbial bio pesticides interact with plants by inducing resistance or priming plants without any direct interaction with the targeted pathogen. Other microbial bio pesticides act via nutrient competition or other mechanisms modulating the growth conditions for the pathogen. Antagonists acting through hyperparasitism and antibiosis are directly interfering with the pathogen. Such interactions are highly regulated cascades of metabolic events, often combining different modes of action. Compounds involved such as signalling compounds, enzymes and other interfering metabolites are produced *in situ* at low concentrations during interaction. The potential of microorganisms to produce such a compound *in vitro* does not necessarily correlate with their *in situ* antagonism. Understanding the mode of action of antagonists is essential to achieve optimum disease control. Also understanding the mode of action is important to be able to characterize possible risks for humans or the environment and risks for resistance development against the Microbial bio pesticides (Kohl *et al.*, 2019).

4. Limitations and Challenges in the Use of Conventional Pesticides

There are harmful effects associated with the use of synthetic pesticides such as toxicity and poisoning [Damalas *et al.*, 2015]. Synthetic pesticides also lead to environmental pollution due to the non-biodegradable nature of their constituent compounds [Kekuda *et al.*, 2016]. According to Parlaman, (2001) degradation of metham sodium and other fumigants was reported to last up to over six months after application. In a report by PAN, metham sodium pollutes the air and soil thereby affecting the population of natural enemies in the soil. Methyl bromide has been banned from agricultural use due to its negative impact on the environment. It is associated with depletion of ozone layer which contributes significantly to climate change (Morrissey, 2006). They also pollute surface and ground water, killing aqua life after inhalation and consumption. It has been reported to have carcinogenic properties leading to its ban from agricultural use.

Continuous use of synthetic pesticides leads to development of resistant plant pathogen strains leading to their resurgence (Ndakidemi *et al.*, 2016). All the problems listed above due to use of chemical pesticides can be addressed safely by using microbial bio pesticides. Thus microbial bio pesticides act as safer alternative to chemical pesticides.

5. Most Commonly used Microbial bio pesticides in plant disease control and their benefits over conventional pesticides

The commonly used biopesticides are living organisms, which are antagonistic to plant pathogen of interest such as *Trichoderma*, *Pseudomonas fluorescens*, *Bacillus* and *Streptomyces* (Figure 3). The list of most important microbial bio pesticides used worldwide and their target crops and target diseases is presented in Table 1.

Table 1. Microbial Biopesticides for the control of Plant Pathogens

Biocontrol Organism	Target Disease	Target Crops
Bacteriophages of <i>Xanthomonas</i> spp. and <i>Pseudomonas syringae</i> pv. tomato	Bacterial spot in pepper and tomatoes and bacterial speck in tomatoes	Tomatoes and pepper
<i>Pseudomonas syringae</i>	Post-harvest frost damage and biological decay	Apples, pears, lemons, oranges or grapefruit
<i>Pantoea agglomerans</i>	Fireblight	Apples and pears
	Fireblight	Apples and pears
<i>Streptomyces lydicus</i>	Soilborne pathogens Foliar pathogens	Greenhouse, nursery and turf
<i>Bacillus pumilus</i>	Rust, powdery mildew, and brown spot	Soybeans, cereal crops, and potatoes
<i>Coniothyrium minitans</i>	White moulds	Agricultural soils
<i>Bacillus subtilis</i>	Wilts root rot and leaf spots	Cotton, peanuts, soybeans, wheat, barley, peas and beans
<i>Trichoderma harzianum</i>	<i>Fusarium</i> , <i>Pythium</i> , and <i>Rhizoctonia</i>	Cucurbit vegetables, flowers, bedding plants, ornamentals, fruiting and leafy vegetables, cole crops, hydroponic crops, pome fruits, shade house, outdoor nursery, stone fruit and tree nuts

	<i>Fusarium</i> , <i>Pythium</i> , and <i>Rhizoctonia</i>	Flowers, bedding plants, ornamentals, fruiting vegetables, herbs and spices, hydroponic crops, leafy vegetables, cole crops, pome fruits, stone fruits and tree nuts
<i>Bacillus subtilis</i>	Fungal and bacterial diseases, brown patch, anthracnose and dollar spot	Turf, ornamentals, trees, shrubs, flowers, bedding plants, tropical plants, seedlings, conifers, fruity and leafy vegetables
	Bacterial spot, powdery mildew, rust, gray mold, leaf blight, scab and more	Fruits, vegetables and flowers
	Bacterial spot, powdery mildew, rust, gray mold, leaf blight and scab	Vegetable, fruit, nuts, ornamentals plants, annual and perennial flowering plants, tropical foliage, trees and shrubs
	Fire blight, <i>Botrytis</i> , Sour rot, rust, <i>Sclerotinia</i> , powdery mildew and bacterial spot	Vegetables, fruit, nut and vine crops
	Fire blight, <i>Botrytis</i> , sour rot, rust, <i>Sclerotinia</i> , powdery mildew and bacterial spot	Vegetables, fruit, nut and vine crops
	Fungi and bacteria that cause scab, powdery mildew, sour rot, downy mildew, and early leaf spot, early blight, late blight, bacterial spot and walnut blight	Food crops including cherries, cucurbits, grapes, leafy vegetables, peppers, potatoes, tomatoes and walnuts
<i>Trichoderma virens</i>	<i>Pythium</i> , <i>Rhizoctonia</i> and root rots	Ornamental and food crop plants grown in greenhouses, nurseries and outdoors
<i>Bacillus pumilus</i>	Fungal pests such as moulds, mildews, blights and rusts	Many food and non-food crops, including trees susceptible to sudden oak death syndrome. For use outdoors, including nurseries, landscapes, and rights-of-way and for use in greenhouses

<i>Trichoderma harzianum</i>	<i>Fusarium, Pythium and Rhizoctonia</i>	Agronomic field and row crops, alfalfa, hay and forage crops, bulb crops, cucurbits, fruiting vegetables, herbs, spices, leafy vegetables, cole crops, legumes, root crops, small grains and tuber crops
	<i>Fusarium, Pythium and Rhizoctonia</i>	Agronomic field and row crops, alfalfa, hay and forage crops, bulb crops, cucurbits, fruiting vegetables, herbs, spices, leafy vegetables, cole crops, legumes, root crops, small grains and tuber crops
<i>Bacillus pumilus</i>	<i>Rhizoctonia and Fusarium</i>	Legumes

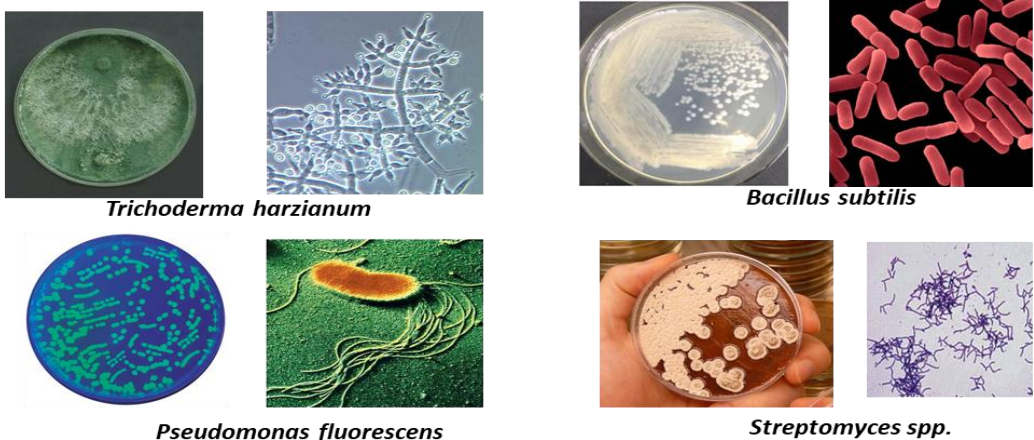


Figure 3. Microbial biopesticides used in plant disease control

Though the above listed microbes are used as microbial bio pesticides in different parts of world for biological management of plant diseases but in India Central Insecticides Board and Registration Committee under (CIB&RC) Directorate of Plant Protection, Quarantine and Storage (DPPQS), Department of Agriculture and Farmers Welfare, Ministry of Agriculture and Farmers Welfare is vested with responsibility of approving the usage of bio pesticides for pests and disease management. Accordingly, all the antagonistic microorganisms to be used in pest and disease management have to be registered and approved by CIB & RC for commercialisation and field level usage. Only few of the above listed microbial bio pesticides are approved (Table 2) for use in management of plant diseases in India under Insecticides Act, 1968 as 30.11.2021.

Table 2. List of Biopesticides (Fungicides) approved as per CIB & RC under Insecticides Act, 1986 as on 30.11.2021

Biopesticides	Target crop	Target disease
<i>Ampelomyces quisqualis</i>	Okra (Bhindi)	Powdery mildew
Azadirachtin 0.030% (300 ppm)	Bhindi	Powdery mildew
<i>Pseudomonas fluorescens</i>	Wheat	Loose smut
	Tomato	Early blight
	Groundnut	Late leaf spot
	Paddy	Bacterial leaf blight
	Rice	Leaf and neck blast
	Late leaf spot	Groundnut
	Tomato	Wilt
	Cotton	Bacterial Leaf blight
	Paddy	Bacterial Leaf blight
	Chili seedlings	Damping off
	Tomato	Tomato Wilt
	Carrot	Root rot
	Okra	Wilt
<i>Bacillus subtilis</i>	Banana	Sigatoka
	Paddy	Bacterial leaf blight
	Grapes	Powdery mildew
<i>Trichoderma harzianum</i>	Cardamom	Capsule rot
	Paddy	Bakane (Foot rot)
	Tomato	Wilt
	Brinjal	Wilt
	Carrot	Root rot
	Okra	Wilt
	Chickpea	Root rot
	Maize	Root rot, Fusarium wilt
<i>Trichoderma reesei</i>	Banana	Panama wilt
<i>Trichoderma viride</i>	Pigeon pea	Wilt, Root rot
	Pulses (Cowpea, Mung bean, Urdbean)	Root rot
	Chilli	Damping off
	Tomato	Wilt
	Groundnut	Seedling wilt
	Wheat	Loose smut
	Chilli	Root wilt
	Cowpea	Root Rot
	Chili seedlings	Damping off
	Urd bean	Root rot
	Pigeon pea	Root rot
	Chickpea	Wilt
	Tomato	Wilt
Brinjal	Wilt	

<i>Trichoderma viride</i>	Carrot	Root rot
	Okra	Wilt
	Cauliflower	Stalk rot
	Brinjal	Root Rot/ Wilt/ Damping off
	Cabbage	Root rot/Collar rot
	Tomato	Seedling wilt, Damping off
	Bengal gram	Seedling wilt, Damping off
	Pigeon pea	Root rot
	Urd bean	Root rot
	Chilli (Nursery)	Damping off
	Urd Bean (Black gram)	Root rot
	Rice	Brown spot
	Pea	Powdery mildew

The key benefits of the biopesticides are cost-effectiveness, costlier but reduced number of applications; low residual effect and mostly biodegradable low pest resurgence; target specific and less harmful on beneficial pests. Biopesticides are considered to be the best alternative to synthetic pesticides that are highly effective, target specific and reduce environmental risks. These factors led to its application in disease management program instead of chemical pesticides throughout the world. The advance research and development in the field of biopesticide applications greatly reduces the environmental pollution caused by the chemically synthetic pesticides residues and promotes sustainable development of agriculture. Since the advent of biopesticides, a large number of products have been registered and released, some of which have played a leading role in the agromarket. The development of biopesticide has prompted to replace the chemical pesticide in pest management.

Bio pesticides are having several advantages, more environment friendly than conventional pesticides, offer more targeted activities toward desired pests, often are effective in very small quantities, thereby offering lower exposure. They decompose quickly, leaving virtually no harmful residue and allowing field re-entry almost immediately after application, and can be used in rotation with conventional pesticides when used in IPM programs. Such programs can offer high crop yields while dramatically reducing the use of conventional pesticides and engage family labour. All pesticides must be evaluated using an empirically based risk assessment, because generalizations based on chemical origin do not hold true in all cases (Christine et al., 2010).

6. Conclusion and Future Prospects

Despite the many challenges faced during the adoption of biopesticides, they still remain suitable alternatives to conventional pesticides. Use of synthetic chemicals has raised numerous concerns due to their negative effects on the environmental, human health, natural enemies and ecosystem balance. Some of the active ingredients of synthetic

pesticides have been found to be carcinogenic thus posing a threat to human life. Biopesticides offer better alternative to synthetic pesticides due to their low toxicity, biodegradability and low persistence in the environment. The base materials for biopesticides are readily available and inexpensive. Data on toxicity levels, chemistry, active compounds and their compatibility with other methods of pests and disease management is needed to aid in formulation and commercialization. Globally, researchers have conducted studies on effectiveness of natural plant protection products with significant results being from in vitro experiments. There are also studies on effectiveness of biopesticides under controlled environments and field conditions with varying results. Further research is recommended to close the gaps in formulation of biopesticides. Stable products under field conditions will be a guarantee of utter effectiveness of biopesticides in crop pest management. Researchers should therefore work together with engineers in the government and industry as well as farmers to provide stable, durable formulations of biopesticides.

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Around the World

- The global biopesticides market is projected to grow at a Cumulative Annual Growth Rate of 14.7% from an estimated value of USD 4.3 billion in 2020 to reach USD 8.5 billion by 2025 (<https://www.marketsandmarkets.com/Market-Reports/biopesticides-267.html>).
- Africa is expected to witness the fastest growth in the forecast period. In addition, the United States is likely to be the largest individual market over the forecast period.
- Biopesticides are majorly used for crops such as grains & oilseeds, fruits & vegetables, among others. The fruits & vegetable segment was estimated to be valued at over \$1.6 billion in 2019. Escalating global demand for organic fruits & vegetables coupled with increasing awareness regarding healthy diet are the factors driving the growth of the segment (<https://www.marketsandmarkets.com/Market-Reports/biopesticides-267.html>).
- The total world production of biopesticides is increasing at a rapid rate. India has a vast potential for bio-pesticides. In India, bio-pesticides cover 3% of total pesticide production. Recently biopesticides usage in India

raised 23% while chemical pesticides only 2%. The market share of bio-pesticides is only 2.5% of the total pesticide market (Udayashankar *et al.*, 2022).

Training Programs

Plant BioSecurity Division

The Plant Biosecurity Division has organized following training programmes during the months of **January-March, 2022**.

CAPACITY BUILDING PROGRAMMES:

S. No.	Name of The Programme	Duration	Date	
			From	To
Plant Biosecurity Division (PBD)				
1.	Phytosanitary Inspection Training for Phytosanitary Service Agency and Phytosanitary Service Provider for Inspection of Plants/ Plant Products & other Regulated Articles in Export	30 Days	03.01.2022	01.02.2022
2.	Stored Grain Pest and Warehouse Management for APSWC officers	5 Day	03.01.2022	07.01.2022
3.	Fruit fly Surveillance and Management	5 Days	17.01.2022	21.01.2022
4.	Plant Bio Security & Incursion Management (PBIM)	12 Days	07.02.2022	18.02.2022
5.	Introduction to Plant Biosecurity and Plant Quarantine"	5 Days	07.02.2022	11.02.2022
6.	Pest Risk Analysis	5 Days	14.02.2022	18.02.2022
7.	Forced Hot Air Treatment (FHAT)	5 Days	21.02.2022	25.02.2022
8.	Fumigation as a Phytosanitary Treatment (Methyl Bromide and Aluminium Phosphide Fumigation)	15 Days	28.02.2022	14.03.2022
9.	Collaborative training programme with TSHDCL, Telangana and Horticulture Department of Tamil Nadu on "Export promotion procedures of APEDA Cluster crops (Mango, Chilli , Turmeric and Banana)"	2 Days	08.03.2022	09.03.2022
10.	Plant Quarantine Procedures for Import and export	5 days	07.03.2022	11.03.2022

Vertebrate Pest Management (VPM)				
1.	Rodent Pest Management	5 Days	14.02.2022	18.02.2022
2.	Certificate Course on Urban Integrated Pest Management	15 Days	01.03.2022	15.12.2021
PBD Farmers Programme				
1.	Export procedures and related IPM on Oranges Export in collaboration with Regional Central Integrated Pest Management Centre, Nagpur, Maharashtra	2 Days	14.03.2015	15.03.2022

A. DETAILS OF TRAINING PROGRAMMES (Govt. Officials & Private sector)

- 1. Phytosanitary Inspection Training for Phytosanitary Service Agency and Phytosanitary Service Provider for Inspection of Plants/ Plant Products & other Regulated Articles in Export:** As per the requirement of NSPM-23, thirty days training for 5th batch was organized from 03.01.2022 to 01.02.2022 and 15 eligible aspirants were attended the programme at NIPHM, Hyderabad. During this programme the trainees were trained in International & National Regulations, all related ISPMs& NSPMs, methodologies for inspection & sampling, Detection and Diagnosis of pests in agri- commodities, different phytosanitary treatments, how to avoid non-compliances, phytosanitary requirements of different countries, report submission etc.





2. Stored Grain Pest and Warehouse Management to APSWC, AP: A 5 days duration programme was conducted from 03.01.2022 to 07.01.2022. A total 30 participants were attended the programme. The programme was organized with an objective to create awareness and to train the officials involved in storage of food grains at warehouse level to improve the technical efficiency in maintenance of the grain storage and other technical quality control aspects at godowns with respect to Prophylactic and Curative treatments (Fumigation with ALP).



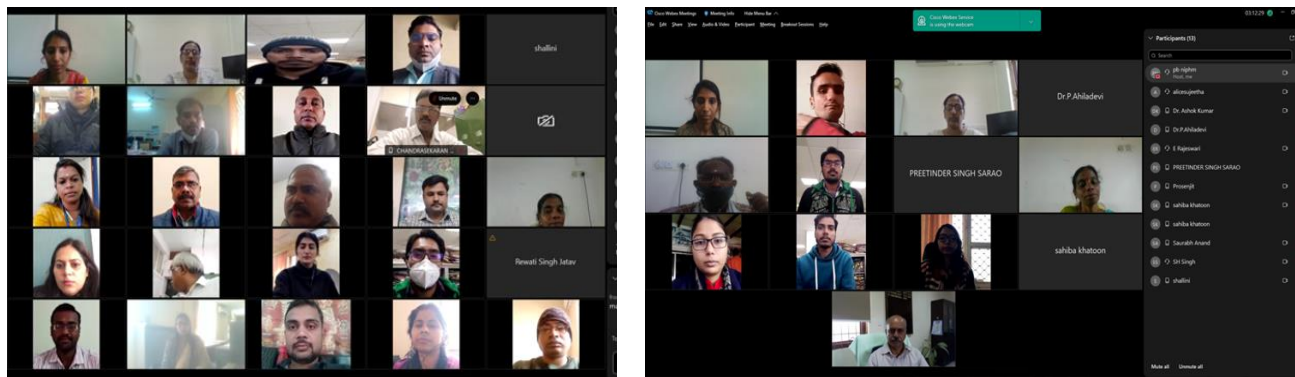
3. Fruit fly Surveillance and Management: One online training programme was conducted from 17.01.2022 to 21.01.2022 (5 Days). The programme was attended by 32 officers from various states and departments of agriculture & horticulture. Experts have been invited and different lectures were organized for identification & detection of fruit fly species, lure preparation and other different aspects of fruit fly surveillance and management.



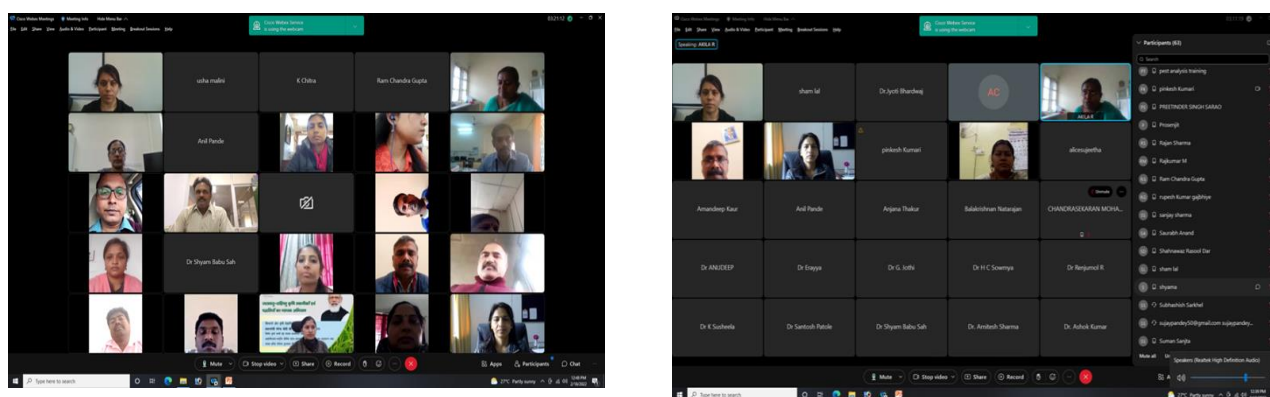
4. Plant Biosecurity & Incursion Management (PBIM): Well organized incursion management of plant pests is the need of the hour to safeguard the plant biosecurity of the Nation. National Institute of Plant Health

Management (NIPHM) has been designated as a nodal Centre by Department of Agriculture & Farmers Welfare, Ministry of Agriculture & Farmers Welfare, Government of India to develop human resource in Plant Biosecurity. A 12- Days online Training Program was organized from 07th to 18th February, 2022 and totally, 40 participants attended the programme.

- 5. Introduction to Plant Biosecurity and Plant Quarantine (IPB&PQ):** A Five days online training programme (sub- module under PBIM programme) was organized from 07th to 011th February, 2022 and 9 participants attended the IPB&PQ programme through virtual platform.



- 6. Pest Risk Analysis:** Pest Risk Analysis is used to assess the risks of entry, establishment and spread of exotic pests. PRA helps to identify the options to prevent the entry and management options in the event of pest establishment. The international standards brought out by IPPC serve as guidance for carrying out PRA. A five days online programme (sub-module of PBIM) was organized from 14th- 18th February, 2022 and 43 eligible officers from various organizations attended the programme. The participants learnt the importance and steps of PRA for market access of new commodities in the international trade through technical sessions and followed by mock exercises.



- 7. Forced Hot Air Treatment (FHAT):** One on campus programme of 5 days duration was organized on payment basis for Operators from 21st to 25th February, 2022. Total 39 participants were attended the programme. The programme aimed to provide knowledge on NSPM-9 and other issues related to treatment of solid wood packing material. Training covered requisites associated with Solid Wood Packing Material (SWPM), its associated pests

(fungi, insects and nematodes), phytosanitary treatments, design and construction of FHAT, equipments and their specifications, accreditation and audit protocol and calibration of sensors and treatment procedures. NIPHM is the only resourceful institute specialized in offering training on FHAT in accordance with ISPM-15 and NSPM-9.



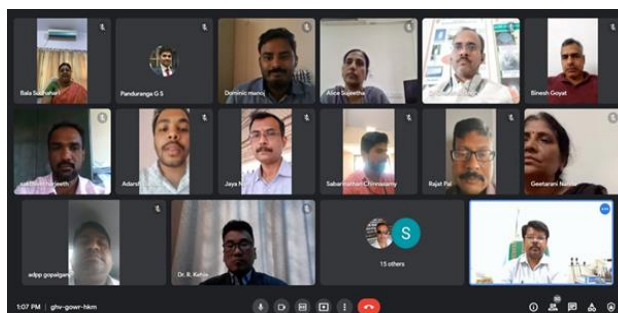
8. Fumigation as a Phytosanitary Treatment (Methyl Bromide and Aluminium Phosphide Fumigation): One On Campus programme of 15 days was conducted from 28.02.2022 to 14.03.2022 on payment basis and a total 25 participants were attended the programme. The participants got familiarized with physical and chemical properties of Phosphine and Methyl bromide, safety precautions to be followed while handling fumigants, mode of action of fumigants, principles of fumigation, monitoring the fumigant concentration, appropriate use and maintenance of fumigants and safety equipments. The participants were made to understand the guidelines laid in NSPM-11, 12 (MBr fumigation) and NSPM-22 (Phosphine fumigation) to conduct appropriate fumigation procedures as well as the accreditation procedure of fumigation operators prescribed by the DPPQ&S. The trainees gained hands-on practical experience in creating gas-tight enclosure, laying gas supply and monitoring lines, use of vaporizer, fan, leak detector and gas concentration monitor.



- 9. Collaborative training programme with TSHDCL, Telangana and Horticulture Department Tamil Nadu on Export promotion procedures of APEDA Cluster crops (Mango, Chilli, Turmeric and Banana):** Two Days programme from 08th to 9th February, 2022 (payment basis) was organized for the officers of Horticulture Department of Telangana and Tamil Nadu with an objective to create awareness about plant quarantine and the procedures involved in export of horticultural commodities (as per APEDA clusters) as well to improve the export performance of horticulture products by adoption of Good Agriculture Practices (GAP) which will also help in boosting the exports.. Different lectures were scheduled in such a way that all the 17 officers' get well acquainted with procedures for export of Mango, Chilli, Turmeric and Banana as per the requirement of the importing country.



- 10. Plant Quarantine Procedures for Import and Export:** A Five days online programme from 7th- 11th February, 2022 was organized and forty eight officers were attended the programme. The international regulatory framework and plant quarantine procedures for export and import of agricultural commodities meant for consumption, propagation, bio-control and germplasm were covered during the sessions.
- 11. Rodent Pest Management:** A 5-Days online training programme was organized from 14th to 18th February, 2022 for Agricultural Extension officers and scientists of SAUs, ICAR. Total 32 officers (AOs/ ADAs/ Scientists from SAUs) were trained on various aspects such as major rodents pests in agriculture and horticulture cultural ecosystem, biology and morphology of rodents, breeding profile of rodents, rodent borne diseases, non-chemical and chemical management of rodent pest etc.



12. Certificate Course on Urban Integrated Pest Management- Payment Programme: NIPHM is the premier Institute in India to offer specialized capacity building programs such as training in the area of Vertebrate & Urban Pest Management. As per the Insecticides Rules framed under Insecticides Act, 1968 the PCOs who apply for grant of license for undertaking pest control operations should be at least a graduate in Agriculture or in Science with Chemistry as a subject with a certificate of minimum 15 days training on Urban Integrated Pest Management. Considering these aspects, National Institute of Plant Health Management has organised a certificate course on Urban Integrated Pest Management for the structural pest management professionals. The specific areas covered were ecology and ethology of rodents, mosquitoes, termites, cockroaches, bedbug and flies etc. and their management practices. In addition other topics *i.e.* safe and judicious use of pesticides, care, handling and maintenance of pesticide application equipment, food safety & standards in food processing industries and urban weed management etc. were also covered and a total 30 candidates were attended this programme from 1st to 15th March, 2022.



B. FARMERS PROGRAMMES

- a. **Export procedures and related IPM on Oranges Export:** Two days training programme in collaboration with Regional Central Integrated Pest Management Centre, Nagpur, Maharashtra was organized from 14th to 15th March, 2022. The world is having the demand of 73 lakh tons but the India only exporting about 60000 thousand tons of oranges. There is continuous increase in the area of orange production. Hence, a lot of

scope of orange export from India. India is on 3rd rank in case of production of orange and 9th rank in export when compared at world level.

A total of one hundred and four orange growing farmers of Katol region, Nagpur were attended the programme. During this programme emphasis was given on the export procedures of orange and required GAP to enhance the export to different countries. The export procedure was explained in detail to FPOs to take lead in learning and creating awareness among the farmers about the export procedure of oranges and enlightened about international market of oranges and export requirements. Information was also shared on other product of oranges like orange Acids, Orange essential oils having the demand of export and use of waste oranges used for preparation of such products.



C. FORTHCOMING PROGRAMMES OF PBD & VPM (APRIL- JUNE, 2022)

Division	Name of the programme	No. of Days	From	To
PBD	Fruit fly: Surveillance and Management	05 days	04.04.2022	08.04.2022
	Invasive Alien Species: Introduced and Emerging Pests	03 Days	11.04.2022	13.04.2022
	Plant Quarantine Procedures for Import and Export	05 Days	18.04.2022	22.04.2022
	Refresher course for fumigation (Aluminium Phosphide and Methyl Bromide)	06 Days	25.04.2022	30.04.2022
	Stored Grain pest detection, identification and management	05 days	09.05.2022	13.05.2022
	Pest Surveillance	05 days	23.05.2022	27.05.2022
	Pest Risk Analysis	05 days	06.06.2022	10.06.2022
	Fumigation as a Phytosanitary Treatment (Methyl Bromide and Aluminium Phosphide)	15 days	13.06.2022	27.06.2022

VPM	Rodent Pest Management	05 Days	18.04.2022	22.04.2022
	Annual conference for members of PMPWAM (Pest Management Professionals Welfare Association, Mumbai)	03 days	07.04.2022	09.04.2022
	Certificate Course on Urban Integrated Pest Management	15 Days	04.05.2022	18.05.2022
	Rodent Pest Management in Grain Storage	05 Days	20.06.2022	24.06.2022

Plant Health Management Division

Training programmes

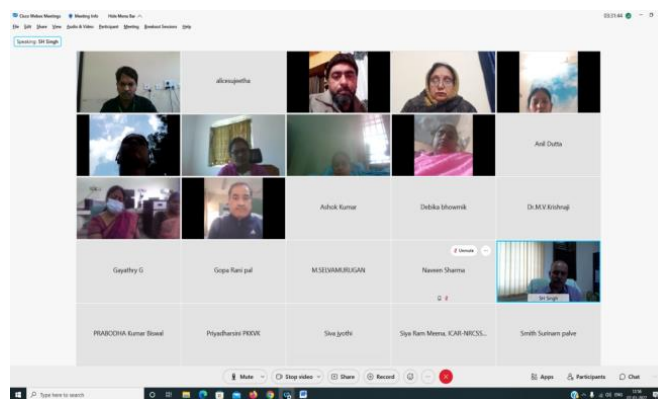
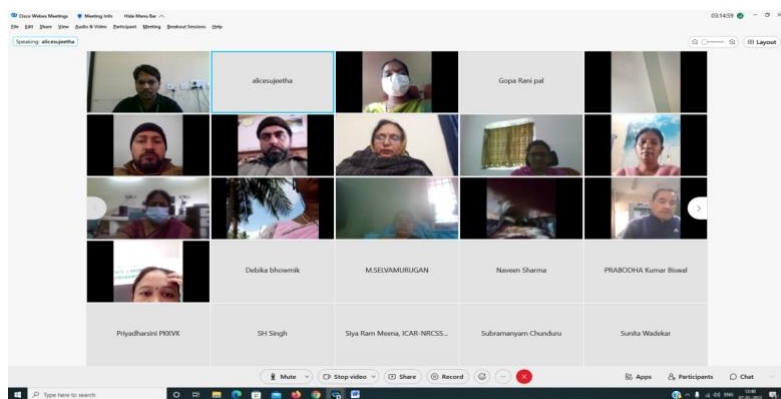
S No	Name of the programme	No. of Days	From	To
I.	Officers programme			
1.	Production Protocol for Biofertilizers	05	03.01.2022	07.01.2022
2.	Good Agricultural Practices	05	17.01.2022	21.01.2022
3.	Integrated Soil Nutrient & Rhizosphere Management	05	07.02.2022	11.02.2022
4.	AESA and Ecological engineering in pest management	05	14.02.2022	18.03.2022
5.	Quality control of Microbial Biopesticides	10	21.02.2022	02.03.2022
6.	Production Protocol for Entomopathogenic Nematodes	05	21.02.2022	25.02.2022
7.	PHM in protected cultivation	05	07.03.2022	11.03.2022
8.	Field Diagnosis and Management of Plant Parasitic nematodes	05	14.03.2022	18.03.2022
9.	On-farm production of biocontrol agents and microbial Biopesticides	05	21.03.2022	25.03.2022
10.	Production protocol for Biofertilizers and Biopesticides	05	28.03.2022	30.03.2022
II.	Farmers training programme			
1.	On farm production of Predators and Parasitoids	01	05.01.2022	-
2.	Farmer training programme on 'Biological Control of Pest and Diseases'	01	03.02.2022	-
3.	Farmers Training programme on On-farm production of <i>Trichoderma</i> and <i>Pseudomonas</i>	01	05.02.2022	-
4.	On farm production of biocontrol agents and microbial Biopesticides	01	08.02.2022	-

5.	On farm production of biocontrol agents and microbial biopesticides	01	15.02.2022	-
6.	On-farm production of biocontrol agents	01	16.02.2022	
7.	Farmers training on nematode management in protected cultivation	01	17.02.2022	-
8.	Ecological approaches for pest management	01	22.02.2022	-
9.	Role biocontrol agents in protected cultivation	01	04.03.2022	-
10.	On-farm production of biofertilizers and Biopesticides	01	07.03.2022	08.03.2022
11.	Farmers training programme on Nematode Management in Protected Cultivation	01	30.03.2022	-
III.	Webinars/Workshop			
1.	Second Bi annual subcommittee of National Network of Plant health Experts.	01	25.01.2022	-
IV.	Educational programme			
1.	Certificate course on Plant Health Management in organic Farming (Part-III)	10	14.03.2022	23.03.2022

I. Training programme report (officers)

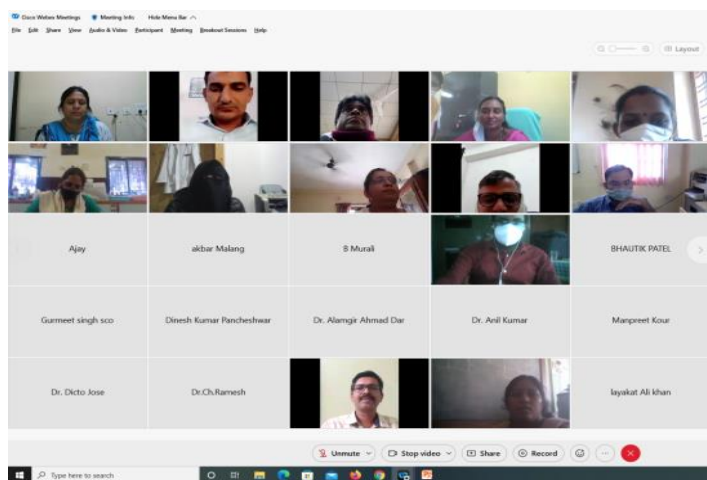
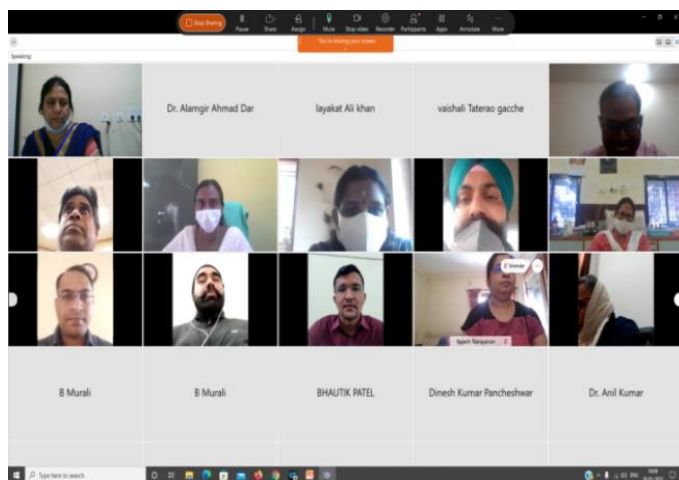
1. Production Protocol for Biofertilizers

As scheduled in the NIPHM training calendar 2021-22, an online training programme on ‘Production Protocol for Biofertilizers’ was organized by NIPHM from 03.01.2022 to 07.01.2022 (5 days). In this programme total of 35 officers/ scientists/ field level officers from different states & organizations have been participated. During this virtual training programme, the topics like role of Biofertilizers in Soil and Plant Health Management , protocol for isolation, purification of microbial isolates used in biofertilizer production, mycorrhizae biofertilizer for sustainable Agriculture, on-farm production of Mycorrhizae (VAM) biofertilizer, isolation and quality control of Mycorrhizae biofertilizers, on-farm production of bacterial Biofertilizers and application methods, mass production of carrier & Liquid based Biofertilizers , guest lecture: Legal aspects of Organic fertilizers and bio-fertilizers by Dr.Gagnesh Shrama, Director (i/c), NCOF, Ghaziabad, U.P., Quality Control of bacterial Biofertilizers, Guest lecture: Novel techniques in bio formulations development by Dr.Mahadeva Swamy, Professor& Head, UAS, Raichur, Karnataka are covered. NIPHM technology videos are also shown for understanding the protocols.



2. Good Agricultural Practices

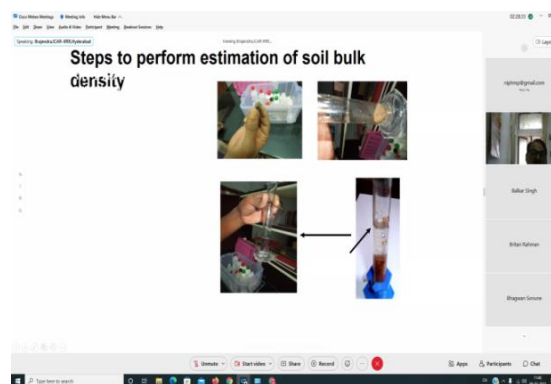
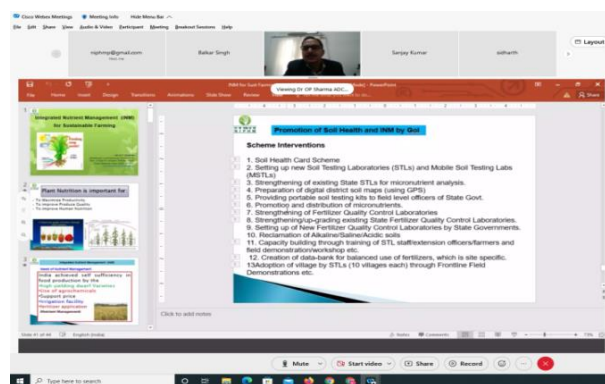
As scheduled in the NIPHM training calendar 2020-21, an online training programme on “**Good Agricultural Practices**” from **17-01-2022 to 21-01-2022 (5 days)** was conducted. In this training programme sessions such as introduction to India GAP-BIS, Role of Bio-control agents in insect pest management, Ecological engineering for pest management and Role of AESA based PHM to promote Sustainable Agriculture, Role of mycorrhiza and other biofertilizers in PHM and On farm production of biofertilizers and Significance of soil testing & soil test based nutrient management, Role of biopesticides in disease management and On farm production of *Trichoderma* and *Pseudomonas*, On farm production of host culture (*Corcyra cephalonica*), parasitoids and predators, pesticide Application Techniques, Pesticides and Food Safety issues in relation to GAP, GAP for the management of Vertebrate pest, Integrated Nematode Management and Mass production of EPF & NPV were delivered. The programme has successfully completed.



3. Integrated Soil Nutrient & Rhizosphere Management

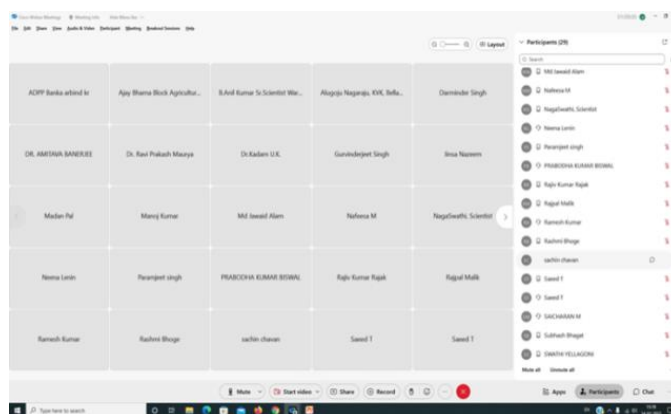
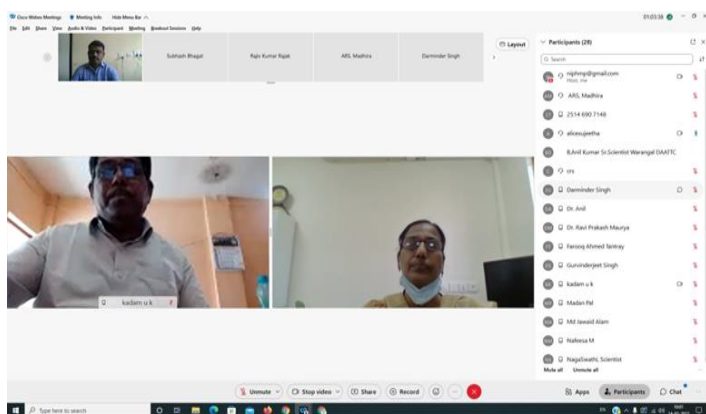
As per the training calendar 2021-22, an online training programme on ‘Integrated Soil Nutrient & Rhizosphere Management’ was organized at NIPHM from 07.02.2022 to 11.02.2022 (5 days). In this programme total of 30 officers/scientists from different states & organizations. The participants underwent various aspects of integrated soil nutrient management aspects including approaches like living soil concept & role of biofertilizers in soil

nutrient management, principles of soil nutrient management, identification of plant nutrient deficiency symptoms, on-farm production of biofertilizers and bio-pesticides, integrated nutrient management for sustainable farming, Soil test-based nutrient management indifferent crops, vermitechnology in soil fertility management, nematode management for soil health management, Ecological Engineering concept for below-ground pest management, rhizosphere engineering for PHM & impact of agrochemicals o soil biological properties, etc. All participants submitted their back at the work plan/home plan and assignments.



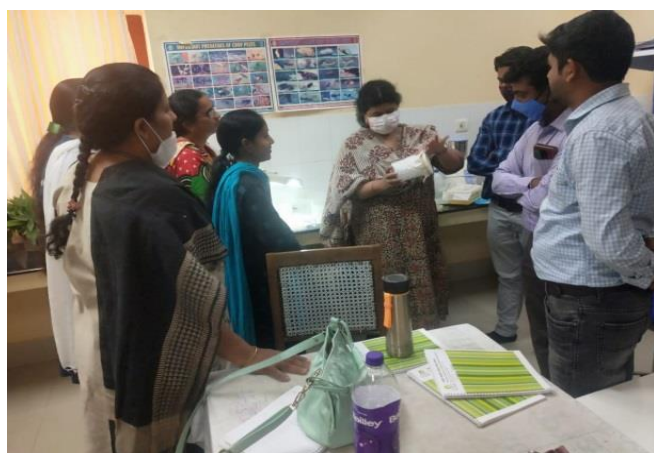
4. AESA and Ecological engineering in pest management

As per the training calendar 2021-22, an online training programme on ‘AESA and Ecological engineering in pest management’ was organized at NIPHM from 14.02.2022 to 18.02.2022 (5 days) .In this programme total of 31 officers/scientists from different states & organizations. The participants underwent various aspects of Principles and concepts of Integrated Pest Management, Introduction to Biological Control -Principles and Concept, Field diagnosis of nematodes, Principles Ecological Engineering for pest management, Agro ecosystem analysis (AESA) Concepts & AESA in different crops, On farm mass production of important biocontrol agents (predators), Trap Crops, Intercropping and Companion Planting in Pest management, Role of bio pesticides in soil health management, On farm mass production of important biocontrol agents (parasitoids), Role of biofertilizers in Soil health Management and On-farm production of bacterial Biofertilizers, Rhizospheric Engineering for Plant Health Management, Technology videos of AESA and Ecological Engineering, Botanicals for pest Management.



5. Quality control of Microbial Biopesticides

As per the training calendar 2021-22, a training programme on Quality control of Microbial Biopesticides was organized from 21.02.2022 to 02.03.2022 (10 days). In this programme total 08 officers from different states & organizations have participated. During this training programme, the trainees underwent online classes on various aspects of the Insecticide Act, 1968-Registered Biopesticides under Insecticide Act, 1968. Explained about Preparation and Maintenance of pure cultures of fungus and bacteria and parameters to be tested for quality control of bio pesticides such as NPV, *Trichoderma viridae*, *Pseudomonas* spp, physico chemical parameters (pH, Moisture content), quality control parameters for Entomopathogenic fungi, Grams staining technique, and POB count for NPV. The participants also underwent classes the establishment of Microbial biopesticide Laboratory, requirements to get Accreditation as per ISO-17025.



6. Production Protocol for Entomopathogenic Nematodes

As scheduled in the NIPHM training calendar 2021-22, an online training programme on “Production Protocol for Entomopathogenic Nematodes” ‘was organized at NIPHM from 21.02.2022 to 25.02.2022 (5 days). In this programme total 22 officers/scientists from different states & organizations have participated. The participants have under gone various aspects of “Production Protocol for Entomopathogenic Nematodes” aspects such as introduction to biological control -principles and concepts, on-farm production of host insect, *Corcyra cephalonica* and Wax moth, introduction to Entomopathogenic nematodes, Entomopathogenic nematodes as best tool for insect Management, On farm production of Entomopathogenic nematodes. Formulation of Entomopathogenic nematodes, Morphological and Molecular Identification of Entomopathogenic nematodes. Success stories of use of EPN for the management of soil insect’s pests, application methods of EPN.

7. PHM in protected cultivation

As scheduled in the NIPHM training calendar 2021-22, an online training programme on ‘Plant Health Management in Protected Cultivation’ was organized at NIPHM from 07th to 11th March, 2022 (5 days). In this programme, 36 officers/scientists from different states & organizations have participated. In this training program a total of 12 lectures were delivered viz., IPM in protected cultivation: Protected Cultivation of vegetables :

Predators in protected cultivation: Role of parasitoids in protected cultivation: Scope of EPF in protected cultivation: Botanical and ITK consortia: preparation and application in protected cultivation: IDM of vegetable crops in green house: Exploitation of NPV in protected cultivation: Nematode management in protected cultivation: Protected cultivation: Opportunity and challenges: Use of biofertilizers in Polyhouse cultivation.

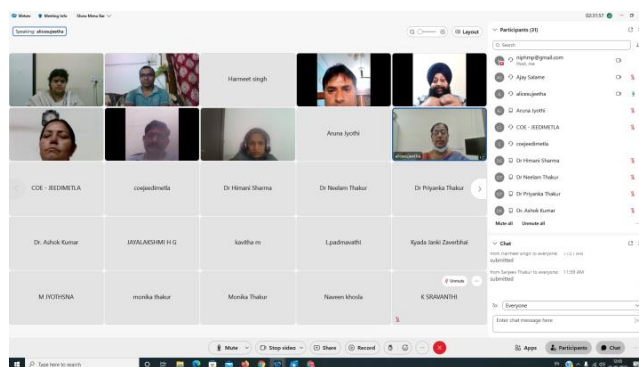
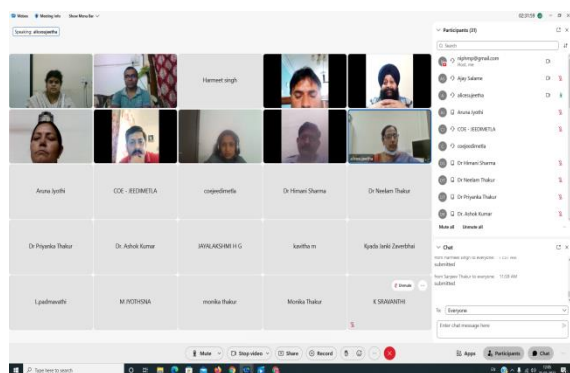


8. Field Diagnosis and Management of Plant Parasitic nematodes

As per the instructions from Higher authority of NIPHM farmers training programme on Field Diagnosis and Management of Plant Parasitic nematodes” 14th to 18th March 2022 (5 days) In this programme total of 45 participants have been participated. This training was useful to the participants in understanding about Current Status of Plant Parasitic Nematode Problems in India. Plant parasitic nematodes of quarantine importance in India. Introduction to Entomopathogenic nematodes. Identification of plant parasitic nematodes. Nematode Problems and their management in in Agricultural crops. Nematode management in polyhouse. On Farm Mass Production of *Trichoderma*, *Pseudomonas*, *Pacelomyces lilacinus* for the biological control of nematodes. Nematode Management in Horticultural crops. Sampling and Extraction of plant parasitic nematodes.

9. On-farm production of biocontrol agents and microbial Biopesticides

The training program on On-farm production of bio-control agents and microbial biopesticides conducted from 21st March to 25th March 2022 through online mode by NIPHM. A total of 34 participants from different organizations have attended this program. In this programme the topics like Introduction to biological control-principles and concept, ecological engineering in pest management, on farm production of host insect *Corcyra cephalonica*, Biopesticide in plant disease management, on farm mass production of important predators, on farm production of important parasitoids, on farm production of *Trichoderma* and *Pseudomonas*, importance of biofertilizer and their use, on-farm production of entomopathogenic nematodes, on farm production of EPF and NPV, use of botanical in plant health management and on-farm production of bacterial biofertilizer are delivered through online.



10. Production protocol for Biofertilizers and Biopesticides

As approved by competent authority a training programme on Production protocol for biofertilizers and biopesticides has been conducted from 28.03.2022 to 30.03.2022 (3 days). In this programme about three participants from biolab, KVK,Sagroli, Maharashtra state have been participated. In this training programme different practical aspects like role of biofertilizers and biopesticides in soil health and plant health, isolation and mass multiplication of bacterial biofertilizers and biopesticides, on-farm production of biofertilizers and *Trichoderma* and *Pseudomonas*, role of EPF,NPV in plant health management and their mass production, quality control of biofertilizers and biopesticides.



II. Farmers training programmes

1. On-farm production of Predators and Parasitoids

A off campus training programme on *On farm production of Predators and Parasitoids* was organized on 05.01.2022. In this training program 20 farmers from Burjugadda thanda and 13 PGDPHM students from NIPHM were participated. During this program on- farm production of important predators like reduviidbugs, anthocorid bugs , Trichogramma and *Chelonusblackburnii* parasitoids and their field application techniques were explained to the participants.Later went to field visit of bhendi ,brinjal cucurbits and explained about important pests of the crops and their management.



2. Farmer training programme on ‘Biological Control of Pest and Diseases’

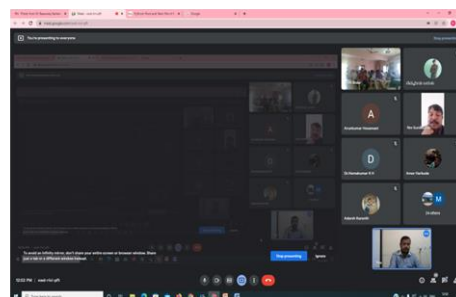
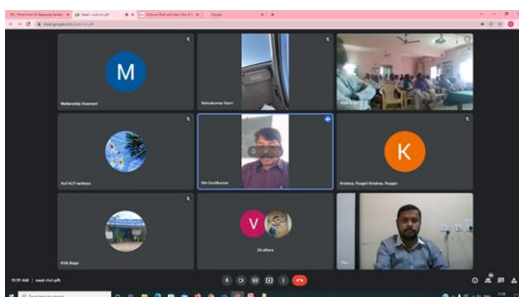
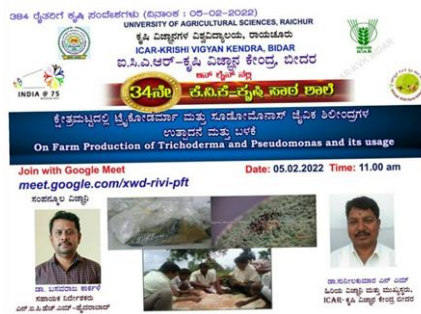
A training cum interaction session on ‘Biological Control of Pest and Diseases’ conducted on 03rd February, 2022 at Chowderapally Village, Ibrahimpatnam Mandal, RR Dist. TS. A total of 15 participants attended the program. In the training, importance and field application techniques of different biological control agent’s viz., natural enemies such as predators (reduviid bugs, lacewing, predatory anthcorid bugs and LBB) and parasitoids (*Trichogramma* spp, *Bracon* spp.) of crop pests. In this training programme farmers were also educated about the importance, usage, mode of actions and methods of applications of bio-pesticides like *Trichoderma* and *Pseudomonas* to manage important plant diseases. Further, the farmers were also explained about the importance of using biofertilizers (*Azotobacter*, PSB, *Rhizobium*) in different crops and farmers were also explained about the methods of application of biofertilizers. Under the training programme the fields of papaya, tomato, bottle gourd, green gram, bitter gourd and ridge gourd were also visited and the suitable recommendations were given for managing the pest and diseases observed in particular fields. After the explanation the cultures of different bio-inputs were distributed to the farmers.





3. Farmers Training programme on On-farm production of *Trichoderma* and *Pseudomonas*

Program Details: An online training cum interaction session on ‘On-farm production of *Trichoderma* and *Pseudomonas*’ was conducted on 05th February, 2022 at Krishi Vigyana Kendra Bidar, Karnataka in Kannada language. A total of more than 100 participants from Bidar district and other parts of Karnataka attended the training program. The training was conducted in Kannada language. The inaugural address and brief introduction about the program was given by Dr M Sunilkumar, Senior Scientist and Head, ICAR-KVK, Bidar Karnataka and lecture was delivered by Dr. S. Basavaraj, Assistant Director (PHM-H&F) NIPHM. In the training programme, the importance, on-farm production technology and field application methods of biopesticides viz., *Trichoderma* and *Pseudomonas* were explained in detail to the farmers and also the information on mode of action and the diseases that can be managed using the above biopesticides was also passed on to the farmers. Further, the farmers also interacted with the resource persons on the on-farm production techniques of biopesticides.



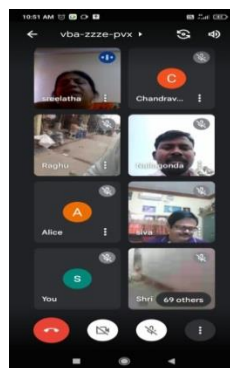
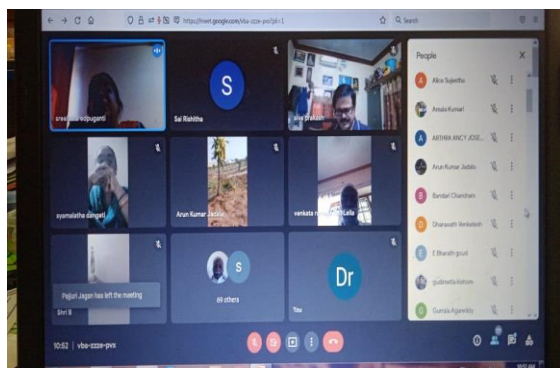
4. On-farm mass production of Biocontrol agents

A training cum interaction session on On-farm production of biocontrol agents and microbial biopesticides’ was conducted on 08th February, 2022 at Tuniki, Medak in telugu language. In this programme total of 50 farmers were participated. Ms. N. Lavanya SO(BP & BC) explained the production technology of bio pesticides, bio fertilizer, parasitoids and predators and distributed handouts to the farmers on production technology of bio-pesticides, bio fertilizer, parasitoids and predators. In the training programme, the importance, on-farm production technology and field application methods of biopesticides viz., biocontrol agents and biopesticides were explained in detail to the farmers and also the information on mode of action and the diseases and pest that can be managed using the above biopesticides was also passed on to the farmers. Further, the farmers also interacted with the resource persons on the on-farm production techniques of biopesticides.



5. On farm production of biocontrol agents and microbial biopesticides

As per the instructions of competent authority, an online farmers training programme on “On farm production of biocontrol agents and microbial biopesticides” on 15.02.2022 was conducted. In this programme total 88 productive farmers from different districts of Telangana and A.P have participated.



6. On- farm production of biocontrol agents

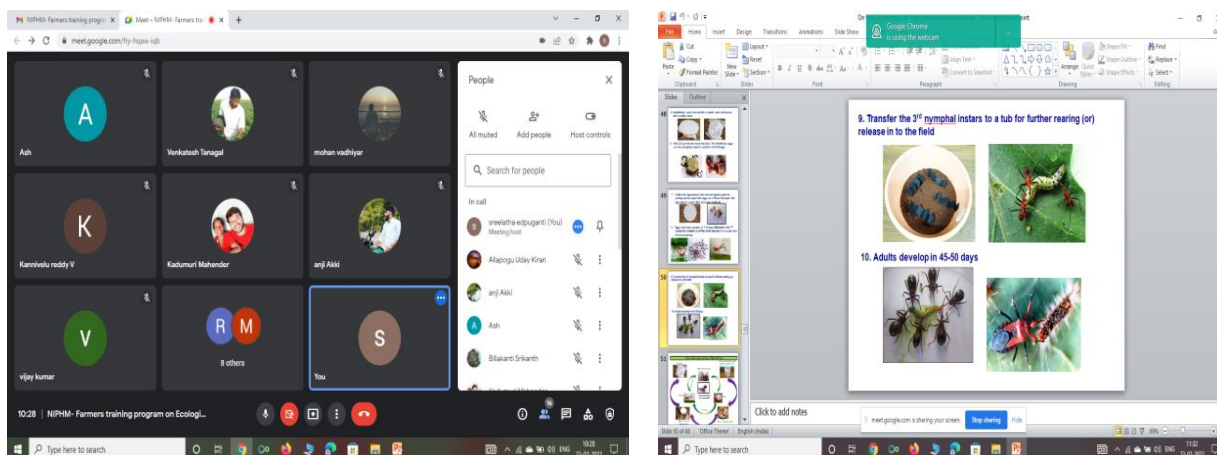
An off- campus training on “on- farm production of biocontrol agents” was conducted on 16.02.2022 at Juluru village of Poachampally Mandal, Badradri district. 30 farmers from the village and AEOs participated in the training. As part of the training program on farm production of predators, *parasitoids*, *Trichoderma* and

Pseudomonas was explained. Use of *Trichogramma* in management of rice pest was explained and method of release of *Trichogramma* was shown to farmers. How pseudomonas is helpful in managing rice diseases was explained to the farmers.



7. Ecological approaches for pest management

As per the instructions of competent authority, an online farmers training programme on “**Ecological approaches for pest management**” on 22.02.2022 was conducted. In this programme total 38 productive farmers from different districts of Telangana and A.P have participated.



8. Farmers training on nematode management in protected cultivation

As per the instructions of competent authority, a farmers training programme on “Nematode management in protected cultivation” on 17.02.2022 was conducted. In this programme total 17 polyhouse farmers from Malakaram village, Shmashabad mandal district of Telangana have participated.

9. Role biocontrol agents in protected cultivation

Conducted an off-campus training to farmers of polyhouses on “Role of biocontrol agent in protected cultivation at chilukuru village of chevella Mandal. A total about 17 polyhouse farmers cultivating vegetables in polyhouses participated from chevella. As a part of the program the different biocontrol agents used in the polyhouse for management of different crop. Pest was shown to farmers. Release of *Chrysoperla* grubs and eggs in aphid infested cucumber plant was shown to the farmers.



10. On-farm production of biofertilizers and Biopesticides

Training cum demonstration on the ‘On-farm production of bio-fertilizers and bio-pesticides’ for beneficiary farmers in 20 IPM villages under the lower palar sub basin of Kancheepuram and Chengalpattu Districts, Tamil Nadu has been conducted on 07th and 8th March, 2022. A total of more than 100 farmers from Kancheepuram and Chengalpattu districts of Tamil Nadu attended the training program. During this training programme briefly explained about the use and application method of important microbial biocontrol agents and also taken success story of on-farm production technology of bio-fertilizers (Mycorrhizae, *Rhizobium*, *Azotobacter*, *Azospirillum* and Phosphorus Solubilizing Bacteria) and microbial bio-pesticides (*Trichoderma harzianum* and *Pseudomonas fluorescens*) and also visited field trail of use of biocontrol agents. In this programme additional director from directorate of agriculture and joint director of agriculture Kancheepuram and Chengalpattu also participated and insisted on the use and the importance of bio-control agents by IPM village farmers.



11. Farmers training programme on “Nematode Management in Protected Cultivation

As per the instructions from higher authority farmers training programme was organized on “Nematode Management in Protected Cultivation” Conducted on 30th March 2022 at Pendiya village Maheswarammandal Ranga Reddy district. In this programme total of 15 farmers of polyhouse were attended. Horticulture farmers including polyhouse farmers were facing serious problems of nematode diseases in the crops

grown in polyhouse and guava orchards. In this programmes organic farming farmers were also attended. This training was useful to the farmers in understanding about Identification of plant parasitic nematode diseases and integrated nematode management in polyhouse condition and guava orchards. Farmers were also learnt about the use of facilities provided by NIPHM for the analysis of soil for nematode infestation and consultation services providing for the management of nematodes.



III. Webinars/Workshop/Conference:

1. **Second Bi annual subcommittee of National Network of Plant health Experts.**

As per approval at 14th GC meeting, Plant Health Management division organized the *Second biannual subcommittee meeting of 'National Network of Plant Health Experts'* via semi online mode (scientist belongs to Hyderabad were physically present at NIPHM, Hyderabad) on 25th January 2022 from 10:30am to 2 .00 pm. The inaugural session was chaired by Dr.Sagar Hanuman Singh, Director General NIPHM. Dr. J. Alice. R. P. Sujeetha, Director PHM i/c welcomed the dignitaries and participants. For this meeting four eminent resource persons were arranged to deliver their ideal topic related to the meeting. In this meeting a total of 50scientists from ICAR's and state agricultural and horticultural universities have participated in the meeting. During this meeting the following discussions held.

Challenges and constraints in the registration and production of microbial bio-pesticides in Indiapresented by Dr. Dr. S.J Rahman, University Head, Department of EntomologyPJ TSAU, Hyderabad. He focused the requirements for bio-pesticides registration in India, what are the issues in registration and compliance are explained well. He enlightened about introduction about insecticide act-1968 and its purview. Explained about steps, issues of CIB&RC registration, complications involved in the process of registration completion.

Next session on Socio Economic impact of spurious and fake pesticide, bio-pesticides and bio-products by Shri. R G Agarwal, Chairman, Dhanuka Group. He presented the session with different linking process of pesticides

market and quality control of pesticides. Focused and explained about impacts of spurious and fake pesticides/ biopesticides on farming community.

Finally, the session held on Use of drones and its implications in agriculture by Dr.C.R.Mehta, Director, ICAR-Central Institute of Agricultural Engineering, Bhopal. He enlightened about different types of drone and its applications in agriculture and allied sciences. He emphasized on SOP of drones and implications.



IV. Educational programme

Certificate course on Plant Health Management in Organic Farming

As per the schedule of the course 22 participants joined the Part-III programme at NIPHM from 14.03.2022 to 23.03.2022. As per the schedule of the course, all the participants prepared the Part II (Project work) presentation as prescribed format. As approved by the competent authority the experts from local IIFSR centre are invited for project report and presentation evaluation. All the participants presented their project work report and submitted the reports.



Forthcoming training programmes

S No	Name of the programme	No. of Days	From	To
I. Officers training programmes				
1.	Farm level production of bio-inputs	10	04.04.2022	13.04.2022
2.	Production Protocol for microbial bio pesticides	05	18.04.2022	22.04.2022
3.	Training on Good Agricultural Practices (GAP)	05	25.04.2022	29.04.2022
4.	Conservation of insect pollinators in Agriculture	03	04.05.2022	06.05.2022
5.	Locust Pest management	03	09.05.2022	11.05.2022
6.	Organic farming practices and certification process	03	17.05.2022	19.05.2022
7.	Plant Health Management in Protected cultivation	05	23.05.2022	27.05.2022
8.	Integrated Soil Nutrient and Rhizosphere Management	05	06.06.2022	10.06.2022
9.	Production Protocol for bio fertilizers	05	13.06.2022	17.06.2022
10.	Training on Good Laboratory Practices	03	20.06.2022	22.06.2022
11.	Production Protocol for Bio control agents (Predators, parasitods, microbial bio pesticides & Bio fertilizers)	21	29.06.2022	19.07.2022
II. Farmers training programmes				
1.	On farm production of bio control agents	03	04.04.2022	06.04.2022
2.	On farm production of bio control agents	03	04.05.2022	06.05.2022
3.	On farm production of bio control agents	03	01.06.2022	03.06.2022
III. Webinars/Workshop/Conference				
1.	Bi-annual sub Committee Meeting of National Network of Plant Health Experts	01	02.06.2022	-

Pesticide Management Division

Training Programme:

A. Division has conducted two online and three offline training.

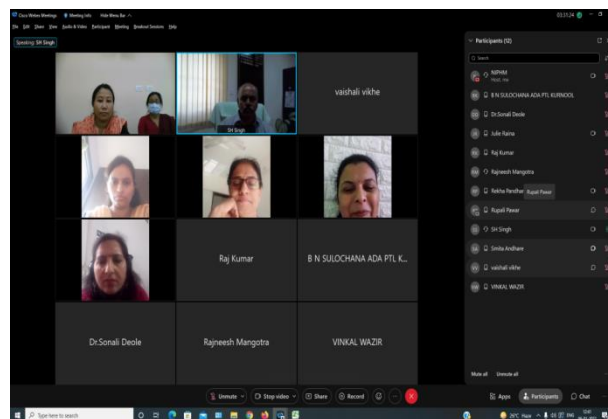
Sl. No.	Name of the programme	No. of Days	From	To
1.	Sampling of Fruits, Vegetables and other items and Calibration of Laboratory equipment for Pesticide Residue Analysis	3 (Online)	04.01.2022	06.01.2022
2.	Pesticide Formulation Analysis	60 (Offline)	18.01.2022	18.03.2022
3.	Role of PT & ILC in Quality Assurance & maintaining accreditation as per ISO/IEC: 17025:2017	1 (Online)	03.03.2022	-
4.	Laboratory Quality Management System and Internal Audit as per ISO/IEC 17025 2017	5 (Offline)	07.03.2022	11.03.2022
5.	Laboratory Quality Management System and Internal Audit as per ISO/IEC 17025 2017	5 (Online)	21.03.2022	25.03.2022

B. One online and two offline training programme for farmers were conducted during Jan to March 2022

Sl. No.	Name of the programme	No. of Days	From	To
1.	Safe Use, Storage and Disposal of Pesticides	1 (Online)	11.03.2022	
2.	Safe handling, Disposal of pesticides and pesticide containers	1 (Offline)	23.03.2022	
3.	Safe handling, Disposal of pesticides and pesticide containers	1 (Offline)	23.03.2022	

1. Sampling of Fruits, Vegetables & other items and Calibration of Laboratory equipment for Pesticide Residue Analysis:

Training on “**Sampling of Fruits, Vegetables & other items and Calibration of Laboratory equipment for Pesticide Residue Analysis**” was conducted from 4th to 6th January 2022, through virtual mode. A total of 12 officials from State Department of Agriculture of Maharashtra, Telangana, Raipur and Jammu & Kashmir were attended the programme. The trainees were trained on sampling guideline and procedure for fruit, vegetables, water, soil and other items for pesticide



residues analysis as per *Codex Alimentarius* methods of sampling for the determination of pesticide residues for compliance with MRLs. Portion of the commodities to which the codex MRL applies and which is analysed for residues were also presented to the trainees.

The trainees were also trained on calibration procedures of laboratory equipment for pesticide residues analysis such as analytical balance, Pipettes, Volumetric Glassware, GLC & HPLC, LC-MS/MS and GC-MS/MS.

2. Pesticide Formulation Analysis:

A 60 days training on “**Pesticide Formulation Analysis**” was conducted from 18th January to 18th March 2022 through physical mode. Seventeen participants from States Agriculture Department of Andhra Pradesh, Maharashtra, Karnataka, Kerala, Punjab, Tamil Nadu and Orissa were attended the training. The aim of the training is to build the capacity of Insecticide Analysts undertaking the Quality Control analysis of Pesticide Formulations on different analytical technique such as volumetric analysis, Chromatographic and Spectroscopic techniques using High Performance Liquid Chromatography (HPLC), Gas Liquid Chromatography (GLC), UV-Vis Spectrophotometer and Fourier-transform infrared spectroscopy (FT-IR) as per Bureau of Indian Standard method.

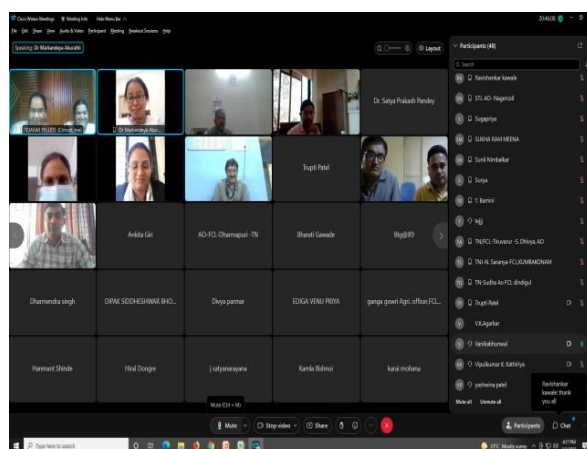
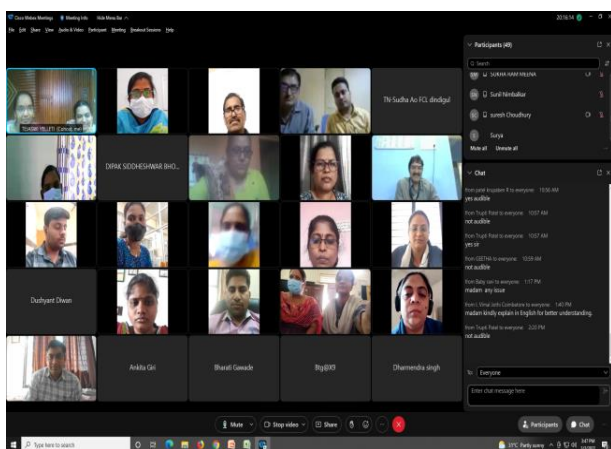
The participants also acquired knowledge on laboratory quality management system and Internal Audit as per ISO/IEC 17025:2017 and procedure for accreditation during 60 days training.



Training on Pesticide Formulation Analysis

3. Role of PT & ILC in Quality Assurance & maintaining accreditation as per ISO/IEC: 17025:2017:

Training on “**Role of PT & ILC in Quality Assurance and maintaining accreditation as per ISO/IEC 17025:2017**” was conducted on 3rd March 2022, through virtual mode. A total of 48 officials were attended the programme from various state department of Agriculture of Maharashtra, Gujarat, Kerala, Tamil Nadu, Rajasthan and Andhra Pradesh. The trainees were trained on importance of participation in PT/ILC for quality assurance in the testing field. During the training, planning and execution procedure of internal quality control and Inter Laboratory Comparison, monitoring of internal quality control activities with root cause analysis, corrective action to be taken were also presented and discussed.



4. Laboratory Quality Management System and Internal Audit as per ISO/IEC 17025 2017:

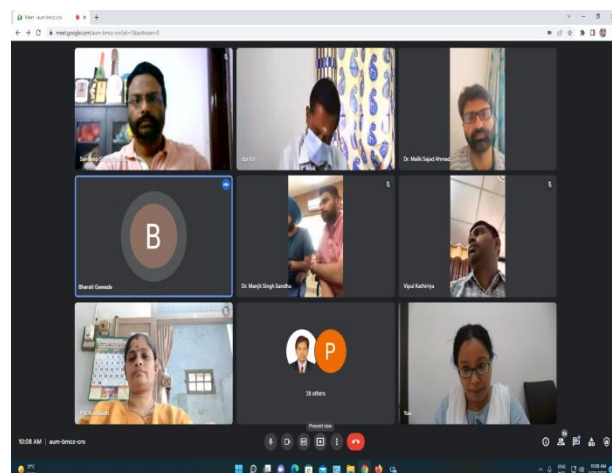
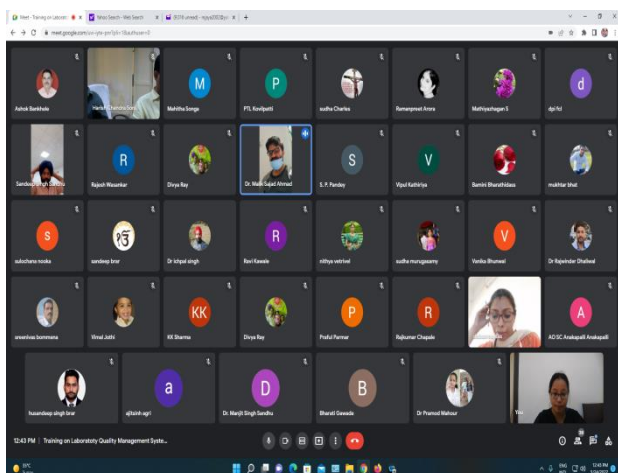
The Division has conducted training on “**Laboratory Quality Management System and Internal Audit as per ISO/IEC: 17025:2017**” from 07.03.2022 to 11.03.2022, through physical mode. A total of 36 officials were attended the programme from various State Department of Agriculture, Pesticide testing/ Fertilizer testing laboratories of Maharashtra, Tamil Nadu, Karnataka, Haryana, Odisha, Telangana, Punjab and Andhra Pradesh. The aim of the training is to understand the general requirement for the competence of testing and calibration laboratories in accordance with **ISO/IEC: 17025 2017**. The trainees were trained on internal audit conduction procedure and other requirements through mock internal audit.





5. Laboratory Quality Management System and Internal Audit as per ISO/IEC 17025 2017

The Division has conducted training on “**Laboratory Quality Management System and Internal Audit as per ISO/IEC: 17025:2017**” from 21.03.2022 to 25.03.2022, through virtual mode. A total of 40 officials were attended the programme from various State Department of Agriculture, Pesticide testing/ Fertilizer testing laboratories of Maharashtra, Gujarat, Tamil Nadu, Rajasthan, Telangana, Jammu & Kashmir, Punjab and Andhra Pradesh. Basically, the training is for laboratory analyst and during the training the trainees were trained on general requirement for the competence of testing and calibration laboratories in accordance with **ISO/IEC: 17025 2017**. The trainees were trained on internal audit conduction procedure and other requirements. The training will be benefited to testing laboratories for accreditation.



Farmers Programs:

6. Safe Uses, Storage and Disposal of Pesticides

One day online training on “**Safe Uses, Storage and Disposal of Pesticides**” for farmers was conducted in collaboration with KVK Sepahijala, Tripura on 11.03.2022. The training was designed for farmer’s awareness on safe uses of

pesticide, safe storage and disposal of pesticides to minimize the health hazard and contamination to the environment due to pesticide uses. A total of 50 farmers from Tripura were attended the programme.



7. Safe handling, Disposal of pesticides and pesticide containers

One day training on “**Safe handling, Disposal of Pesticides and pesticide containers**” for farmers on 23.03.2022 in collaboration with PHE Division was conducted at KVK, Tunki, Maidak District, Telangana. A total of 19 farmers were attended the programme. The training is designed especially for farmers to give awareness on safe handling of pesticide, disposal of pesticides and pesticide containers to minimize the health hazard and environmental contamination due to pesticide uses.



7. Safe handling, Disposal of pesticides and pesticide containers

The Division has conducted one day training on “**Safe handling, Disposal of pesticides and pesticide containers**” for farmers on 23.03.2022 in collaboration with PHE Division at KVK, Tunki, Maidak District, Telangana. A total of 20 farmers were attended the programme. The aim of the training is to give awareness on safe handling of pesticide, disposal of pesticides and pesticide containers to minimize the risk to the health and environmental contamination due to pesticide uses.



Forthcoming training programmes:

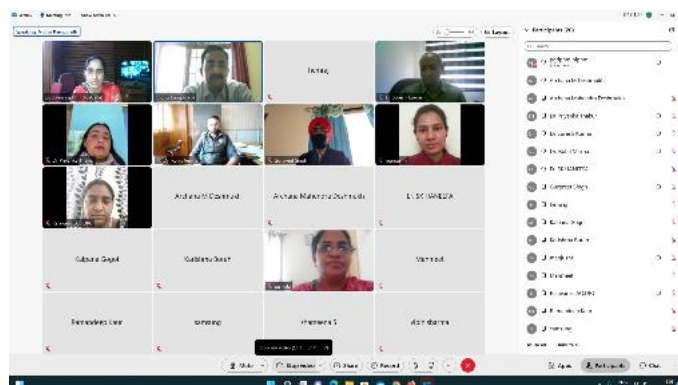
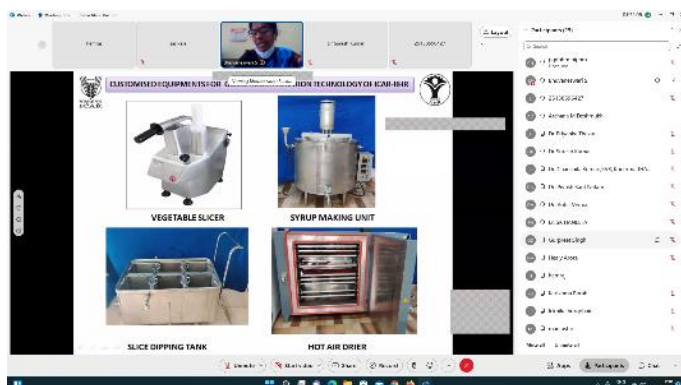
Sl. No.	Title of the Programme	Duration	From	To	Eligibility Criteria
1.	Pesticide Formulation Analysis	60 days	26.04.2022	24.06.2022	Analysts working at SPTLs / RPTLs/ CIL and other Government Labs engaged in Pesticide Formulation Analysis with educational qualification of Graduate in Chemistry / Agril / Hort
2.	Inspection, Sampling and Prosecution Procedures under Insecticide Act, 1968(ISPP)	5 days	09.05.2022	13.05.2022	Agricultural / Horticultural Officer (or equivalent position) working in State Department (or) designated Insecticide Inspector (Central / State)
3.	Laboratory Quality Management System and Internal Audit as per ISO/IEC 17025: 2017	5 days	13.06.2022	17.06.2022	Science Graduate with knowledge in laboratory activities, working in analytical Laboratories of state govt. / central govt. / ICAR / Govt. Universities
4.	Calibration of laboratory glassware and equipment for Pesticide Quality Testing Laboratories	8 days	12.07.2022	19.07.2022	Analysts working at SPTLs / RPTLs/ CIL and other Government Labs engaged in Pesticide Formulation Analysis and undergone training on Pesticide Formulation Analysis (PFA) of NIPHM.
5.	Calibration of laboratory glassware and equipment for Pesticide Quality Testing Laboratories	2 days	12.07.2022	13.07.2022	Analysts working at SPTLs / RPTLs/ CIL and other Government Labs engaged in Pesticide Formulation Analysis and undergone training on Pesticide Formulation Analysis (PFA) of NIPHM.

Plant Health Engineering Division

S No	Category	Name of the programme	No. of Days	From	To
1.	Officers	Post Harvest Management and Storage Techniques	05	07.03.2022	11.03.2022
2.	Officers	Pesticide Application Techniques and Safety Measures	05	21.03.2022	25.03.2022
3.	Officers	Farm Equipment for Plant Health Management- Collaborative programme with AICRP on FIM, Kerala	03	14.03.2022	16.03.2022
4.	Officers	Farm Equipment for Plant Health Management- Collaborative programme with Communication Centre, Kerala Agricultural University, Kerala	03	17.03.2022	19.03.2022
5.	Officer and Stake Holders	National webinar on “ Drone Applications in Agriculture – Spraying and beyond”	01	26.03.2022	26.03.2022
6.	Farmers	Pesticide application Techniques and Safety Measures	01	17.03.2022	17.03.2022
7.	Farmers	Pesticide application Techniques and Safety Measures	01	23.03.2022	23.03.2022

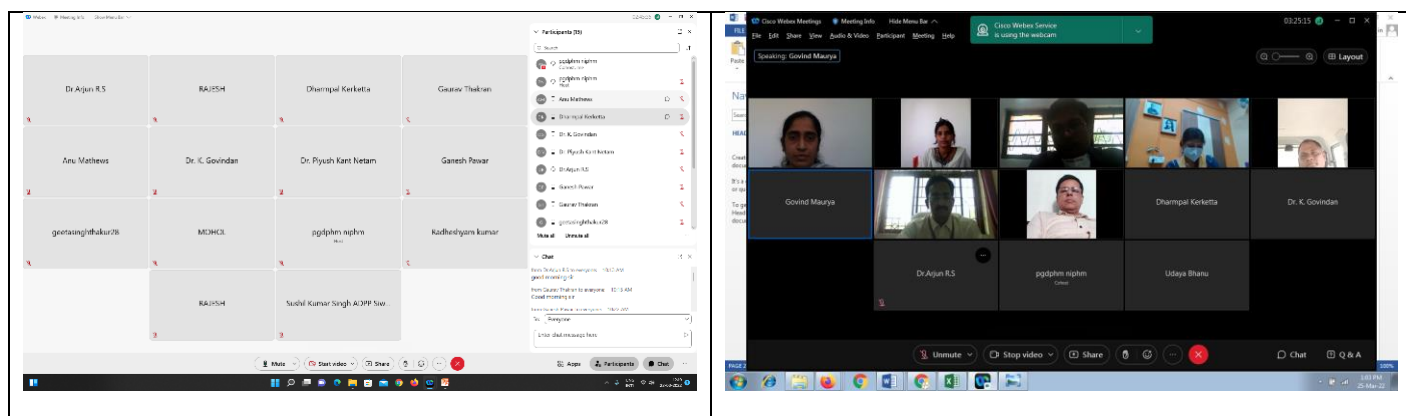
i. Post Harvest Management and Storage Techniques

A 5-day training programme on Post Harvest Management and Storage Techniques was conducted for 24 officers (07 Male and 17 Female) during 07th to 11th March 2022. This training program enhances participants knowledge on post harvest management of agriculture and horticulture commodities.



ii. Pesticide Application Techniques and Safety Measures:

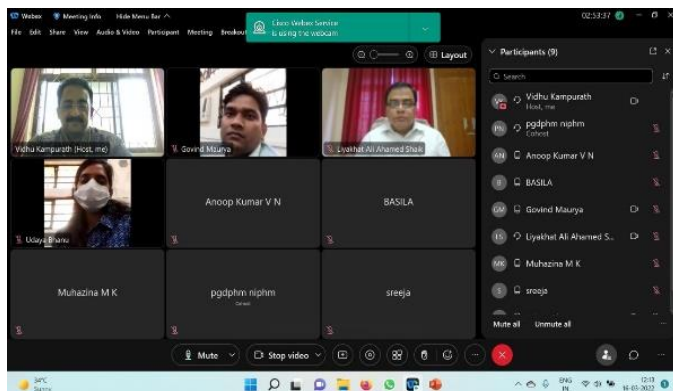
A 5-day training programme on Pesticide Application Techniques and Safety Measures was conducted for 14 officers (11 Male and 3 Female) during 21st to 25th March 2022.



iii. Farm Equipment for Plant Health Management-Collaborative programme with AICRP on FIM, Kerala

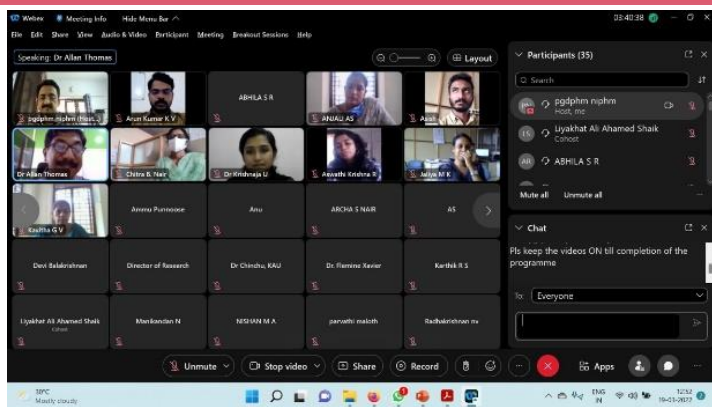
A three-day training programme for officers on Farm Equipment for Plant Health Management was conducted during 14th to 16th March 2022 in collaboration with All India Coordinated Research Project on

Farm Implements and Machinery, operating at College of Agricultural Engineering, Tavanur, Kerala. Total 11 participants (5 Male and 6 Female) attended and got benefitted in the programme.



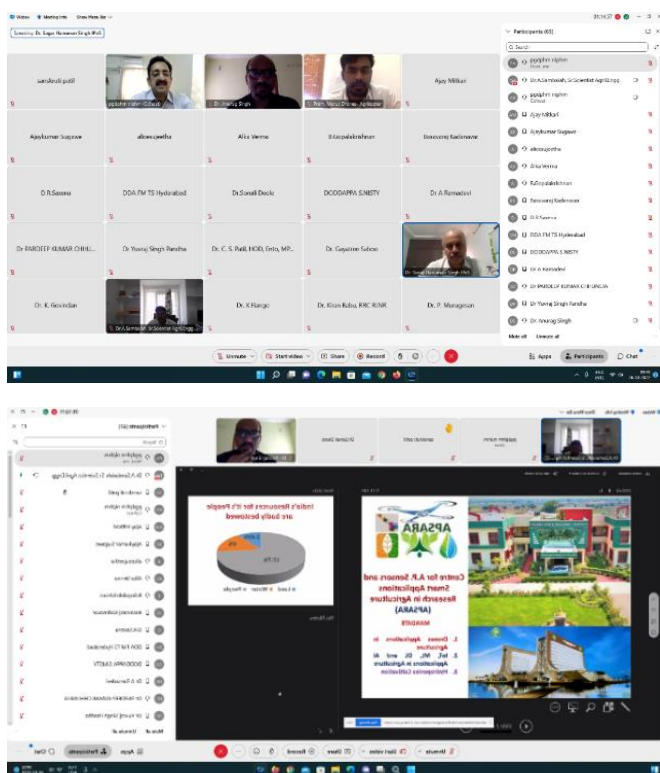
iv. Farm Equipment for Plant Health Management-Collaborative programme with Communication Centre, Kerala Agricultural University, Kerala

A three-day training programme for officers on Farm Equipment for Plant Health Management was conducted during 17th to 19th March 2022 in collaboration with Communication Centre, Kerala Agricultural University, Kerala. Total 38 participants (9 male and 29 female) attended and got benefitted in the programme. The Director of Extension, Kerala Agricultural University inaugurated the programme.



v. National webinar on “ Drone Applications in Agriculture – Spraying and beyond”

A one day webinar was organized on “Drone Applications in Agriculture – Spraying and Beyond” on 26th March 2022. Total 85 participants (54 male and 31 female) from various parts of the country. Discussions and deliberations on various possibilities of usage of drone in various agricultural operations were covered. Discussions on training part, usage of drones in herbicide application, buffer zone requirements, availability of drones at village level, the economics of spraying etc were taken up.



Farmers Programs:

vi. Pesticide application Techniques and Safety Measures “(Farmers)”

An off-campus farmers training was organized on “Pesticide Application techniques and safety measures” at Krishi Vigyan Kendra (KVK) Tuniki, Medak District, Telangana state. Program started with welcoming NIPHM faculty. Total 39 farmers (Male-33, Female-6) attended the training program.



vii. Pesticide application Techniques and Safety Measures “(Farmers)”

A one day training session for the farmers on Pesticide Application Techniques and Safety Measures were conducted during the Farm Mech (Farmers Mela) 2022, organized by All India Coordinated Research project on Farm Implements and Machinery in association with Kelappaji College of Agricultural Engineering and Technology, Tavanur, Kerala on 17th March 2022. Farmers and student members attended the programme. Total 34 participants (28 male and 6 female) successfully completed the programme.



- i. PGDPHM/DPHM: Students visit was organized to Syngenta seeds, Medchal.
- ii. PGDPHM students visited Syngenta seeds, Medchal along with faculty of NIPHM.



Forthcoming training programmes

S.No	Title of the Programme	Division	From	To	Eligibility criteria	Course Coordinator & e-mail
1.	Irrigation systems and advancements	PHE	26.04.2022	28.04.2022	Extension officers from State Agriculture and Horticulture departments, Scientists of ICAR, SAUs and officials from KVKs, DPPQs. NGOs	Er. Govind Maurya Assistant Scientific Officer (PHE) asopeniphm1-ap@nic.in
2.	RS & GIS applications in Plant Health Management	PHE	23.05.2022	27.05.2022	Extension officers from State Dept. of Agri./ Horti., soil survey, soil conservation, Watershed Project, Scientists of ICAR/ SAUs , etc. working on GIS	Er. M. Udaya Bhanu Scientific Officer (PHE) sopeniphm2-ap@nic.in
3.	Pesticide application techniques and safety measures	PHE	20.06.2022	24.06.2022	Extension officers from State Agriculture and Horticulture departments, Scientists of ICAR, SAUs and officials from KVKs, DPPQs NGOs	Er. Haneefa Begum Assistant Scientific Officer (PHE) asopeniphm2-ap@nic.in

Special Events

- NIPHM has celebrated the New Year eve on the 1st January, 2022. Dr. Sagar Hanuman Singh, Director General has interacted with the Officers and Staff and discussions were held on the new initiatives and progress of ongoing activities of NIPHM.



- The 73rd Republic Day has been celebrated at NIPHM on 26-01-2022. Dr. Sagar Hanuman Singh, Director General NIPHM has hoisted the National Flag and acknowledged the work done by our great leaders who made efforts for constitution of India.



- The 15th General Council (GC) meeting held on 21.03.2022 at Krishi Bhawan, New Delhi.
- The “International Women’s Day” was celebrated on 08-03-2022 by all the officers and staff of NIPHM with much enthusiasm.



- On this occasion, the Paper/Poster presentation, Rangoli and other fun games/ activities were conducted among all the women staff working at NIPHM. All the winners and runners in various competitions were given with prizes and certificates.





- Dr. Kalpana Sastry R, Managing Director, Ag-Hub Foudation, PJTSAU, Rajendranagar, Hyderabad has delivered a lecture on theme “Gender equality today for a sustainable tomorrow (#Break The Bias)” on 08.03.2022



- **Deciphering The Mechanism of Resistance to Root Lesion Nematode in Chickpea by Using Genetic and Genomic Approaches**

Project progress during this quarter:

Presented progress of the project to SERB-DST on virtual mode. Recorded data of plant height. Irrigation provided based on requirement and maintained controlled condition as required. Recorded Population count for 21 genotypes of chickpea (Last parameter). PG Student research recorded growth parameters of tomato (Pusa ruby) against Root Knot Nematode (*Meloidogyne incognita*). Parameters considered/taken in experiment: Plant height, days to maturity, total plant dry weight, total Plant wet weight and reproduction factor.

- **AICRP on Biological Control of Crop Pests (ICAR-AICRP-BC)-NIPHM, Hyderabad (Volunteer Centre)**

a. Evaluation of NIPHM white media for the production of *Nomuraearileyi* (*Metarhizium rileyi*) NIPHM MRF-1 strain for management of Maize Fall Army worm (*Spodoptera frugiperda*)

This project aimed for the production of *Metarhizium rileyi* two media viz. NIPHM White media and broken rice were used. To standardize the production technology, the media under test were made into six treatments (Broken rice (without yeast extract), Broken rice (with yeast extract), 1% NIPHM white media, 2% NIPHM white media, 3% NIPHM white media, 4% NIPHM white media) and for each treatment two replications were maintained.

Project progress during this quarter:

Mass Production of *Nomuraea rileyi* on white media and report on mass production of *Nomuraea* on different substrate prepared. Literature citing for different substrate used and components of substrates which supports easy growth of *Nomuraea rileyi*. SMAY broth preparation (500ml) Autoclave and Inoculation of *Nomuraea* in broth. Inoculated flask are kept under observation which is further utilized for mass multiplication of *Nomuraea* on various substrate. Sporulating mother culture of *Nomuraea* inoculated on sterilized bio waste and kept under observation. Overnight Soaking of bio waste. Sterilization of *bio waste* and Inoculation of *Nomuraea* on *bio waste*. Mass production of *Metarhizium rileyi* on *bio waste*, inoculation of *bio waste* with sporulating *Metarhizium rileyi*. Inoculation of SMAY broth with *Metarhizium rileyi* slant culture. Incubated and kept under observation

- **IPM model villages under Tamil Nadu Irrigated Agriculture Modernization Programme (TN-IAMP)**

NIPHM and Department of Agriculture, Tamil Nadu has entered into anMoU for take up the project on ‘*Model IPM village*’ under the scheme of TNIAMP with objectives like to provide technical assistance to all beneficiary farmers in 20 IPM villages under the Lower Palar Sub basin for the establishment of cost-effective sustainable Bio-

control Agents' production units in Kancheepuram District, Tamil Nadu, to train the farmers in the understanding of Good Practices in production and quality maintenance, to provide the mother culture and media initially based on the existing norms of the institution.

Project progress during this quarter:

- Field trials of biopesticides and biofertilizers are conducted at Chenkalpattu and Kancheepuram, Tamil Nadu. Monitored by senior consultant.
- Printing of tamil manual on On-farm production of biocontrol agents'
- NIPHM organized cluster level training cum demonstration on production of bioagents [bio-fertilizers (*Mycorrhizae*, *Rhizobium*, *Azotobacter*, *Azospirillum* and Phosphorus Solubilizing Bacteria) and microbial bio-pesticides (*Trichoderma harzianum* and *Pseudomonas fluorescens*)] with using low cost technologies to the field level officers and progressive farmers in 20 IPM villages (4 clusters of the blocks i.e., Walajabad, Kattangulathur, Lathur and Thirukazhugundram) under the lower palar sub basin of Kancheepuram and Chengalpattu Districts, Tamil Nadu. Under this area, NIPHM has provided quality mother culture of biopesticides, biofertilizers and low cost media for on farm production of different bioagents with standard operating procedure. With cooperation of department of agriculture in Tamil Nadu staff monitoring project activities regularly to the respective cluster villages for the progress of the projects. As low cost technologies of bioproduct production, about 145 progressive farmers are adopted this technologies and producing biofertilizers and biopesticides and using in different crops.
- Training cum demonstration on the 'On-farm production of bio-fertilizers and bio-pesticides' for beneficiary farmers in 20 IPM villages (4 clusters of the blocks i.e., Walajabad, Kattangulathur, Lathur and Thirukazhugundram) under the lower palar sub basin of Kancheepuram and Chengalpattu Districts, Tamil Nadu has been conducted between 07th and 08th March, 2022. A total of more than 100 farmers from Kancheepuram and Chengalpattu districts of Tamil Nadu attended the training program. During this training programme briefly explained about the use and application method of important microbial biocontrol agents and also taken success story of on-farm production technology of bio-fertilizers (*Mycorrhizae*, *Rhizobium*, *Azotobacter*, *Azospirillum* and Phosphorus Solubilizing Bacteria) and microbial bio-pesticides (*Trichoderma harzianum* and *Pseudomonas fluorescens*) and also visited field trail of use of biocontrol agents. In this programme additional director from directorate of agriculture and joint director of agriculture Kancheepuram and Chengalpattu also participated and insisted on the use and the importance of bio-control agents by IPM village farmers.



- The Pesticide Formulation and Residue Analytical Centre (PFRAC) of Pesticide Management Division under Central Sector Scheme “*Monitoring of Pesticide Residues at National Level (MPRNL)*” collected and analyzed about 300 samples (Fruits, vegetables, cereals, pulses, milk and water) for pesticide residues. A total of 90 samples viz. Brinjal, Green Chilli, Grapes and Guava were analyzed under “*How Safe your food from farm*” programme. During the period, 60 samples (Leafy vegetables-30 nos, River water-30 nos.) were tested for heavy metals. About 200 customer samples for pesticide residues were analysed.

A total of 89 botanical bio-pesticides samples were received from different state of Bihar, Gujarat, Telangana and Karnataka Insecticide Inspector and the samples were tested for pesticide contamination. Sixteen bio pesticide samples were also collected from Khammam market and analyzed based on the farmer’s survey on uses of biopesticide in green chillies.

- Proficiency Testing Center (PTC), Pesticide Management Division, has initiated PT program on Water (PTC/PR/03/21-22) and Chana Dal (PTC/PR/05/21-22) during the month. The samples were dispatched to 41 participants during Feb, 2022. Final reports of PT-PFA programme on chlorpyrifos technical, copper oxy chloride technical and propiconazole EC (PT/PF/04, 05& 06/2021-22) were prepared and sent to 48 participants during the month.



Fig: Sample preparation for water PT-PRA programme (PTC/PR/03/21-22)



Fig: Sample preparation for orange PT-PRA programme (PTC/PR/04/21-22)



Fig: Sample preparation for channa dal PT-PRA programme (PTC/PR/05/21-22)

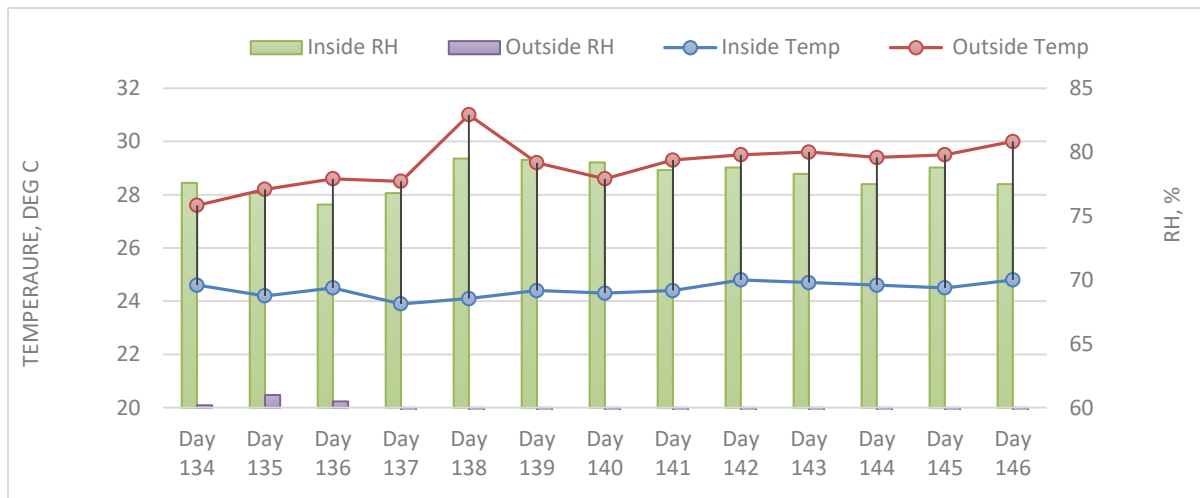


Fig:PT Samples for dispatched

• **Construction and Evaluation of Zero energy cool chamber**

Zero Energy Cool Chamber is an eco-friendly storage system that doesn't require any type of energy to be adopted. A cool chamber was designed and constructed for the purpose of demonstration to trainees. The performance evaluation of ZECC is under process to optimize the parameters of the chamber. The following are the parameters are measured to evaluate the ZECC.

1. Outside temperature and RH
2. Inside temperature and RH



For performance evaluation of ZECC, the shelf life of commodities grown at NIPHM field were taken to evaluate the shelf of commodities in three different storage conditions were selected like control, refrigeration and ZECC. The commodity selected is coriander leaves, curry leaves and Amaranthas at three different conditions normal, wrapping in paper and placed plastic cover.



Leafy vegetables stored in ZECC



Leafy vegetables stored in ZECC



Leafy vegetables stored in ZECC



Leafy vegetables stored in ZECC



Tomato stored in ZECC

i. Feasibility studies on usage of treated sewage water for vegetables :

This project is proposed to use sewage water in a safer manner. The sewage treatment plant of the Institute is having a capacity of 50 KLD. The treated wastewater can be used as powerful nutrients source that could be intensified with additional sources of irrigation water and nutrients. In view of this, to assess the usability of treated water for the cultivation of leafy vegetables. The Spinach crop is selected. The Physical, Chemical and biological parameters of Soil, crop and water have been evaluating to see the actual impact of irrigation with treated water.



Glimpses of project

Extension Activities / Village Adoptions

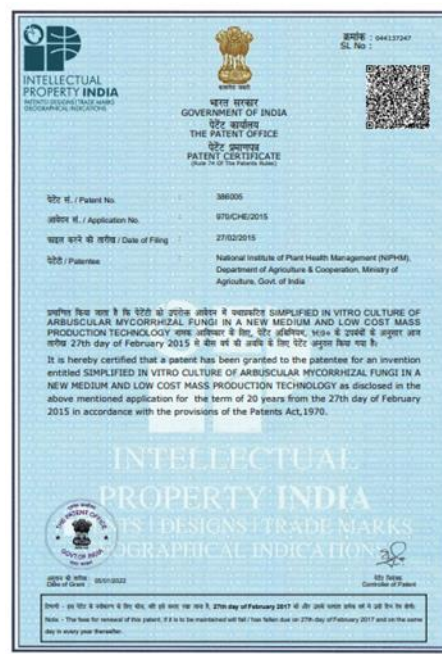
- As per the approval of the competent authority, NIPHM staff Mr.Lavanya, SO(BP& BC), visited the Mohammed village along with Ekalavya Foundation, KVK, Medak on 08.02.2022 and observed the progress of the biocontrol laboratory construction and guided for further improvements and facilities required for lab establishment. Further atraining cum interaction session on On-farm production of biocontrol agents and microbial biopesticides' wasconducted on on the same day. In this programme total of 50 farmers were participated. Ms. N. Lavanya SO(BP & BC) explained the production technology of bio pesticides, bio fertilizer, parasitoids and predators and distributed handouts to the farmers on production technology of bio-pesticides, bio fertilizer, parasitoids and predators. In the training programme, the importance, on-farm production technology and field application methods of biopesticides viz., biocontrol agents and biopesticides were explained in detail to the farmers and also the information on mode of action and the diseases and pest that can be managed using the above biopesticides was also passed on to the farmers. Further, the farmers also interacted with the resource persons on the on-farm production techniques of biopesticides.



- Scientists from NIPHM visited Krishna and Guntur districts of Andhra Pradesh on 03.1.2022 and 04.01.2022 to survey on chilli affected regions of thrips (*Thripsparvispinus*) an invasive pest. Prepared and submitted the report of joint survey on chilli flower thrips on chilli crop conducted in Krishna, Guntur and Prakasham districts of Andhra Pradesh state
- In coordination with KVK, Mahaboobnagar, the survey for selecting spray men at 3 villages, Chennaram, Munnampur and Ramanpadu was taken up.



- **MOOCs in Plant Biosecurity:** VIIth Batch is scheduled to commence with time duration of 3 months from April – June, 2022. Screening of registered application to verify eligibility and qualification for the programme is in continuation.
- **MOOCs in Rodents and Household Pest Management:** Vth Batch is scheduled to begin with time duration of 3 months from April – June, 2022 and screening of applications as well the verification of eligibility and qualification for the programme is in continuation.
- **Kerala PGDPHM:** The IIIrd Semester contact examination of Vth Batch PGDPHM (Kerala) has been proposed to conduct at SAMETI Trivandrum from 6th to 8th April 2022.
- **Farmer Advisory Cell Activities:** During this quarter the advisories related to Good Agricultural Practices (GAP), preparation and installation of fruit fly traps, vermicomposting *etc.* and pest management in crops were given to 888 farmers and stakeholders on various aspects through phone calls/visits.
- **Lab Activities:**
 - Maintaining/Rearing of stored grain insect cultures
 - Rearing of fruit fly culture
 - Fruit fly lure preparation
- **Patent No. : 386005**, granted to the National Institute of Plant Health Management (NIPHM), Department of Agriculture & Cooperation, Ministry of Agriculture, Govt. of India for the invention on “SIMPLIFIED IN VITRO CULTURE OF ARBUSCULAR MYCORRHIZAL FUNGI IN A NEW MEDIUM AND LOW COST MASS PRODUCTION TECHNOLOGY”.



- **Patent No. : 349873** granted to the National Institute of Plant Health Management (NIPHM), Department of Agriculture & Cooperation, Ministry of Agriculture, Govt. of India for invention on “MEDIA FOR CULTURING MICROORGANISMS THAT REQUIRES LESS AGAR”.



- **Maintenance of vermicompost unit at NIPHM and Staff Quarters:** Bio char has been prepared from the waste wood items and an experiment on effect of bio char and vermicomposting in chilli crops is being carried out for further study.
- VPM Faculty has delivered a lecture on “Rodent pest management in storage godowns” at IGMRI (Indian Grain Storage Management & Research Institute), Hyderabad.
- **NIPHM Instructional farm:**
Irrigation and Weeding has been done in Tomato, Brinjal, Groundnut, Carrot, Beetroot and Cucurbits crops. Harvesting has been done in tomato, brinjal, carrot, beetroot and cucurbits and kept for sale. Threshing of Redgram has been done. Released anthocorid predator *Blapatoctethus pallesence* in tomato crop. Sprayed neem oil and hing extract @ 5ml/l in tomato crop. Sowing of proso, kodo, foxtail, little and finger millets has been done. Planted fruit crops like papaya, custard apple, mango and passion. Sown groundnut, okra, bitter gourd, millets and ridge gourd in field. Monitoring and maintaining herbal, flower and rose garden. Insect pest, natural enemies and disease data of field crops were carried out. Name boards prepared and placed in field and herbal garden. Released anthocorid predator *Blapatoctethus pallesence* in tomato crop. Sprayed botanical pesticides.



- **Polyhouse (Protected Cultivation)**

During this quarter (2022), the following farm activities are performed under protected cultivation.

Irrigation and weeding has been done in Capsicum, cucumber, broccoli, tomato and leafy vegetables like fenugreek, coriander, spinach and amaranthus. Staking was carried out in tomato and cucumber. Harvesting and sale has been done in cucumber, broccoli, and leafy vegetables like fenugreek, coriander, spinach and amaranthus. Applied biocontrol agents in polyhouse for management of sucking pests. Sown cucumber and field beans Staking done in cucumber. Irrigation and weeding done in cucumber and field beans. Sown and maintained palak and *Portula oleracea* leafy vegetable. Tomato, brinjal and lettuce nursery maintenance. Transplanted lettuce and palak

in hydroponics. Insect pest, natural enemies and disease data has been recorded in field and polyhouse crops. Application of fertilizers in cucurbits, okra and groundnut has been done.



• **Faculty achievements (Publications / trainings / webinar-seminar / Awards etc):**

- On production and use of biofertilizers in organic farming during on 21.02.2022 during certified farm advisor training programme by ICAR-IIFSR.
- Delivered lecture on *On-farm production protocols of insect predators- Certified Farm Advisor on Organic Farming*, PC Unit, ICAR-IIFSR.
- On-farm production of biofertilizers during farmers training programme by WALMTARI on 23.02.2022.

- Dr. Vidhukampurath, JD (PHE) attending the hindi pragya course.
- Dr. Vidhu Kampurath, JD (PHE) has given invited lecture on “Capacity building of FPO members in Plant Health Management (PHM) in Workshop on **Development of Business Plan for FPOs** to be organized by ICAR-IIOR, Hyderabad on 22.02.2022
- Er. M. Udaybhanu , SO (PHE) delivered a lecture on Artificial Intelligence in Spraying for a training programme conducted by EEI, Nilokheri on 10.02.2022
- Dr. Vidhu Kampurath, JD(PHE) attended National webinar on "Sustainable development through farm mechanization" as part of Aazadi ka Amrut Mahotsav, conducted by Agri Business Incubator, Kerala Ag University, on 11.02.2022.
- Technical staff of PHE division attended a joint workshop on Drone use in agriculture, conducted by ANGR Agricultural University and Department of Agriculture, AP on 16th Feb 2022 was attended by all faculty, as per request from host. Dr. Vidhu gave the inputs from NIPHM on requirements of training, research etc on drone use.
- Dr. Vidhu Kampurath, Er. Govind Maurya, Er. Sk Haneefa Begum attended a workshop on “Capacity building of FPO members in Plant Health Management (PHM) in Workshop on **Development of Business Plan for FPOs** to be organized by ICAR-IIOR, Hyderabad on 22.02.2022
- Dr. Vidhu Kampurath and Er. Sk Haneefa Begum attended National Workshop on "Emerging trends and new opportunities in High Pressure Processing" from 21.2.2022 to 22.2.22 organized by Kerala Agricultural University.
- Er. M Udaya Bhanu attended National virtual symposium on “Doubling farmers income by revitalizing Agri business Ecosystem” organized by KAU.
- Er. Govind Kumar Maurya attended webinar on ' Solar Energy utilization in agri farming" Conducted by MANAGE.
- Er. Govind Kumar Maurya attended Webinar on 'Micro-irrigation - A Potential Input for Enhancing Farmers Income' organized by The Institution of Engineers (India)
- 37 batches of training programmes are running under NIPHM for Gujarat state.



Glimpses of training programme

- As a member of the FAD 11 of Bureau of Indian Standards (BIS), attended a review meeting (in virtual mode) for the standards on sprayers and other agricultural machinery by Dr. Vidhu Kampurath, JD(PHE).
- PHE division has celebrated “World Water Day: Making the Invisible Visible” and organized the awareness programme among the NIPHM staff.

राजभाषा हिंदी से संबंधित क्रियाकलाप

राजभाषा कार्यान्वयन समिति की चतुर्थ बैठक एवं अन्य गतिविधियां संपन्न

राजभाषा कार्यान्वयन समिति)राकास(की चतुर्थ बैठक वर्ष 2021-22 हेतु दिनांक 22-04-2022 को डॉ .सागर हनुमान सिंह,भा.डा.से, महानिदेशक, एनआईपीएचएम की अध्यक्षता में आयोजित हुई । बैठक में महानिदेशक के समक्ष जनवरी-मार्च,202 2 की तिमाही हिंदी प्रगति रिपोर्ट प्रस्तुत की गई । उन्होंने उक्त रिपोर्ट की समीक्षा करते हुए संस्थान में राजभाषा अधिनियम की धारा (3)3के पूर्णतः अनुपालन किये जाने के निदेश दिये । एनआईपीएचएम के सभी प्रौद्योगिकी वीडियो या किसानों से संबंधित अन्य प्रौद्योगिकी वीडियो एवं अन्य दिशा-निर्देशों का भी हिंदी में अनुवाद किया जाए । महानिदेशक ने निदेश दिया कि संस्थान के प्रशिक्षण कैलेंडर 2022-23 का हिंदी में अनुवाद किया जाए ।

संस्थान की गतिविधियां :

हिंदी कार्यशाला :

दिनांक 110-320-22 को राष्ट्रीय वनस्पति स्वास्थ्य प्रबंधन संस्थान में डॉ .सागर हनुमान सिंह,भा.डा.से, महानिदेशक-एनआईपीएचएम की अध्यक्षता में अधिकारियों एवं कर्मचारियों के लिए एक दिवसीय हिंदी कार्यशाला का आयोजन किया गया । इस कार्यशाला में प्रभारी निदेशक डॉ .निर्माली साइकिया)पीएमडी (ने कहा कि संस्थान में राजभाषा हिंदी का उपयोग काफी बढ़ा है और राजभाषा हिंदी का क्रियान्वयन हो रहा है । उन्होंने आगे कहा कि उपस्थित कर्मचारी इस कार्यशाला का भरपूर लाभ उठाएं एवं अपने दैनिक सरकारी कामकाज में इसका उपयोग अवश्य करें । डॉ. गिरीश ए.जी, उप निदेशक)पीपी-पीबीडी प्रभाग (ने कर्मचारियों को संबोधित करते हुए कहा कि कर्मचारियों को हिंदी कार्यशाला में भाग लेना चाहिए, ताकि उनको हिंदी में कार्य करने में जो कठिनाईयां आ रही है, उसका निवारण किया जा सके । हमारा संस्थान एक केन्द्रीय प्रशिक्षण संस्थान है । इसलिए, हम सभी का यह संवैधानिक एवं नैतिक जिम्मेदारी बनती है कि हम अधिक से अधिक कार्यालयीन कामकाज हिंदी में करें । और संस्थान में हिंदी शिक्षण योजना, सिकंदराबाद द्वारा संस्थान के कर्मचारियों को ऑन लाइन के माध्यम से प्राज्ञ प्रशिक्षण भी दिया जा रहा है एवं कर्मचारियों के लिए प्रति तिमाह में हिंदी कार्यशाला का आयोजन किया जाता है ताकि, कर्मचारियों की समस्याओं का निराकरण किया जा सके ।

कार्यशाला के अतिथि वक्ता अतिथि वक्ता श्री जयशंकर प्रसाद तिवारी, सहायक निदेशक, ने राजभाषा नीति, हिंदी यूनिकोड कोड और कंप्यूटर पर वॉयस टाइपिंग के बारे में संक्षिप्त विवरण दिया । कार्यशाला के दौरान यूनिकोड को हमारे कंप्यूटर पर कैसे अपलोड किया जाए, इसके बारे में उन्होंने पॉवरपॉइंट प्रेजेंटेशन के माध्यम से महत्वपूर्ण जानकारी दी ।

इस समारोह में संस्थान के वरिष्ठ अधिकारी डॉ .विधु कम्पूरत.पी, संयुक्त निदेशक)पीएचई(, डॉ. एम जयादेवी, उप निदेशक)रसायन(, इंजी .शेख लियाखत अली अहमद, सहायक निदेशक)आईसीटी (एवं अन्य कर्मचारीगण उपस्थित थे । कार्यक्रम के अंत में हिंदी अधिकारी ने अधिकारीगण, अतिथि वक्ता एवं प्रतिभागियों का आभार व्यक्त किया एवं संस्थान के हिंदी अनुवादक श्री राठौड़ मोहन ने कार्यक्रम के संचालन में सहयोग दिया ।



(एनआईपीएचएम में 'हिंदी कार्यशाला' का आयोजन)

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