Vocational Higher Secondary Education (VHSE)

Second Year

AGRICULTURE
CROP HEALTH MANAGEMENT

Reference Book

Government of Kerala
Department of Education

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Foreword

Dear Learners,

This book is intended to serve as a ready reference for learners of vocational higher secondary schools. It offers suggested guidelines for the transaction of the concepts highlighted in the course content. It is expected that the learners achieve significant learning outcomes at the end of the course as envisaged in the curriculum if it is followed properly.

In the context of the Right- based approach, quality education has to be ensured for all learners. The learner community of Vocational Higher Secondary Education in Kerala should be empowered by providing them with the best education that strengthens their competences to become innovative entrepreneurs who contribute to the knowledge society. The change of course names, modular approach adopted for the organisation of course content, work-based pedagogy and the outcome focused assessment approach paved the way for achieving the vision of Vocational Higher Secondary Education in Kerala. The revised curriculum helps to equip the learners with multiple skills matching technological advancements and to produce skilled workforce for meeting the demands of the emerging industries and service sectors with national and global orientation. The revised curriculum attempts to enhance knowledge, skills and attitudes by giving higher priority and space for the learners to make discussions in small groups, and activities requiring hands-on experience.

The SCERT appreciates the hard work and sincere co-operation of the contributors of this book that includes subject experts, industrialists and the teachers of Vocational Higher Secondary Schools. The development of this reference book has been a joint venture of the State Council of Educational Research and Training (SCERT) and the Directorate of Vocational Higher Secondary Education.

The SCERT welcomes constructive criticism and creative suggestions for the improvement of the book.

With regards,

Dr. P. A. Fathima
Director
SCERT, Kerala

CONTENTS

ABOUT THE COURSE

Agriculture is the cultivation of plants, fungi and other life forms for food, fibre, biofuel, medicinal and other products used to sustain and enhance human life. Modern agronomy, plant breeding, agro chemicals such as pesticides and fertilizers, and technological improvements have sharply increased yields from cultivation, but at the same time have caused widespread ecological damage and negative effects on human health. A major problem faced by the farmers of Kerala is the attack by various pests and diseases in all cultivated crops. It is a known fact that the incidence of pests and diseases vary with weather, soil and ecology and a clear understanding of this variation is essential. One of the main reasons for low productivity of crops is the increased incidence of pests and diseases. There is no sufficient mechanism to monitor the incidence of pests and diseases in agro ecological units of the state. Considering the importance of the crop health management Govt. of Kerala has launched major schemes for crop health management from 2013 -14 onwards - (Vide Order No.GO(RT) No.1659/13/AD/NCA dated 19/09/2013 and Govt. of Kerala, Directorate of Agriculture, Circular No. TD(1)42860/13 dated 05/10/2013.

The course of study focuses on sound crop health management strategies.The nation has an acute shortage of trained personnel to cater to the demands of crop production technology and disease management. This vocational course aims at meeting this situation by generating skilled human resources for the total remedies for agri - crop health management. The course is designed in such a way as to train students and to have a direct link with farmers at grass root level and give them proper guidance. The course hopes to develop the students in to independent crop health consultants at village level or in any agri research organization to meet the supervisory level crop health management requirements. As village level consultants, the students with wide subject acquaintance can be valuable resources to farmers for identifying problems, giving them timely and proper advice and helping them in pest control. With the acquired knowledge they can suggest the farmers pick up proper health control methods and modes of application, thereby contributing to effective check measures.

Objectives of the course

1. To create awareness on environmental hazards due to indiscriminate use of pesticides.
2. To use pest and disease diagnostic tool kit.

3. To learn how to monitor pest and disease surveillance system.
4. To understand how and where to implement the surveillance system.
5. To integrate pest and disease management.
6. To create awareness about production techniques of various biocontrol agents.
7. To acquire skill in mass production of biocontrol agents and to manage biocontrol labs.
8. To produce new biopesticides.
9. To create awareness on quality control measures of organic and biopesticides.
10. To develop skill in field level application of safer / new generation pesticides.
11. To manage crop health clinics at Panchayat or Village levels.
12. To associate with Krishi Vigyan Kendras for supporting pest surveillance and agri clinics.

Major Skills (with Subskills)

Module 3 - Major Skills

1. Symptom diagnostic skills.
2. Ability to differentiate between damage caused by pathogens and insects.
3. Diagnosis and management of pests and diseases of major crops of Kerala.
4. Preparation and field application of commonly used botanicals.
5. Field level application of biofertilizers and biocontrol agents.
6. Operation of plant protection equipments and application skills.

Subskills

- Diagnosis of bacterial disease using ooze test.
- Differentiate between infectious and non- infectious disease.
- On farm mass multiplication and application of Trichoderma.
- Diagnosis of pest/ disease of vegetables based on symptoms and adopting suitable integrated management practices.
- Differentiate between botanicals, biofertilizers and biocontrol agents.
- Preparation and installation of low cost traps.

Module 4 - Major Skills

1. Crop health management skills in Protected Cultivation.
2. Judicious selection and application of pesticides for pest management.
3. Skill in simple pesticide residue decontamination methods.
4. Computer application skills in crop production and technology transfer.

Subskills

- Differentiate between protected cultivation structures.
- Identifies the different components of drip irrigation system.
- Identify the types of fertilizers used for fertigation.
- Demonstrate the ecofriendly management of common pest and diseases in protected cultivation.
- Distinguishes between the different types of pesticides.
- Calculates the correct quantity of pesticides for field level application.

SYLLABUS

Module III - Integrated Pest And Disease Management

Unit 1 Pest and Disease Diagnosis (100 periods)

Pest - definition - classification- into insects and non insects and weeds with examples, categories of pests -based on occurrence - based on level of infestation - based on percentage of crop loss they cause with examples, pest outbreak-definition-reasons, Impact of global warming on pest status, Insect - its specific characteristics - classification into bugs, beetles, flies, moths etc. - types of mouthparts -feeding habit - metamorphosis -young ones- wing characters and destructive stages, disease definition - classification - biotic (infectious) and abiotic(non infectious), biotic factors(pathogen) - fungus- bacteria- virus- phytoplasma-algae with examples, abiotic factors -physiological disturbances- nutrient deficiency-air pollutants-lack of moisture- stress, classification of disease based on pathogen- based on mode of spread with examples , diagnosis of disease - signs and symptoms of plant diseases- Koch's postulates - ooze test, disease epidemiology-disease triangle, plant disease forecasting and its application, E-Crop doctor and other related softwares for pest and disease diagnosis.

Unit 2 Integrated Pest and Disease Management of Crops of Kerala (150 periods)

Integrated Pest Management (IPM)- concept-principles of IPM, Economic Threshold Level (ETL)-Economic Injury Level(EIL), Methods of IPM- ecological engineering -cultural methods - mechanical methods-physical methods-legal methods-biological methods- chemical methods , Plant disease management - Integrated Disease Management(IDM)-concept,Weed management - cultural -mechanical-chemical-biological- Integrated weed management, Integrated Pest and Disease Management (IPDM)- concept- components, Pest surveillance -objectives , Identification of pests and diseases of important crops of Kerala - symptoms-management (IPDM) - rice- coconut- banana- pepper-solanaceous vegetables-cucurbitaceous vegetables- cowpea- bhindi- amaranthus- cardamom- ginger-Mango-rubber- cashew- papaya - tea- coffee-tapioca- sweetpotato - ornamentals, Pests of stored products -identification-nature of damage- management.

Unit 3 Agro Biopharmacy (50 periods)

Agro biopharmacy- definition- concept ,Botanicals -preparation- application- neem oil emulsion- neem oil garlic emulsion- neem seed kernel extract- tobacco decoction-hyptis emulsion -andrographis garlic mixture -papaya leaf extract-birds eye chilli cow's urine extract- peruvalam extract- custard apple seed extract,-baking soda turmeric asafoetida mixture- tulsi extract-leaf extracts, preparation of permitted fungicides for organic farming- Bordeaux mixture- Bordeaux paste, Preparation of organic nutrient solutions- panchagavya - dasagavya, fish amino acid, egg amino acid, Biofertilizers - Familiarization and application- Rhizobium -Azotobacter - Azospirillum- Acetobacter-azolla- Phosphate solubilising microorganisms-Arbuscular Mycorrhizal Fungus(AMF) -application techniques, biocontrol agents - fungal and bacterial pathogens-AMF-Trichoderma-Pseudomonas- Method of production of Trichoderma - media preparation- inoculation- formulation-mass multiplication and field application of Trichoderma,Entomopathogens - Fungi,bacteria,virus, common pheromone traps used for insect control - Low cost Pheromone traps for fruitfly management.

Unit 4. Plant Protection Equipments (40 periods)

Plant Protection(PP) equipments - parts of a sprayer, types of sprayers- manually operated hydraulic sprayers-hand sprayers, hydraulic knapsack sprayer, rocker sprayer, bucket sprayer, manually operated pneumatic sprayers, pneumatic hand

sprayers, pneumatic knapsack sprayers, power sprayers, dusters, other PP equipments-Granule applicator -electrostatic sprayer-Fogging machine-Rat traps - site specific spraying, maintenance of PP equipments- field problems and remedies.

Module IV Hitech Farming

Unit 1. Protected Cultivation (170 periods)

Protected cultivation - definition - benefits - scope, Factors emphasizing the need of Hitech Horticulture in Kerala, Different types of protected structures - classification based on structural material -shape of the structure -use of structure - covering material -type of ventilation -environmental control - cost, Important parts of Green House, crops recommended for cultivation in protected cultivation, Principles and practices to be followed in protected cultivation, Climate control inside green houses-equipments for measuring climatic parameters in green houses - Automation in climate control, micro irrigation system- components, fertigation - characteristics of fertilizers used for fertigation - Advantages and disadvantages of fertigation, nutritional disorders, Major Pests and disease of greenhouse crops - factors affecting multiplication of pests under polyhouse-management, General integrated management procedures -preventive approaches-sanitation and cultural practices-inspection- scouting and surveillance- trap crops or indicator plants, curative approach -biological control - neem based and homemade botanical pesticides for pest management - entomopathogenic fungi useful in protected cultivation - Chemical management - List of safe pesticides and other options for management of pest and diseases in polyhouses, Crop protection equipments, Soil less cultivation-hydroponics-aquaponics -advantages and disadvantages.

Unit 2. Pesticides and Pesticide Residue Management (100 periods)

Pesticides-classification- classification of insecticides-Based on mode of entry- mode of action and chemical nature- common insecticides, fungicides-classification, herbicides-classification, pesticide formulations- solid and liquid - other formulations-pesticide adjuvants, list of new generation pesticides and banned pesticides with substitutes, Calculation of pesticide formulations(Insecticide, fungicide, herbicide), Pesticides and Toxicity - Acute toxicity - Chronic toxicity - Toxicity categories, Pesticide labels and labelling-Legal regulatory measures regarding pesticide handling, Bio magnification-Residual toxicity- Maximum Residue Limit - Waiting Period, Precautions to be taken while handling pesticides, pesticide residue decontamination - simple methods to remove pesticide residues from vegetables.

Unit 3. Organic Certification (20 periods)

Definition- production standards-purpose, Process of organic certification-product labelling, Organic certification in India -Agencies involved, Good Agricultural Practices - definition- objectives- key elements- potential benefits.

Unit 4. ICT Enabled Extension Services in Agriculture (50 periods)

ICT enabled extension services in Agriculture - Familiarization with popular agri extension related softwares - crop decision support system - pest, disease and nutrient deficiency diagnose softwares - ICT enabled agriclinics - Kisan Call Centres, Farmer support schemes.

PART B

Module 3 - Integrated Pest and Disease Management

Agriculture is influenced by an array of biotic and abiotic stresses which have to be managed through multipronged strategies. A strategic science based approach is needed to address the plant health risks and issues that affect productivity. The looming threat of climate change may further exacerbate the crop losses due to pests. The integrity of agro-ecosystem is vital for sustainable agriculture. Intensive use of ecosystems to enhance productivity can affect agro-ecosystems through soil erosion, water depletion/ contamination, biodiversity loss and disruption in flow of ecosystem services which will have a bearing on plant health and bio-security.

Indiscriminate use of chemical pesticides has been causing widespread environmental pollution, resistance, resurgence of insect pests and is impacting food safety. Plant Health Management is vital for Sustainable Agriculture, food security, food safety, agro-based industries and economy of a country.

Incorporation of bio-fertilizers, particularly mycorrhizae in agricultural practices, plays a vital role in the promotion of soil health and uptake of important macro and micronutrients by the crops. Biological control through parasitoids, predators and microbials constitutes a significant component of holistic management of insects and diseases as well as abiotic stresses.

This module goes through different aspects of Integrated pest and disease management like pest and disease diagnosis, IPDM of crops of Kerala, Biopharmacy and handling of plant protection equipments.

Unit 1

Pest and Disease Diagnosis

It is estimated that in our country about 30% of crop production is being lost due to the incidence of pests and diseases. If pests and diseases could be detected as early as possible using symptomatic and other means, appropriate preventive action can be taken. Inorder to effectively tackle the problems caused by pest, its identification, diagnosis and nature of damage should be known. It is required to keep watch over suspected pests and diseases by taking samples and observing symptoms. The specific characteristics of insects, mouth parts and feeding habits should be understood for their proper control. The concept of infectious and non-infectious diseases and the knowledge on various agents causing them is essential. Diagnosis of plant diseases using signs, symptoms and specific tests should be familiarized for the management of pests.

Learning Outcomes

The learner :

- defines pest and classifies pests as insects, non-insects and weeds with examples.
- categorises the pests based on occurrence, based on level of infestation and based on the percentage of crop loss they cause with examples.
- defines pest outbreak and narrates the reasons for pest outbreak.
- analyses and interprets the impact of global warming on pest status.
- observes the specific characteristics of insects and classifies them into bugs, beetles and weevils, flies, moths and thrips.
- identifies and compares the different types of mouth parts of insects , feeding habits, metamorphosis, young ones, wing characters and their destructive stages.
- defines disease and classifies disease based on causal factors as biotic (infectious) and abiotic (non infectious).
- defines pathogen (biotic factors) and classifies it as fungus, bacteria, virus, phytoplasma, algae with examples.
- describes abiotic factors like physiological disturbances, nutrient deficiency, environmental pollution, lack of moisture and stress.
- categorises the diseases based on pathogen and mode of spread with examples.
- diagnoses disease based on signs and symptoms, explains Koch's postulates and practises ooze test.
- defines disease epidemiology and explains disease triangle.
- defines plant disease forecasting and explains its application.
- practises E-crop doctor and other related softwares for pest and disease diagnosis

3.1.1 Pest

Definition

"Pest has been defined as any organism detrimental to man and his property by causing significant damages of economic importance".

PEST -Derived from French word 'Peste' and Latin word 'Pestis' meaning plague or contagious disease.

3.1.2 Different Pest Groups

Pests include insects, nematodes, mites, snails, slugs, etc. and vertebrates like rats, birds, etc that cause damage to crops, stored products and animals. Disease producing pathogens of plants including fungus, bacteria, viruses, mycoplasma and weeds are also referred as crop pests.

i. Insect pests

Insects are tracheate arthropods with distinct head, thorax, and abdomen, single pair of antennae, a pair of compound eyes, three pairs of walking legs confined to the thorax and two pairs of wings.

- Beetles, weevils
- Moths & Butterflies
- Bugs, Aphids, Whiteflies, Mealy bugs
- Flies
- Grass hoppers, Crickets
- Stored grain pests

ii. Non-insect pests

Besides insect pests, there are a large number of non-insect pests that cause considerable loss to crops.

- Rats
- Mites
- Nematodes
- Slugs & Snails
- Birds

iii. Diseases

Diseased plants are distinguished by changes in their morphological structures or physiological processes which are brought about by unfavourable environment or by parasitic agencies.

- Fungal diseases
- Bacterial diseases

- Viral diseases
- Mycoplasmal / Phytoplasmal diseases
- Physiological disorders

iv. Flowering parasites

They are parasitic in nature and reduce the yield and vitality of crop plants. eg: Striga, Orobanchae, Cuscuta, Loranthus.

v. Weeds

Weeds are unwanted , uncultivated plants, that reduce crop yield and contaminate the produce and act as alternate hosts of many pests and diseases.

- Dicot weeds
- Monocot weeds
- Annual weeds
- Perennial weeds
- Aquatic weeds
- Upland weeds
- Others

Based upon the importance, pests may be agricultural, forest, household, medical, aesthetic and veterinary pests.

3.1.3 Classification of different pest groups

a) Vertebrates

Phylum	Class	Characters	Examples	Nature of Damage
1) Chordata	Mammalia	Hairy,fourfooted, milk secreting	Rats, squirrel, rabbit,monkey	Eat plant parts, flowers, seeds and fruits
2) Chordata	Aves	Wings,feathers and beak	Sparrow,parrot, pigeon, crow etc	Eat grains, seeds, fruits etc

b) Invertebrates

Phylum	Class	Characters	Examples	Nature of Damage
1)Arthropoda	Insecta	Body divided into head, thorax and abdomen. Three pairs of legs and two pairs of wings.	Beetles, butterflies, moths, bugs, flies etc.	Adults or immature stages damage plants by chewing of external parts or sucking plant sap. They also bore into fruit, seed, and bud or feed on plant stem or mine leaf surface
2)Arthropoda	Arachnida	Minute creatures with an oval or elongate oval body, head and thorax fused to form cephalo-thorax, Abdomen distinct, four pairs of walking legs and no antennae.	Red spider mites, tea eryophyid mites	They pierce through the plant tissue with their sharp mouth parts for sucking the sap and destroying chlorophyll. As a result of feeding, discolouration of leaves or galls appears.
3)Arthropoda	Crustacea	Hard limy chitinous exoskeleton, two pairs of antennae.	Crabs	Cut basal portions of rice seedlings, make holes on field bunds thus cause water to drain off.
4) Mollusca	Gastropoda	Soft bodied, non-segmented, non jointed appendages. Body enclosed in calcareous shell.	Slugs and snails	They feed on foliage of plants mainly ornamentals like orchids and anthurium
5) Nemata	Nematoda	Tiny cylindrical, elongated un-segmented body with tough cuticle. Some forms are micro-scopic. size generally less than 2mm.	Root knot nematode, burrowing nematode	They possess a protruding stylet for feeding. They form knots or galls.

Practical Activity

Collect and observe various pests affecting agricultural crops and classify them into different groups.

Complete the following table

Sl. No	Group of pest	Brief Description	Examples	Remarks
1	Insect Pests			
2	Non insect pests			
3	Diseases			
4	Weeds			

3.1.4 Categories of pests

1. **Based on occurrence**

   Regular pests: Frequently occurs on crop -close association

   e.g. Rice stem borer, Brinjal fruit borer

   Occasional pests: Infrequently occurs, no close association

   e.g. Caseworm on rice, Mango stem borer

   Seasonal pests: Occurs during a particular season every year

   e.g. Red hairy caterpillar on groundnut, Mango hoppers

   Persistent pests: Occurs on the crop throughout the year and is difficult to control

   e.g. Chilli thrips, mealy bug on guava

   Sporadic pests: Pest occurs in isolated localities during some period.

   e.g. Coconut slug caterpillar

2. **Based on level of infestation**

   Epidemic pests: Sudden outbreak of a pest in a severe form in a region at a particular time . In plants, the epidemic is also known as epiphytotic.

   e.g. Brown Plant Hopper, Red Hairy Caterpillar

   Endemic pests: Occurrence of the pest in a low level in few pockets, regularly and confined to particular area .

   e.g. Rice gall midge , Mango hoppers

3. **Based on the extent of damage**

   Major Pest - cause a yield loss of more than 10% (>10%)

Minor Pest - 5 - 10% yield loss

N**egligible Pest** - a loss of less than 5% of yield (<5%)

Percentage of loss caused by different groups of pests

- Weeds - 45%
- Insects - 30%
- Diseases - 20%
- Other factors - 5%
- Total 100%

3.1.5 Pest outbreak

Definition

If the natural forces controlling pest population are upset or disturbed, there will be a sudden increase in pest population and consequent damage to crops. This is termed as pest outbreak.Activity of human beings which upsets the biotic balance of ecosystem is the prime cause for pest outbreak.

Reasons for pest outbreak

i. Deforestation and bringing under cultivation

- Pests feeding on forest trees are forced to feed on cropped land
- Biomass/unit area more in forests than agricultural land
- Weather factors also altered -Affects insect development

ii. Destruction of natural enemies

Due to excessive use of insecticides, natural enemies are killed .This affects the natural control mechanism and pest outbreak occurs. e.g. Synthetic pyrethroids

iii. Intensive and extensive cultivation

Intensive monoculture leads to multiplication of pests .Extensive cultivation of susceptible variety in large area results in no competition for food leading to multiplication of pests. e.g. Stem borers in rice and sugarcane

iv. Introduction of new varieties and crops

Varieties with favourable physiological and morphological factors cause multiplication of insects.e.g. Succulent, dwarf rice varieties favour leaf folders

v. Improved agronomic practices

- Increased N fertilizer -High leaf folder incidence on rice
- Closer planting -BPH and leaf folder increases

- Granular insecticides -Possess phytotonic effect on rice

vi. Introduction of new pest in new environment

Pest multiplies due to absence of natural enemies in new area, eg.Apple wooly aphid multiplied fast due to absence of the parasite Aphelinus mali.

vii. Accidental introduction of pests from foreign countries (through air/sea ports)

- Diamondback moth on cauliflower, Potato tuber moth on potato, Cottony cushion scale on wattle tree and Wooly aphid on apple.

viii. Large scale storage of food grains

- Serve as reservoir for stored grain pests, Urbanisation -changes ecological balance, rats found in underground drainage etc.

3.1.6 Impact of global warming on pest status

- Due to change in climate, temperature and water availability, the farmers may change the type of crops grown.
- Due to increase in temperature, there can be outbreak of certain insect pests and diseases.
- In forest areas there will be a shift in tree species and also pest species.
- In agriculture lands since cropping pattern is changed, new crops to suit the climate is introduced and new pests are also introduced.
- When water availability is less, crops will be raised as rainfed. It will be difficult to take up control measures without water.

3.1.7 Specific characters of insect pests

About 80% of the known species of the animal kingdom consists of insects. Both beneficial and harmful insects are present around us.

- Insects are tracheate arthropods with distinct head, thorax and abdomen, single pair of antennae, a pair of compound eyes, three pairs of walking legs confined to the thorax and two pairs of wings.
- The integument is hardened to an exoskeleton covering the body muscles with striated fibres arranged segmentally.
- The head is usually composed of 6 segments fused immovably together.
- Thorax is composed of 3 segments - prothorax, mesothorax and metathorax.
- Abdomen is usually composed of 11 segments.

- *The science of Entomology deals with the study of insects.*
- *The word entomology is derived from two Greek words*
  entoma (Insects) and
  logos (to study).

3.1.8 Classification of Insects

Sl No	Order	Insect Group	Mouth parts	Feeding Habits	Metamorphosis	Young ones	Wing Characters	Destructive Stage
1	Coleoptera	Beetles, weevils	Biting and chewing	Chewing	Complete	Grub	Fore wings -elytra Hind wings membraneous	Grub or adult
2	Lepidoptera	Moths, butterflies	Siphoning	Sucking	Complete	Caterpillar	Scaly	Caterpillar
3	Diptera	Flies	Sponging	Sucking	Complete	Maggot	Hind wings as halters	Maggot
4	Hemiptera	Bugs, aphids, hoppers	Piercing and sucking	Sucking	Incomplete	Nymph	Membraneous wings	Nymphs and adult
5	Thysanoptera	Thrips	Rasping and sucking	Sucking	Incomplete	Nymph	Fringed	Nymphs and adult

Practical Activity

1. Identification of different groups of insects

Identify and understand common insect pests, their groups, characteristic features and nature of damage.

Materials required : Insect collection net, killing bottle, hand lens, setting board, specimens.

Procedure: Collect and observe various insects, analyze the characters, identify the groups to which they belong and record relevant information.

Sl No	Insect pest	General characters	Crop/ host plant	Nature of damage	Damaging stage

2. Identification of types of mouthparts of insects and their feeding habits

Study the different types of mouthparts of insects and their feeding habits.

Materials required: Live insects, Magnifying glass, photographs.

Procedure: Observe the insect mouth part and identify the type of mouth part, classify them into solid or liquid feeders and neat sketches to be prepared in record.

Assessment Activity

1. Prepare a picture album on insects and identify the groups and order to which they belong.

Group	Order

2. You are asked to handle a session on different groups of agriculturally important insects and their characters. Prepare a chart with insect group, order, young ones, type of metamorphosis, mouth parts and wing characters to be used in the session.

3.1.9 Classification of insects as solid feeders and liquid feeders

a. Solid feeders - They have biting and chewing types of mouths parts.

eg. Beetles, Caterpillars of butterflies, grasshoppers, termites, cockroaches etc.

b. Liquid feeders - They have sucking type of mouthparts

- Butterflies and moths - adults sucking/siphoning type & have a coiled proboscis.
- Bugs (adults and nymphs) - piercing and sucking type and have a stylet.
- Thrips - rasping and sucking type
- Flies - spongy type of mouth part with a hinged proboscis

Assessment Activity

Complete the following table after observing the specimens

Sl. No	Specimen	Crop	Attacking stageof pest	Type of Damage	Type of feeder	Type of mouthparts	Pest identified
1	Leaf	Brinjal	Grub & Adult	Defoliation	Solid	Biting and Chewing	Epilachna beetle
2	Fruit	Bhindi	Caterpillar	Holes on fruit	Solid	Biting and Chewing	Fruit & Shoot borer
3	Leaf	Chilli	Nymphs & Adults	Curling of leaves	Liquid	Piercing &sucking	Thrips
4	Leaf	Rice	Caterpillar	Leaf fold defoliation	Solid	Biting and Chewing	Rice leaf folder
5	Pods	Cow pea	Nymphs & Adults	Malformed fruits	Liquid	Sucking	Cowpea aphid
6	---------						

Practical Activity

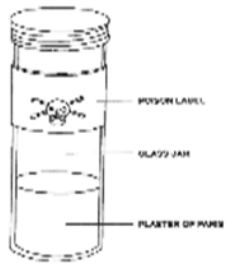
Collection and preservation of insects.

Familiarisation with the methods of collection of insects, equipments used for collection and methods of preservation.

Materials required - Hand sweep net, Killing bottles, Killing agent, Setting board, Insect display box (Insect box), Cards, Insect pins.

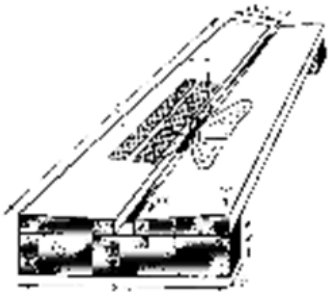
Procedure - Collect the insects using various methods, kill them and sort them into different groups and preserve in insect boxes. Identify and write the use of the equipments and draw diagram. Make a note and diagram of pinning position of different insects.

Insects can be collected in many ways such as hand picking, beating, sweeping, using traps etc. While pinning insects1/3 of the pin should be left protruding from the dorsal side of the specimen, 2/3 remaining ventral.



Killing bottle

Hand sweep net



Insect setting board

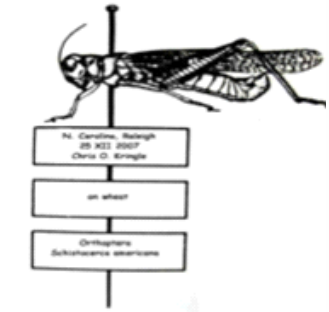
Insect pin

Insect display box

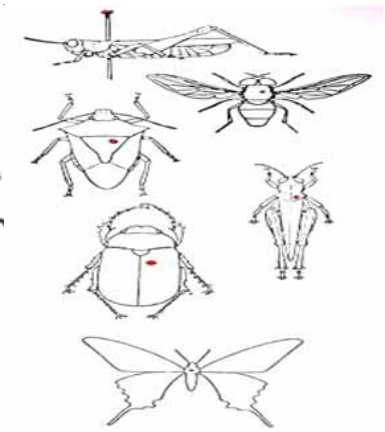
Insects are pinned in specified pinning positions with the help of entomological pins and dried for preservation. The insect's body should be perpendicular to the pin. Labels are to be attached containing details such as date of collection, place of collection etc.

Standard pinning positions of insects.

Order	Group of insect	Pinning Position
Coleoptera	Beetles and weevils	Right elytra
Lepidoptera	Moths& Butterflies	Middle portion of mesothorax
Hemiptera	Bugs	Right side of scutellum
Hymenoptera	Bees &Wasps	Middle portion of mesothorax
Orthoptera	Grass hoppers, Crickets	Right side of prothorax
Diptera	Flies	Middle portion of mesothorax



Pinning of insects



Pinning Position

Assessment Activity

Submit an insect box with 25 preserved insects representing various orders.

3.1.10 Disease

Definition

Disease may be defined as a series of harmful physiological processes caused by continuous irritation of the plant by a primary agent. It is an interaction among the host, parasite and environment.

Diseased plants are distinguished by changes in their morphological structures or physiological processes which are brought about by unfavourable environment or by parasitic agencies.

Plant Pathology(Phytopathology) is the study of the diseases of plants. It is the study of the nature, development and control of plant diseases.

Pathogen - Any organism which cause disease.

3.1.11 Classification of factors causing disease

Disease is caused by biotic (living) factors and abiotic (Non-living) factors.

A.Biotic factors

When a parasitic micro-organism enters into the causal complex of a disease, it is commonly considered to be the cause of the disease. There are mainly four types of organisms that cause plant diseases.

1) Fungus - Fungi are thread like and propagated by spores. In favourable conditions, the spores germinate and produce infection on susceptible plants. They attack plants and produce symptoms like rot, wilt, damping off, leaf spot, rust, blast, blight and mildews.
2) Bacteria - They are small single celled organisms. They gain entry into the plants through natural openings like stomata and wounds caused by insects, nematode and by man. They multiply inside the plant utilizing the nutrients from the plant and due to this activity symptoms are produced.
3) Virus - Virus consists of D.N.A or R.N.A often surrounded by a thin protein coat. Reproduction takes place inside the host plant. Usually viruses are transmitted by insects and these insects are called vectors. The common vectors are aphids and white flies.
4) Mycoplasma or Phytoplasma and MLOs - These are smaller than virus and contain both DNA and RNA. The symptoms are yellowing, greening, witches broom and stunting.
5) Algae.

B. Abiotic factors

The common characteristics of abiotic stress is that they are caused by the lack or excess of something that supports life. It includes temperature, soil moisture, soil nutrients, light, air and soil pollutants, air humidity and pH.

- Physiological disturbances
- Nutrient deficiency
- Air pollutants
- Moisture
- Temperature
- Light

i. **Physiological disturbances:** :Physiological plant disorders are caused by non pathological conditions such as adverse weather, poor light, water logging, phytotoxic compounds or lack of nutrients and affects the functioning of plant system.

ii. **Nutrient deficiency:** They are caused by shortage of nutrients. Eg: Khaira disease of rice (Zn deficiency), Whip tail of cabbage (Mo deficiency), Crown choking of coconut (B deficiency), etc.

iii. **Air pollutants:** Air pollutants like automobile exhausts , Sulphur dioxide, nitrogen dioxide, chlorine, particulate matter and ethylene cause injuries to plants. Eg: Silver leaf due to PAN(Phenoxyacyl nitrates) from automobile exhaust, ozone injury, crusty layer formation and direct burning of leaf tissues due to particulate matter.

iv. **Moisture:** Lack of moisture causes plants to suffer from water stress and wilt. Heavy rains cause plant roots to split. Eg. onion saddle back(splitting at base), tomato split, potatoes become hollow or deformed.

v. **Temperature :** Low temperature causes late frost tip necrosis, caramelisation of potato due to the hydrolysis of starch to sugars, frost killing of buds, flowers, young fruit and cat face of tomato.

High temperature causes sunscald injuries on the sun exposed sites of fleshy fruits and vegetables, such as capsicum, tomatoes, onions and potatoes and on succulent leaves of some plants.eg; water core of apple, blossom end rot of citrus fruit, etc.

vi. **Light :** Lack of sufficient light leads to etiolation. Usually seen in outdoor plants when they are spaced too close together or when grown under shade. It is common in house plants and in plants grown in greenhouses.

3.1.12 Classification of disease based on causal organism

Sl. No	Disease causing agent	Type of disease	Examples
1	Bacteria	Bacterial disease	Bacterial Leaf Blight of paddy, Bacterial leaf streak of paddy
2	Fungus	Fungal disease	Sheath blight of paddy, Blast of rice, Quick wilt of pepper, Blight of paddy, Bud rot of coconut, loose smut of wheat
3	Virus	Viral disease	Bunchy top of Banana, Katte of Cardamom, Cassava mosaic
4	Phytoplasma or MLO	Phytoplasmal disease or Mycoplasmal disease	Root wilt of coconut, little leaf of Brinjal, Phyllody in snake gourd.
5	Algae		Algal rust of fruit crops

Classification of disease based on mode of spread of pathogen

Sl. No	Mode of spread	Nature of spread	Examples
1	Spread through air	Air borne	Rice blast
2	Spread through water	Water borne	Sheath blight of paddy Bacterial Leaf Blight of paddy
3	Spread through soil	Soil borne	Soft rot of ginger, Quick wilt of pepper, Damping off of seedlings
4	Spread through seed	Seed borne	Loose smut of wheat, Blast of rice, Blight of paddy

3.1.13 Diagnosis of disease

A. Symptoms of plant diseases

Symptoms are external or internal reactions or alterations as a result of a disease Symptoms of plant diseases fall into 4 main groups.

1. **Necrotic symptoms** - seen as drying of cells, tissues or organs.
   - Hydrosis - A water soaked condition of tissues caused by water leaving the cells and filling up the intercellular spaces.
   - Wilting - The flaccid condition of leaves or shoots caused by a loss in turgidity.

- Blight - Similar to scorch but is usually applied to foliage or blossoms killed by a disease organism.
- Die-Back - The dying backward from the tip of foliage, twigs or branches of plants.
- Spot - A term applied to more or less discoloured circular or angular lesions on foliage, fruit, or stems.
- Rot - Dead tissue in a more or less advanced stage of decay.
- Scorch (firing) - The sudden death and browning of foliage or some times fruit.
- Canker- Localized, sharply demarked dead lesions, usually sunken or cracked, in the bark of the trunk, stems and roots of trees and shrubs.
- Damping off - The rapid rotting of seeds or seedlings before they emerge from the ground or the rapid rotting of the bases of seedlings so that they fall over.
- Bleeding - The continuous oozing of sap from wounds or injuries.

2. **Chlorotic symptoms** - These are characterised by loss, suppression or reduction of the normal green colour in plants.
   - Chlorosis - The partial failure of the development of green colour in organs that are normally green. Chlorosis may be diffused or patterned.
   - Yellowing - The yellowing of normally green tissue (usually foliage) is due to a breakdown of chloroplasts or chlorophyll
3. **Hypoplastic symptoms** - occur as underdevelopment or stopping of growth of cells, tissues and organs.
   - Suppression - The failure of certain organs such as flowers or seeds to develop at points where they normally develop.
   - Etiolation - Excessive spindliness accompanied by dwarfing of foliage and flowers and lack of natural chlorophyll development.
   - Dwarfing or Stunting - A symptom characterized by the abnormal size of the whole plant or of some of its organs.
   - Rosetting - The crowding of the foliage into a rosette formation caused by the shortening of the internodes of stems or of branches.
4. **Hyperplastic symptoms** - cause over development of cells, tissues and organs.
   - Abscission or Defoliation - The premature falling of leaves, flowers, or fruits caused by the formation of the abscission layer at the bases of their petioles.

- Galls - Local swellings or tumour - like growths on any part of a plant. They may be large or small, smooth or rough, and fleshy or woody. They may bear descriptive names such as warts, knots, tubercles, boils, blisters, and clubs.
- Curling (Rolling) - The abnormal curling or bending of shoots or leaves because of tissue overgrowth on one side of the affected organ.
- Scab - Definite, slightly raised and roughened lesions on fruits, tubers, leaves etc.
- Fasciculation - The abnormal development of twigs or roots about a common point. When this occurs on the aerial parts of a plant, it is usually called a witches broom.

B. General symptoms of plant diseases

- Chlorosis / yellowing - leaves and other parts of the affected plants become pale green or yellow due to destruction of chlorophyll. eg: yellow dwarf of rice.
- Mosaic - under development of chlorophyll, resulting in alternate light and green patches, eg: Cassava mosaic disease.
- Little leaf - size of leaves are affected, affected plants get reduced in size. eg: Little leaf of brinjal.
- Stunting - affected plants become under developed, internodal distance gets reduced. eg: Grassy stunt of rice.
- Galls and tumors - this refers to over growth and enlargement of plants. eg: Club root of crucifers.
- Leaf curl, blistering and puckering - caused by fungi and virus, eg: blister blight of tea.
- Spots - death of tissue in a limited area. eg: brown leaf spot of rice.
- Blight - necrotic area is extended to a large area eg: Bacterial leaf blight of rice.
- Anthracnose - characterized by limited sunken black lesions. eg: anthracnose of bean
- Witches broom - abnormal and excessive development of auxillary buds. eg: witches broom in mango
- Phyllody - floral parts transformed in to green leaf like structures. eg: phyllody in sesame
- Damping off - collapse and death of young seedlings. eg: damping off of vegetables
- Dry rot - rotting of plant parts such as fruits, bulbs, tubers etc, no oozing of liquid from affected parts, affected parts become shrunk and produce a powdery mass black in colour, eg: dry rot of ground nut.

- Wet rot - oozing out of liquid from affected parts. eg: soft rot of ginger.
- Wilt - drying of entire plant, loose turgidity and droop, eg: fusarial wilt of cotton
- Die back - twigs and young branches start drying from tip downwards. eg: die back of mango.
- Scab - on affected parts round or crust like lesions appear, eg: apple scab
- Canker - localised death of cortical tissues of stem, leaves and fruits eg: citrus canker.
- Rust - rusty appearance on plant parts, small pustules of spore break through host epidermis. eg: black stem rust of wheat.
- Smut - floral parts converted in to a black powdery mass. eg: loose smut of wheat.
- Mildew - powdery or cottony growth on green plant parts. eg: downy mildew of grapes

Practical Activity

Familiarisation with important disease causing organisms and symptoms seen in major crops

Materials required - specimens of plants, photographs, CDs, symptoms of attack.

Procedure - Familiarize with the disease causing organism and symptoms. Sketches can be drawn in the practical record. Tabulate the symptoms of given specimen.

Sl. No	Specimen	Crop	Type of symptoms	Causal organism	Description
1.	Leaf	Amaranthus	Leaf Spot	Fungus	White spots with dark margin
2.					
3.					
4.					
5.					
6.					
7.					
8.					
9.					
10.					

C. Koch's postulates

Koch's postulates are used to prove whether a plant is affected with a particular disease.

1. The organism should be associated with all cases of a given disease.
2. The organism must be isolated from the diseased plant.
3. When the organism is subsequently inoculated into susceptible plant, it must reproduce the disease.
4. The organism could be re-isolated from the experimentally infected plant.

D. Ooze test

This test is done for field diagnosis to confirm bacterial diseases and separate them from other vascular wilts.

- Take the affected stem and cut it cross wise near the ground.
- Immerse it in a transparent glass of clear water.
- Creamy white bacterial ooze can be seen in the xylem bundles of an affected stem.
- If cut surface is pressed with a knife blade or finger, the ooze will string out forming fine shiny threads from the affected ones (the sap of a healthy plant is watery and will not string).

Practical Activity

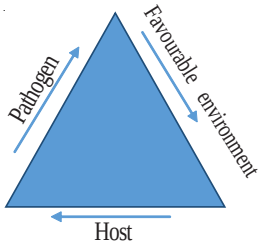
Practicing ooze test.

3.1.14 Disease Epidemiology

Disease Epidemiology is a study of the factors affecting the outbreak of an infectious disease.

Disease Triangle

Plant disease is the outcome of the interaction between the plant, the pathogen and the environment.



In this disease triangle the environment favorably or unfavorably influences both the plant and the pathogen. When favorable interactions between the three components of incidence of a disease continue for long, epidemics occur.

The study of epidemics helps to,

- Understand the various factors involved in the development of an epidemic.
- Understand the interaction of these factors in the development of the disease.
- Predict a forthcoming infection to take timely control measures and to reduce losses.

3.1.15 Essential condition for the development of an epidemic / disease

1. Host related factors

- Level of genetic resistance of the plant.
- Genetic uniformity of the population.
- Abundance and distribution of susceptible host.
- Presence of collateral hosts.

2. Pathogen related factors

- Presence of a virulent pathogen.
- High birth rate and low death rate of the pathogen.
- Easy and rapid dispersal of the pathogen.
- Adaptability of the pathogen.

3. Environment related factors

- Temperature
- Moisture
- Cultural practices that modify temperature and moisture
- Presence of antagonistic micro flora

4. Time related factors

- Season of the year suitable for disease development
- Time of planting
- Duration of favourable conditions to develop the disease

5. Human activities

- Selection of field for cultivation
- Selection of planting materials
- Choosing the time of planting
- Transportation of planting materials
- Control measures taken to protect or manage the disease.

Meteoropathology deals with the study of relationship between the weather and epiphytotics.

3.1.16 Plant disease forecasting & it's application

Plant disease forecasting provides early information about the probable occurrence of a disease to facilitate chemical control at appropriate time either to stop pathogen multiplication or further spread of the disease.

Plant disease forecasting is generally done by establishing relationship between pathogen population and physical weather parameters like air temperature, rainfall, relative humidity,cloudiness, dew wetness or leaf wetness duration.

Field monitoring for pre disease symptom at susceptible stage and monitoring of favourable weather conditions make the basis of disease monitoring.Forecasting gives us an opportunity to revise our plans in order to avoid or reduce losses.

Forecasting and monitoring of major airborne diseases have been made based on

- The knowledge on biology and ecology of the pathogen.
- Quantitative seasonal study over several years.
- Seasonal range and variation in the population pattern.
- Geographical distribution and weather records.

Bacterial blight of paddy develops readily above 25^{o}C and symptoms may not appear below 20^{o}C. So a combination of rainy weather, strong winds and a temperature of 22 - 26^{o}C favour the outbreak of the disease.

In India for forecasting rust epidemics, rain samples were collected and analyzed which gave precise data on the advent of the inoculum in a particular locality.

Practical Activity

Familiarisation with disease forecasting models and interactive softwares.

Blitecast for late blight of potato, tomcast for tomato diseases.

Assessment Activity

Prepare an assignment on the concept of Plant Disease Epidemiology and its importance in management of plant diseases.

Use the following hints

- Time of attack
- Disease triangle
- Essential conditions of severity
- Possibility of disease forecasting

3.1.17 Softwares for pest and disease diagnosis

1. KAU E-Crop Doctor : *www.celkau.in*
   - helps to have a realistic estimation of the quantity of pesticides recommended for the crop plants of Kerala.
   - the details of trade name and quantity for various pesticides can be easily taken from the information system.
2. Oushadham : *www.ctcri.org*
   - an online disease and pest diagnostic tool developed from CTCRI, Trivandrum.
   - the online system with the help of photos and systematic reasoning procedure arrive at the problem. The control measures are also included.
3. Crop Health Decision Support System : *www.kissankerala.net*
   - developed by a team of KAU scientists.
   - covers plant protection aspects of major crops of Kerala.
   - good quality original photos with comprehensive management recommendation are the salient features.
   - problem identification is done through photographs.
4. Karshikajalakam : *www.celkau.in.*
   - developed by KAU.
   - adopts an interactive pest diagnosis methodology.
   - through a series of elimination questions the diagnosis is reached.

5. Pest doctor : *www.farm extensionmanager.com.*
   - diagnosis starts from the basic plant part where symptoms are noticed.
   - based on elements of visual perception, pest diagnosis is made.
6. Online rubber clinic : *clinic.rubberboard.org.in*
   - developed by rubber board.
   - helps to arrive at the problems in rubber cultivation through a series of questions and photographs.
7. Farm Extension Manager : *www.farmextension manager.com*
   - developed by KAU and DRISHTI.
   - covers the major five crops of Kerala in detail.
   - it includes an online fertilizer calculator, pest doctor, management guide, irrigation advisor, crop planner etc.
   - agri-business and veterinary aspects are also covered in detail.
8. KAU Agri-infotech Portal : *www. celkau.in*
   - developed by Center for E-Learning, KAU, Vellanikkara.
   - the e- learning platform was the first of its kind in Kerala.
   - provides information on important crops of Kerala besides fisheries and veterinary aspects.
   - unique feature are KAU Fertulator, KAU E-Crop Doctor and media gallery.
9. TNAU Agritech Portal : *www.agritech.tnau.ac.in*
   - provides detailed information on all round production aspects of a number of agricultural crops.
   - the voluminous nature of the plant protection make the information system unique.
10. Online plant Clinic, Govt of Kerala.

Practical Activity

Practicing pest and disease diagnosis softwares.

TE questions

1. Application of pesticides may lead to pest outbreak. Substantiate.
2. Distinguish between the mouth parts of thrips and bugs.
3. You are asked to handle a session on different groups of agriculturally important insects and their characters. Prepare a chart with insect group, order, young ones, type of metamorphosis, mouth parts and wing characters to be used in the session.
4. Classify the following into insects and non- insects.

   Beetles, nematodes, bugs, mites, rats, flies
5. A specific organism is always associated with a specific disease. This is the first part of a famous postulate. Complete the postulate.
6. Find the missing pair

   a) Beetles : ……. Bugs : Piercing and sucking

   b) Regular pest : Thrips on chillies ……. : Rice swarming cater pillar
7. Match the following

Air borne	-	Sheath blight of paddy
Water borne	-	Rice blast
Soil borne	-	Loose smut of wheat
Seed borne	-	Soft rot of ginger
8. An organism which causes plant disease is called a ……..

Unit - 2

Integrated Pest and Disease Management (IPDM) of crops of Kerala

The over reliance and indiscriminate use of chemical pesticides has resulted in a series of problems in agro-ecosystem mainly the development of resistance in insects to insecticides, pest resurgence, outbreak of secondary pests into primary nature, environmental contamination and residue hazards, destruction of natural enemies etc. In this context , the integrated approach to pest management becomes relevant. Identification of different pests, their nature of damage and symptoms caused by them are to be familiarized for better and precise plant protection. New trends in pest management like ecological engineering, AESA are also included.

Learning Outcomes

The learner :

- explains the concept and principles of Integrated Pest Management (IPM).
- defines Economic Threshold Level (ETL), Economic Injury Level (EIL) and explains the concept.
- explains the different methods of IPM with examples.
- defines the concept of plant disease control and Integrated Disease Management (IDM).
- explains the concept and methods of weed management including Integrated weed management.
- defines the concept of Integrated Pest and Disease Management (IPDM) and enlists its components.
- describes the concept of pest surveillance and its objectives
- identifies the symptoms of pests and diseases of important crops of Kerala and recommends the management (IPDM) practices.
- identifies the pests of stored products, their nature of damage and explains management practices.

3.2.1 Integrated Pest Management (I P M)

Integrated pest management is the use of various control measures like physical, chemical, biological, legal, cultural, mechanical and modern plant protection methods in an integrated and compatible manner so as to reduce the pest population below economic injury level without much disturbance to the ecosystem.

3.2.1.1 Principles of IPM

- Identification of key pests and beneficial organisms
- Defining the management unit, the Agro-ecosystem (AESA)
- Development of management strategy
- Establishment of Economic thresholds (loss & risks)

Economic Threshold Level (ETL) - is the level of pest population at which suitable control measures have to be taken to prevent the pest population from reaching EIL.

Economic Injury Level (EIL) - is the level of pest population at which the damage caused by the pest is no longer economically tolerated.

3.2.1.2 Methods of IPM

i. Ecological engineering for pest management

It is a new concept which emphasises the use of cultural techniques to effect habitat manipulation to enhance biological control.

a. Above Ground :

- Growing specific plants to attract beneficial insects like Marigold, Mint, Sunflower, Sunhemp.
- Not to uproot weed plants those are growing naturally like Tridax procumbens, Ageratum sp., Alternanthera sp.

b. Below Ground :

Keeping soils covered year-round, adding organic matter in the form of reducing tillage intensity, applying balanced dose of nutrients using biofertilizers, applying *Trichoderma* and *Pseudomonas fluorescens*.

ii. Cultural methods

Some of the ordinary farm practices which are done to keep the insect infestation under check are called cultural methods. They are adjusting the time of sowing or planting, using resistant variety, crop rotation, flooding, mulching, trap cropping, cover cropping, mixed cropping, tillage operations like summer ploughing / deep ploughing digging etc.

iii. Mechanical methods

It is a control method by using mechanical devices or by manual operation. Eg: Collection and destruction , provision of preventive barriers and traps.

iv. Physical methods

Controlling insects by using physical forces. eg. Activated kaolinic clay is mixed

with stored products to prevent attack of storage pest, artificial heating or cooling, male sterilization technique and irradiation with UV light.

v. Legal methods

- Legislative measures are taken to prevent introduction of new pest, disease etc and to prevent spread of already established pest and disease from one part to another. The laws enforced by government are called 'quarantine' laws. (Foreign quarantine & Domestic quarantine laws). Import and export of a plant or plant material is done through quarantine stations.
- Quarantine stations are situated at various airports and seaports -

  Air ports - Bombay, Chennai, Calcutta, New Delhi and Amritsar.

  Seaports- Bombay, Chennai, Calcutta, Kochi and Vishakhapatanam
- A phytosanitary certificate is to be issued by the agriculture department of the exporting country stating that the particular consignment is free of pest, weeds or disease. Only along with this certificate, the plant is received in the quarantine station.

vi. Biological methods (Bio Control)

It is the pest control by using living organisms. Bio control can be classified into two.

Macrobial control - is by using parasites and predators. Predators include insects, mites, spiders, birds, reptiles etc.

Microbial Control - is by using pathogens. Pathogens include disease producing virus, fungus, bacteria, protozoa and Nematodes.

vii. Chemical methods

It is the control of insects by using chemicals. Pesticides are substances used to control pest and they include insecticides, fungicides, nematicides, rodenticides, acaricides, weedicides or herbicides, molluscicides etc.

3.2.2 Plant disease management

The main aim of plant disease control is to prevent or reduce the severity of the disease, so as to minimize the economic losses. To achieve a satisfactory control a combination of different control measures have to be adopted.

The control measures are divided in to two.

a. Prophylactic method - All the methods applied to prevent disease occurrence

Eg: Prophylactic spraying of Bordeaux mixture before monsoon to prevent incidence of quick wilt disease in pepper.

b. Curative methods - All the methods applied to cure a diseased plant.

Eg: Application of tridemorph for the management of stem bleeding in coconut.

3.2.2.1 Integrated Disease Management (IDM)

Integrated Disease Management is a system that utilises all suitable techniques and methods in a compatible manner and maintains the pathogen population at levels below those causing economic injury.

IDM includes all practices involving physical, cultural, legal, biological and chemical methods.

3.2.3 Weed management

Weed management is a system approach whereby whole land use planning is done in advance to minimize the invasion of weeds in aggressive forms and give crop plants a strong competitive advantage over the weeds.The major principles of weed control are prevention, eradication, control and management.

A. Prevention

It includes all measures taken to prevent the introduction and/or establishment and spread of weeds. Eg. Planting materials, feeds, manures, implements, etc. should be free of weeds, keep irrigation channels, fence-lines, and un-cropped areas clean, follow quarantine regulations,use certified seeds only etc.

B. Eradication

It infers that a given weed species, its seed & vegetative part has been killed or completely removed from a given area & that weed will not reappear unless reintroduced to the area.

3.2.3.1 Mechanical weed control

The mechanical methods include tillage, hoeing, hand weeding, digging, sickling, mowing, burning, flooding, mulching etc.

Tillage : It may weaken plants through injury of root and stem pruning, reducing their competitiveness or regenerative capacity.

Hoeing : Hoeing is more effective on annuals and biennials as weed growth can be completely destroyed.

Hand weeding: It is done by physical removal or pulling out of weeds by hand or removal by implements called khurpi, which resembles sickle.

Digging: Digging is very useful in the case of perennial weeds to remove the underground propagating parts of weeds from the deeper layer of the soil.

Sickling and mowing: Sickling is also done by hand with the help of sickle to remove the top growth of weeds to prevent seed production and to starve the underground parts.

Burning : Burning or fire is often an economical and practical means of controlling weeds.

Flooding : Flooding is successful against weed species sensitive to longer periods of submergence in water.

3.2.3.1.1 Mechanical weeders

Dry Land Weeder ,Power rotary weeder, Tractor drawn weeding cum earthing up equipment, Tractor operated multi row rotary weeder, Cono weeder.

3.2.3.2 Cultural weed control

Cultural practices like tillage, planting, maintenance of optimum plant population, crop rotation, growing of intercrops, cleanliness of the farm mulching, solarisation, stale seedbed, blind tillage etc.

3.2.3.3 Chemical control

Herbicides are chemicals capable of killing or inhibiting the growth of plants.

eg.2,4 D,MCPA, Alachlor, Glyphosate etc.

3.2.3.4.Biological control

Use of living organism's like insects, disease organisms, herbivorous fish, snails or even competitive plants for the control of weeds is called biological control. In biological control method, it is not possible to eradicate weeds but weed population can be reduced.

Outstanding examples of biological weed control .

- Salvinia, a major aquatic weed of rice is controlled by the weevil *Cyrtobagus salviniae*. In areas where Salvinia is a problem the weevils are released. Even a pair of weevil is sufficient for establishment in an area but generally 50-100 weevils are recommended in an area. If collection of weevil is not possible, 1 kg of infested Salvinia can be used. Weevils are released to tender Salvinia for easy establishment. Within a period of 1-1.5 years complete destruction of Salvinia is obtained.
- Larvae of *Cactoblastis cactorum*, a moth borer, control prickly pear *Opuntia sp.*
- Lantana camera is controlled by larvae of *Crocidosema lantana.*
- Herbivorous fish Tilapia controls algae.

3.2.3.5 Bio-herbicides/ Mycoherbicides

Bio herbicides are plant pathogens used to kill the targeted weeds. Fungal pathogens have been used to a larger extent than bacterial, viral or nematode pathogens, because, bacteria and virus are unable to actively penetrate the host and require natural opening or vectors to initiate disease in plants. Here the specific fungal spores or their fermentation product is sprayed against the target weed..

Common mycoherbicides

No	Product	Content
1.	Devine	A liquid suspension of fungal spores of *Phytophthora palmivora* causes root rot.
2.	Collego	wettable powder containing fungal spores of *Colletotrichum gloeosporoides* causes stem and leaf blight.
3.	Bipolaris	A suspension of fungal spores of *Bipolaris sorghicola*.
4.	Biolophos	A microbial toxin produced as fermentation product of *Steptomyces hygroscopicus*.

Practical Activity

Practicing skill development on mechanical weed management.

3.2.3.6 Integrated weed management

Integrated weed management may be defined as the judicious utilization of a combination of mechanical, cultural, biological and chemical methods of weed management in a planned sequence to bring the weed population below ETL without disturbing the ecosystem.

3.2.4 Integrated Pest and Disease Management(IPDM)

IPDM is designed around six basic components.

- Acceptable pest levels - To establish ETL Economic Threshold Levels. Apply management only if the pest population crosses ETL.
- Preventive cultural practices.
- Mechanical control.
- Biological control.
- Responsible use of pesticides.
- Monitoring/Surveillence: It is the backbone of IPDM which includes identification and inspection. This helps to issue forewarning and facilitates proper timing of plant protection measures thereby preventing avoidable losses and environmental contamination.

3.2.5 Pest Surveillance

Surveillance is the regular or repeated collection, analysis and dissemination of uniform plant health information for monitoring and intervening in a timely manner when necessary.

3.2.5.1 Objectives of surveillance

- Fixed plot survey and roving pest survey are conducted for uniformity in data processing. In the fixed plot survey pest and disease incidence are recorded from a fixed plot which represents the agro ecological situations in the locality. For pest monitoring over a large area in short time roving pest surveys are conducted.
- The data collected by field scouts on pest and diseases and common beneficial insects through surveys should be properly analysed by an expert and message communicated to the end user.

3.2.6 Identification and Management of Pests and Diseases of Crops of Kerala

3.2.6.1 RICE

A. Pests of Rice

Pest	Symptom of attack	Stage of attack of pest	EIL
Rice stem borer	**In vegetative phase : dead heart symptom** Larvae bore into the stem and feed on internal contents thereby stopping the translocation of food to upper parts. Thus central leaf dries up. **In reproductive phase: white ear head** In the Panicle initiation stage translocation to the panicle is stopped and grains are unfilled (chaffy) and white.	Caterpillar	Nursery: 1 moth/1 egg mass per sq.m. Upto pre-tillering, Mid tillering: 10% Dead Heart/ 1 egg mass/ 1 moth/sq.m. Panicle initiation to booting - 1 egg mass/1 moth per sq.m Flowering and after : 2% white ear head.
BPH	All stages are susceptible. **Hopper burn-** As a result of desapping from the base of plants the plants turn yellow and later dry up. Circular patches of such plants are seen here and there in the plant. Yellowing and drying extend rapidly.	Nymph and adults	Upto pre-tillering : 5-10 insects/hill Mid tillering : 10 insects/hill PI to booting: 15-20 insects/ hill Flowering and after : 20-30insects/hill

Gall midge	Hatched out larvae moves towards the growing point of the leaf and start feeding. Irritation caused by continuous feeding an oval elongated chamber is formed surrounding the larvae. **Silver shoot** (Instead of Central stem)	Maggot	Nursery: 1 silver shoot/sq.m Upto pre-tillering : 1 gall/sq.m Mid tillering : 10% silver shoots
Leaf folder	Leaves of plant are seen folded, rolled and often webbed together with white patches	Caterpillar	2 freshly damaged leaves per hill from planting to booting.
Rice bug	**Chaffy grains.** Brownish discoloured patches on the husk. Damage seen only in reproductive stage	Nymph and adult	Flowering and after 1-2 bugs/hill
Case worm	Leaves of plants eaten by caterpillars within small cylindrical cases made from leaves. These cases are seen hanging.	Caterpillar	5% hills attacked
Rice swarming caterpillar	The nursery and early stages of the crop are attacked leaving the plant as mere stumps	Caterpillar	4-5 caterpillars/sweep

B.Diseases of Rice

Disease	Pathogen	Symptoms of damage	ETL
Blast	Fungus	Spindle shaped water soaked greyish green spots which enlarge in size and develop to spots with grey centre and brown margin Nodal blast, neck blast.	Nursery: 5% Planting to pre-tillering: same as nursery Mid-tillering:10% PI and booting :10% leaf area damage
Sheath blight	Fungus	Symptoms first appear on lower leaf sheath near the water level as oval, oblong or irregular greenish grey spots, which enlarge and become greyish white with brown margin	At PI to booting and flowering and after 10% or more tillers affected
Brown spot	Fungus	Small definite oval / oblong spots with brown colour are formed on leaves and glumes	10% area damaged

Sheath rot	Fungus	Oblong/irregular brown spots on the leaf sheath enclosing the panicle.Later spot turn grey with dark brown margin Young panicle may remain inside the sheath.	Flowering and after 5%
Foot rot	Fungus	Drying of leaves and leaf sheath. Adventitious root formation from lower nodes.	
Bacterial leaf blight	Bacteria	Water soaked lesions on the tip of leaves which later increase in length downwards along the margins resulting in yellow to straw coloured stripes with wavy margins. Systemic infection in seedlings - KRESEK.	2%
Tungro	Virus Vector- Leaf hoppers	Stunting, change in colour of leaves to different shades of yellow or orange.	1 affected hill/sq.m

C. IPDM of Rice

1. Select HYV of rice showing resistance or tolerance to major pest or disease.
2. Use only certified seeds.
3. Resort to seed treatment to minimize pest and disease problem.
4. Avoid overlapping of cultivation.
5. Maintain bunds and fields free of weeds.
6. Assure nursery protection so that the problem in the main field can be minimized.
7. Assure protection and multiplication of natural enemies of pests or disease in the field.
8. Egg masses of rice stem borer seen in the field may be often parasitized. Collect them in perforated polybags and keep them in the field so that the parasites that emerge from parasitized ones can establish in the field effectively.
9. *Trichogramma chelonis* and *T. japonicum* effectively control eggs of leaf roller, stem borer, skippers and cut worms.
10. Parasitoids are to be released in the form of Trichocards 15 -30 days after transplantation or 25-30 days after sowing or immediately after noticing leaf roller or stem borer moth activity in the field. Release @1lakh parasitoids of

both *Trichogramma chelonis* and *T. japonicum* (@ 5cc/ha). The release has to be carried out at weekly intervals. 6-8 releases are necessary to manage the pest. Trichocards are to be placed either in the early morning or late in the evening. The cards should not be exposed to direct sunlight

11. *Pseudomonas flourescens* and *Trichoderma* are very effective in the management of several diseases of paddy.
12. Spray supernatent liquid of cowdung taken from 200g of fresh cowdung in 10 L of water. This is effective in managing bacterial diseases.
13. Subject the field to frequent observation and assess the pest population or damage or disease incidence and natural enemies
14. During the early stages of the crop try to avoid insecticides to protect natural enemies especially predators which make early appearance in the field well before the establishment of the pest
15. During initial pest or disease incidence resort to spot application of PP chemicals
16. Immediately after harvest destroy the stubbles by burying in soil by ploughing

Practical Activity

1. Identification of the major pests of rice, its symptom of damage and management

   Materials required - Preserved specimens, damaged specimens, diagrams, CDs etc.

   Procedure - collect, observe, identify and preserve the pest and its symptoms. Record relevant information in the following table.

Sl No	Symptom of attack	Feeding habit	Name of pest	Management

2. Identification of major diseases of rice, its symptoms, and management

   Materials required: diseased specimens, chart, CDs, photographs

   Procedure - Visit nearby paddy field, collect the specimens and record relevant information.

Record relevant information in the following table.

Sl No	Symptom	Name of disease	Management

3.2.6.2 COCONUT

A. Pests of coconut

Pest	Symptom of attack	Stage of attack	EIL
Rhinoceros beetle	Attacked frond when fully opened shows characteristic triangular cuts.	Adult	2 trees.
Red palm weevil	Presence of holes on the stem, oozing out of a viscous brown fluid through the holes, longitudinal splitting of leaf base and wilting of central shoot.	Grub and adult.	Mere presence.
Leaf eating Caterpillar	The caterpillar feeds on green matter from the lower leaf surface, remaining within galleries of silk and frass.	Caterpillar.	When damage crosses the outer whorl of leaves and seen in one upper leaf.
Root grub	Infested palm turn pale yellow and there will be considerable reduction in yield.	Grub.	10 grubs/tree.
Coreid bug	Attacked buttons become deformed with characteristic crevices on the husk below the perianth with gummy exudations.	Nymph and adults.	10 damaged nuts.
Coconut eriophyid mite	Pale yellow triangular patches below the perianth which later becomes brown. Later these develop into brown to black necrotic lesions with longitudinal fissures on husk.	Nymphs and adults.	5 %.

B. Diseases of coconut

Disease	Pathogen	Symptoms of damage	EIL
Bud rot	Fungus	Yellowing of spindle leaves and droop down. Later the tender leaf base and soft tissues of the crown rot into a slimy mass of decayed material emitting a foul smell. Finally rotting progresses and kills the entire palm.	Mere presence.
Leaf rot	Fungus	Water soaked lesions in the spear leaves of Root(wilt) affected palms As the leaf unfolds the rotten portions of the lamina dry and get blown off in wind giving a "fan shape" to leaves.	Mere presence.
Stem bleeding	Fungus	Exudation of reddish brown liquid through the growth cracks at the basal part of trunk. Trunk gradually tapers towards the apex.	Mere presence.
Ganoderma Wilt/ basal stem rot	Fungus	Rotting of basal portion of stem. Bark turns brittle and gets peeled off in flakes leaving open cracks and crevices. Ultimately the palm dies off.	Mere presence.
Root(Wilt)	Phytoplasma	Leaves show flaccidity, ribbing, yellowing and marginal necrosis. Yield gradually decreases.	Mere presence.

C. IPDM of Coconut

1. Provide field sanitation.
2. Rogue out plants that are affected severely with root (wilt) and replant with disease tolerant varieties eg Chandrasankara.
3. Apply lime, organic manure, magnesium sulphate and fertilizers as per recommendations.
4. Grow green manure crops such as sun hemp, cowpea etc in the basins and incorporate.
5. Cut and remove leaf rot infected portions of the spear and two adjacent leaves and pour fungicidal solution @300 ml prepared by mixing Hexaconazole or Contaf 5 EC 2 ml or Mancozeb 3g/l.
6. Spray crowns and leaves with 1% BM or COC @ 4g/l.
7. Conduct regular field survey to detect incidence of bud rot, stem bleeding,

Tanjavur wilt and incidence of red palm weevil, rhinoceros beetle, coconut leaf caterpillar, button mealy bugs,coreid bugs, mites and rodents and carry out appropriate management practices. If wherever bud rot is noticed remove the affected tissues and protect it with BP.

8. Hook out the rhinoceros beetle and fill the leaf axils with the mixture of neem cake and sand and naphthalene balls.
9. Incorporate *Clerodendron infortunatum* leaves in the manure pits.
10. Inoculate the manure pits with *Metarrhizium anisopliae* @ 20 g/l of water.
11. Release Baculovirus infected Rhinoceros beetle @ 10-15 /ha.
12. Set away from the garden pheromone traps for rhinoceros and red palm weevil as recommended.
13. Avoid making injuries on the tree trunks. When green leaves are cut from the palm stumps of not less than 120 cm are to be left on the trees.
14. In palms suspected to be infected with red palm weevil, observe for the bore holes and seal them except the top most one inorder to enable effective injection of insecticides (carbaryl).
15. Cut and burn outermost leaves infested with black headed caterpillar.
16. Arrange for the release of larval or pupal parasitoids of black headed caterpillar.
17. Clean the crown of all the dried inflorescence, young bunches and wide open two or three leaf axils surrounding the central spindle.
18. Control the mealy bugs, coreid bugs and mite infestation by applying 2% neem oil garlic emulsion.
19. Chisel out completely the affected tissues from trees showing stem bleeding infection and burn . Paint the wound with Bordeaux Paste followed by coal tar.
20. Apply neem cake, *Trichoderma* - cowdung mixture at the basins. Apart from this in stem bleeding affected plants, incorporate neem cake @ 5 kg/palm/ year.
21. In areas where root grub is a problem, deep plough the soil to expose different stages of insects during pre and post monsoon period. Collect and destroy adults during May-June.

Practical Activity

1. Identification of major pests of coconut, its nature of damage and management.

Materials required : Specimens of pests, damage symptoms etc.

Procedure - Visit nearby coconut garden. Collect and observe pest and symptoms of damage and record relevant information in the practical record. (Follow the table as given in rice).

2. Identification of major diseases of coconut, its symptoms and management.

Materials required : Diseased specimens, photographs.

Procedure - Visit nearby coconut garden, observe photographs and CDs. Collect and observe diseased specimens, symptoms and record relevant information. (Follow the table as given in rice).

3.2.6.3 BANANA

A. Pests of banana

Pest	Symptoms of attack	Stage of attack	EIL
Pseudostem weevil	Bore holes on the pseudostem, Oozing of viscous fluid from bore holes. Yellowing and withering of leaves and decaying of peduncles. In advanced stages pseudostem turns pale and bend down.	Grub and Adult.	One plant infested.
Rhizome weevil	Premature yellowing, withering of outer leaves and death of heart leaves Young plants wilt and die. Older plants show growth retardation.	Grub and Adult.	10 beetles from 5 plants.
Banana aphid	Indirect damage as it is a vector of bunchy top.	Nymphs and adults.	Mere presence.
Banana leaf caterpillar (sporadic pest)	Scraping of the upper tissues of leaves making it papery which later dries up- by just hatched larvae. Feeding holes on leaves by older larvae.	Caterpillar.	1 to 2 plants.
Nematode- Root knot nematode, burrowing nematode etc	Lanky pseudostem and foliar necrosis due to poor root growth. Heavily infested plants topple over easily. Very small bunches are produced.	All stages.	Mere presence.

B. Diseases of banana

Disease	Pathogen	Symptoms of damage	EIL
Bunchytop	Virus	Severe stunting, narrowing of leaves with chlorotic margins. Crowding of leaves/ rosette, brittle leaves.	Mere presence.
Kokkan / banana bract mosaic	Virus	Characteristic dark reddish brown mosaic pattern in the bracts of inflorescence. Distinctive pinkish streaks on pseudostem which later turn dark. Travellers palm like aestivation.	Mere presence.
Banana mosaic/ Infectious chlorosis	Virus	Appearance of parallel chlorotic streaks on younger leaves. Later heart leaf and central cylinder rots.	Mere presence.
Sigatoka	Fungus	Yellow streaks appear on older leaves which later turn brown with yellow halo.	Moderate incidence (10-20%) leaf area damaged.
Panama wilt	Fungus	Yellowing of margins of older leaves which may spread to younger leaves. Such leaves collapse at the petiole and hang down.	Mere presence.
Rhizome rot/ tip over	Bacteria	Affected plants show discolouration and soft rotting of rhizomes and suckers. Pockets of dark water soaked areas and cavities develop in the rhizome.	Mere presence.

C. IPDM of Banana

1. Adopt field sanitation- remove and destroy the rhizomes of affected crops along with the pseudostem.
2. Deep plough the land to expose inner layers to sun.
3. Select healthy planting materials from disease free areas.
4. Apply lime @ 500kg/ha at the time of land preparation.
5. Cut and remove the outer layer of rhizome of the sucker and sun dry for 3-4 days after smearing with a slurry of cowdung and ash.
6. Incorporate 50 g of neem seed cake powder per baby pit just before planting.
7. Incorporate neemcake @1kg in two equal splits one month and two months after planting.
8. Mulch the pit with lemon grass.
9. Just before planting dip the rhizome in 2% *Pseudomonas* suspension for 20 minutes.

10. Apply *Trichoderma*- cowdung-neemcake mixture @1 kg/ plant one month after planting.
11. Three months after planting cut, remove and burn lower most leaves showing leafspot symptoms and spray COC @ 4g/L or 1% BM. A second spray can be done with *Pseudomonas* @20 g/ L. There should be a minimum of 15 days gap between the two sprays.
12. Place bleaching powder cloth bags at the mouth of irrigation channel @ 5kg/ ha. In addition to this place 10 g bleaching powder cloth bags per plant at the basin for checking bacterial infection.
13. If Panama wilt is endemic dip the sucker for half an hour in carbendazim 0.1%and drench the base with the same fungicide.
14. Set traps(100 traps/ha) using pseudostem of 0.5m length which are split lengthwise and laid in the field after treating the cut surface with *Beauvaria bassiana* @ 20g/L or 5ml/L.
15. Drench the base of the plant and fill the leaf axils with *Beauvaria* or *Metarrhizium*@ 20g or 5ml/ L 3-4 months after planting. Care should be taken to see that there is a gap of atleast 10-15days between the chemical treatment and microbial pesticide application.
16. Cut and remove all the dried and drooping outer leaves as close to the pseudostem as possible.
17. Whenever Nanma(botanical from tapioca developed by CTCRI) is available fill the leaf axil and spray all the pseudostem @50ml/ha 4-5 months after planting. Even after application of Nanma if pseudostem borer infestation is noticed inject Menma @15ml/plant just below the bore hole at 3 different locations around the pseudostem.
18. Brush the pseudostem with cowdung slurry mixed with wood ash (1kg fresh cowdung+ 250g wood ash+ 30ml neem oil mixed with water so as to make a paste) when the plant is 4 months old.
19. Regularly uproot and destroy plants showing symptoms of bunchy top/ banana bract mosaic/ banana streak mosaic.
20. Whereever sigatoka disease is a problem cut and burn infected leaves and spray fungicides.

Practical Activity

1. Identification of the major pests of banana, its nature of damage and application of control measures.

   Materials required : specimens of pest, chart, CDs, damage symptoms.

   Procedure : Visit nearby banana field. Collect and observe pest and symptoms of damage and record relevant information.

2. To familiarize with the major diseases of banana, symptoms and application of control measures.

   Materials required: diseased specimens, chart, CDs, photographs.

   Procedure - Visit nearby banana garden, observe photographs and CDs. Collect and observe diseased specimens, symptoms and record relevant information.

3.2.6.4 PEPPER

A.Pests of pepper

Pest	Symptoms of attack	Stage of attack of pest	EIL
Pollu beetle	Attacked berries become hollow (pollu) and crumble when pressed. Attack on spike results in murithiri (broken spike). Holes on leaves.	Grub and adult.	4% damage.
Marginal gall thrips	Marginal galls on leaves Galled leaves are malformed, thickened and crinkled.	Nymph and adult.	10%.
Scale insects	Leaves become yellow, wither and fall. Infested vines wilt and dry up	Nymph and adult.	Mere presence.
Nematode-Rootknot nematode, burrowing nematode	Stunted growth, yellowing and drooping of leaves. Affected vines show slow decline.	All stages.	Mere presence.

B. Diseases of pepper

Disease	Pathogen	Symptom	EIL
Quick wilt/ foot rot	Fungus	Occur during rainy season. Disease spread to entire vine through rain splash. Tender leaves and succulent shoot tips of freshly emerging runner shoots on the soil turn black. Water soaked lesions with characteristic fimbricate margin. Breaking up of branches at nodes and the entire vine collapse within a month.	5% diseased plants.
Anthracnose/ fungal pollu	Fungus	Chlorotic angular leafspots surrounded by yellow halo. Later leaf spots may join together resulting in leaf blight followed by defoliation. Necrosis on the stalk of the spike lead to spike shedding. Affected berries dry up gradually (fungal pollu).	2% damage.

C.IPDM of peper

1. Regulate shade in the plantation.
2. Removal and destruction of dead vines affected by quick wilt along with root system.
3. Planting materials to be collected from disease free gardens.
4. Soil solarisation of nursery beds for avoiding quickwilt and nematode attack.
5. Adequate drainage should be provided.
6. Tie back the freshly emerging runner shoots.
7. Spraying formulations like *Metarrhizium anisopliae* or *Beauvariabassiana* or *Lecanicilium lecani* @20g/ L or 5ml/ L against pest population.
8. Spray 2% neem oil garlic emulsion or 0.4% neem based insecticides at spike emergence, berry formation and berry maturation stages when needed.
9. Apply lime @ 1kg/standard/yr.
10. Apply neem cake @1kg/vine against nematode and 2kg/standard/year against quick wilt.
11. Apply pepper vines with AMF, *Trichoderma* and *Pseudomonas fluorescens* at the time of planting in the nursery and main field. Apply *Trichoderma* as enriched organic manure @5-10kg/vine/yr. Spray nursery and main field with 2% *Pseudomonas*@ 20g/L.

12. Spray plants with 1% BM / 0.2% COC @ 5-10L thrice a year (drenching, foliar spray, drenching).
13. Do not use copper fungicides if the garden is protected with biocontrol agents as they are not compatible. Instead apply Potassium Phosphonate 0.3%@5-10L/vine
14. Apply BP upto a height of 50cm from collar region.
15. Spray anyone of the following insecticides Quinalphos/Dimethoate@ 0.05% at spike emergence, berry formation and berry maturation stages when needed.

Practical Activity

1. To familiarize with the major pests of pepper, its nature of damage and application of control measures.

   Materials required: specimens of pest, chart, CDs, damage symptoms etc.

   Procedure: Visit nearby pepper plantation. Collect and observe pest and symptoms of damage and record relevant information.

2. To familiarize with the major diseases of pepper, symptoms and application of control measures.

   Materials required: diseased specimens, chart, CDs, photographs

   Procedure - Visit nearby pepper garden, observe photographs and CDs. Collect and observe diseased specimens, symptoms and record relevant information.

3.2.6.5 SOLANACEOUS VEGETABLES

i.Brinjal

A.Pests of Brinjal

Pest	Symptoms of attack	Stage of attack	ETL
Shoot and fruit borer	Infested shoots droop, wither and dry up. Affected fruits show holes on the surface plugged with excreta .	Caterpillar	1 plant.
Epilachna beetle	Skeletonisation of leaves and drying.	Adults and grubs	Average population (adult, grub, pupae) - 2/plant.
Green jassids	Yellowing from margin inwards, finally leaves become brick red and brown in colour- hopper burn.	Adults and nymphs	2 adults or nymphs per plant.
Red spider mite	Leaves become whitish, ashy discoloured giving the plant a sick appearance.	All stages	Mere presence.

B. Diseases of Brinjal

Disease	Pathogen	Symptoms of damage	EIL
Damping off	Fungus	Pre emergence-Seedlings are killed before they emerge from the soil. Post emergence- Toppling over of the infected seedlings at any time after they emerge from the soil until hardening of the stem.	Mere presence One plant
Little leaf Vector- Leaf Hopper	Phyto plasma	Reduction in the size of the leaves. With narrowing, softening , smoothening and yellowing. Internodes shortened , axillary buds enlarged which give the crop a bushy appearance, floral part deformed leading to sterility.	Mere presence
Phomopsis blight and fruit rot	Fungus	Circular grey to brown spots on the leaves nearer to the soil. Lesions also formed on the stem. Fruits are attacked while still attached on the plant covering the entire fruit.	10%
Bacterial Wilt	Bacteria	Wilting, stunting,yellowing of the foliage and collapse of the whole plant. Entire vascular system undergoes blackening and bacterial slime oozes out from it if cut open.	Mere presence

ii. TOMATO

A.Pests of Tomato

Pest	Symptoms of damage	Stage of attack	EIL
Fruit borer	Emerging caterpillars feed on leaves, bore into the fruits.	Caterpillar	5%
Leaf caterpillar	Scraping of green matter leads to drying. Defoliation. Larvae bore into the fruits.	Caterpillar	2 larvae/plant.
American Serpentine Leaf Miner (ASLM)- polyphagous pest	Mining of the leaves in a serpentine manner appear as white lines on the surface. Drying of leaves.	Maggots	2 freshly damaged leaves per plant.

B. Diseases of tomato

Disease	Pathogen	Symptoms of attack	EIL
Damping off (Same as brinjal)			
Septoria leaf spot	Fungus	Small spherical spots on the under surface of older leaves which later enlarge to develop white or grey centre with dark brown margin.	2 plants showing fresh damage.
Powdery mildew	Fungus	White, chalky spots forming all over the plant including the stems, flowers and fruit.	1 plant .
Tomato Spotted Wilt Virus (TSWV) Thrips	Virus	Slight thickening of the veins of younger leaves. Simultaneously concentric rings appear in the foliage, curling of younger leaves Green fruits show concentric rings of yellow or brown.	Mere presence.
Leaf curl Vector white fly	Virus	Plants initially show stunting and erect growth. Curling, puckering and blistering of leaves.	Mere presence.
Bacterial wilt (Same as brinjal)			

iii. CHILLI

A. Pests of chilli

Pest	Symptoms of attack	Stage of attack	EIL
Thrips Vector of chilli virus	Infested leaves crinkle and attain boat shape. Affected plants become stunted and fruits deformed.	Adults and nymphs	Mere presence
Aphid Vector of virus disease of chilli	Leaves become yellow and later shed.	Adults and nymphs	Mere presence
White fly Vector of leaf curl virus	Leaves become yellow and later shed.	Adults and nymphs	Mere presence
Mites	Leaves become thick, brittle and tubular.	All stages	Mere presence

B.Diseases of chilli

Disease	Pathogen	Symptoms of damage	EIL
Damping of (Same as brinjal)			
Anthracnose and fruit rot of chilli	Fungus	Seedling blight. Dark sunken lesions on leaf and fruit. Die back. Fruit rot.	Vegetative phase : 5%, Reproductive stage : 10%

Leaf curl Vector white fly	Virus	Curling of leaves, thickening and swelling of veins followed by puckering and blistering of interveinal areas.	Mere presence
Bacterial wilt	Bacteria	Wilting,stunting,yellowing of the foliage and collapse of the whole plant. Entire vascular system undergoes blackening and bacterial slime oozes out from it if cut open.	Mere presence

C. IPDM of solanaceous vegetables

1. Use healthy seeds for planting.
2. Use resistant varieties -Surya, Swetha, Neelima(Brinjal), Sakthi, Mukthi, Anagha, Vellayani Vijay(tomato), Ujwala, Anugraha, White Kandari (chilli) against bacterial wilt.
3. Provide good drainage.
4. Soil solarisation.
5. Prompt collection and destruction of shoots and fruits harbouring the larva,and diseased plant parts.
6. Rouge out virus and phytoplasma infected plants.
7. Protect the seedlings in the nursery with net.
8. Spray gruel water on the lower surface of leaves for reducing mite population.
9. Place pheromone traps @ 100/ha against fruit and shoot borer.
10. Install flame torch during dusk to attract and kill adult moths.
11. Install yellow sticky traps @1trap/5 cents to attract white flies.
12. Cultivate marigold against nematode, fruit borer of tomato.
13. Incorporate *Eupatorium* or neem leaves or neem cake with organic manures against nematodes.
14. Spray neem oil garlic emulsion 2% or 5% against sucking pest.
15. Spray castor oil neem oil emulsion + garlic extract diluted in water against epilachna and jassids.
16. Spray *Hyptis* extract against aphids.
17. Spray BT available as Dipel, Delphin, etc.@ 0.7ml/L against Lepidopteran larva.

18. Apply lime @500kg/ha 15 days before planting against bacterial wilt.
19. Apply *Lecanicilium lecani* @20g/L or 5ml/L against sucking pest.
20. Apply *Trichoderma, Pseudomonas fluorescens* or PGPR mix-II to soil.
21. Apply chlorantraniliprole 0.3ml/L against shoot and fruit borer, mite, thrips etc.
22. Apply dimethoate 0.05% against sucking pest.
23. Apply mancozeb 0.2% or COC 0.3% or carbendazim 0.1%.

3.2.6.6 CUCURBITACEOUS VEGETABLES

A. Pests

Pest	Symptoms of attack	Stage of attack	EIL
Fruit fly	Microorganisms gain entry through the injury formed by the ovipositor on the fruits. Emerging larvae feed within the fruit which as a result rot and drop.	Maggot	5%damage
Aphid Vector of mosaic virus	Leaves become highly crinkled and the plants become weak.	Adults and nymphs	5 adults/nymphs per leaf
Green Jassids	Yellowing from margin inwards, finally leaves become brick red and brown in colour- hopper burn.	Adults and nymphs	2 adults or nymphs per leaf
Yellow Mites	Leaves become small and brittle.	All stages	5% damage
White fly	Leaves become yellow and later shed.	Nymphs and adults	5 adults or nymphs per leaf
Epilachna beetle	Scraping and skeletonising the leaves.	Grubs and adults	Average population (adult,grub,pupae) - 2/plant
Pumpkin beetle	Grubs bore into the base of the plant resulting in wilting and drying of plants. Adult beetles damage by making feeding holes on leaves.	Grubs and adults	5 insects per sweep
Snake gourd caterpillar	Damage on leaves leads to defoliation. Flowers and young fruits also eaten up by the caterpillars.	5/sq.meter	
Pumpkin caterpillar	Caterpillar feed on leaves, flowers and young developing fruits.	5/sq.meter	

B.Diseases

Disease	Pathogen	Symptoms of damage	EIL
Fruit rot	Fungus	Soft dark green water soaked lesions that gradually develop to form watery soft rot.	5%
Downy mildew	Fungus	Pale yellow angular patches on the upper surface of leaves. Gradually the spots turn dark brown and dry up. Downy growth of fungus visible on lower surface of affected leaves.	Mere presence
Powdery mildew	Fungus	Whitish grey superficial spots on upper surface of leaves. Later defoliation.	Mere presence
Anthracnose	Fungus	Yellowish water soaked region on leaves which later turn brown or black and dries up. Rounded dark sunken spots develop on the affected tissues.	8% for leaves and mere presence for fruits
Fusarium wilt	Fungus	Wilting. Characteristic tip burn symptom on foliage.	Mere presence
Mosaic	Virus	Leaves become mottled, deformed and reduced in size and are curled.	Mere presence

C.IPDM of cucurbitaceous vegetables

1. Collect and destroy fruit fly infested fruits.
2. Collect and destroy pumpkin beetles.
3. Rouge out virus infected plants.
4. Use seeds from virus free plants.
5. Cover the fruits with paper or perforated polythene tubes to protect from fruit fly attack.
6. Suspend different types of traps @2.5m spacing.
7. Apply lime @100g/pit followed by regular application of well decomposed neem cake against fusarial wilt and to destroy fruit fly pupa.
8. Apply 1.5% fish oil soap against aphids, neem oil garlic emulsion against sucking pest.
9. Use pheromone traps @10nos/ha (cue -lure) to attract male fruit flies.
10. Spray castor oil neem oil emulsion + garlic extract diluted in water against sucking pests.

11. Spray gruel water on the lower surface of leaves for reducing mite population.
12. Spray 2% *Pseudomonasfluorescens* against fungal diseases.
13. Apply *Trichoderma* enriched organic manure @ 250g/pit.

3.2.6.7 COWPEA

A. Pests of cowpea

Pest	Symptoms of attack	Stage of attack	EIL
Pea aphid	Yellowish hue on infested leaves Growth of the plant retarded. Pods become malformed.	Nymphs and adults	5 aphids
Pod bug	Seeds shrink and shrivel within the pods. Attacked seeds become discoloured.	Adults and nymphs	One bug/plant
Pod borer	Seeds and buds destroyed by larva.	Caterpillar	
Spotted borer	Caterpillar enter bud,flower or the pod. Entrance hole plugged with excreta.	Caterpillar	
ASLM	Mining of the leaves in a serpentine manner appear as white lines on the surface, drying of leaves.	Maggots	2 freshly damaged leaves per plant

B.Diseases of cowpea

Disease	Pathogen	Symptoms of damage	EIL
Collar rot and web blight	Fungus	Reddish brown lesions at the collar region. Girdling of stem. Collar region becomes sunken and rotten with thick mycelium at later stages. Yellowing and defoliation and web blight on foliage with mycelia growth.	Mere presence
Fusarium wilt	Fungus	Plant show yellowing, withering and drooping of leaves. Vines show blackening and drying. Roots show rotting and blackening. Basal swelling.	Mere presence
Powdery mildew	Fungus	Whitish grey superficial spots on upper surface of leaves. Later defoliation.	Mere presence
Anthracnose	Fungus	All parts are affected. Severely affected pods are curled . and do not contain normal size seeds.	5 plants showing fresh symptom
Cowpea aphid Vector: aphid	Virus	Irregular chlorosis of young leaves. Mosaic mottling.	Mere presence

		Vein banding. Puckering and distortion. Pods twisted, curved and reduced in size and seeds shrivelled.	
Cowpea bud necrosis Vector : thrips	Virus	Typical chlorotic spots on leaves. Necrosis in advanced stages seen in stem growing point, buds, pods, etc. Entire plants dry up.	Mere presence

C.IPDM Of cowpea

1. Remove and burn the crop residue.
2. Rogue out the weeds.
3. Select healthy seeds.
4. Select healthy seeds showing resistance/tolerance.
5. Apply lime @500kg/ha.
6. Incorporate *Trichoderma* enriched organic manure against fungal diseases.
7. Immerse the seeds in 1% *Pseudomonas* for atleat 6hrs before sowing.
8. Treat the seeds with *Rhizobium* culture@ 250g/ha.
9. Application of ash, keeping yellow sticky traps, collection of infested plant parts and pests.
10. Install flame torch to attract and kill bugs and moths.
11. Drench and spray with *Pseudomonas* 2% when the plant attains 15 and 20-25 days.
12. Instead of *Pseudomonas*, 1% BM or 0.2% COC can be applied.
13. To manage residual population of insects spray *Beauvaria bassiana* and *Lecanicilum lecani.*
14. Include neemcake and *Eupatorium* in manuarial schedule.

3.2.6.8 OKRA

A. Pests

Pest	Symptoms of attack	Stage of attack
Fruit and shoot borer	Larvae bore into terminal shoot or fruit and feed on internal contents leading to drooping, withering and drying up of shoots.	Caterpillar

	Deformed appearance of infested fruits with holes plugged with excreta.	
Leaf hopper	Crinkling and yellowing of leaves which finally turn brick red-hopper burn.	Nymph and adults
Aphid	Crinkling of leaves. Plants stunted.	Nymph and adults
Root knot nematode	Stunted growth, yellowing and drooping of leaves.	All stages

B. Diseases

Disease	Pathogen	Symptoms of damage	EIL
Yellow vein mosaic Vector- white fly	Virus	Yellowing of veins followed by veinal chlorosis. Thickening of veins and veinlets. Chlorosis may extend to interveinal areas. Fruits are dwarf, malformed and yellowish green.	Mere presence

C. IPDM of okra

1. Collect and destroy leaf rolls, bored fruits and shoots with different stages of pest.
2. Use YVM Resistant varieties like Arka Anamika, Arka Abhay and Susthira.
3. Rogue out virus infected plants and collateral hosts like *Ageratum*, *Croton sp*.
4. Apply saw dust/ paddy husk @500g/plant or neem leaves or *Eupatorium* leaves @250g/ plant in basins one week prior to planting to manage nematodes.
5. Seed treatment with *Bacillus macerans* @3% w/w(2.5kg/ha) and followed by drenching 30 DAP with 3% solution.
6. Apply botanicals like Neem oil garlic emulsion or Neem seed extract, neem oil emulsion or 4% leaf extracts of *Thevetia*/neem against borers and sucking pest.
7. Aphids, Jassids and mealy bugs on okra can be controlled by 4% leaf extracts of neem/ *Thevetia/Clerodendron* with soap water.
8. Apply Quinalphos 0.05% against Jassids.

3.2.6.9 AMARANTHUS

A. Pests

Pest	Symptoms of attack	Stage of attack	EIL	Management
Leaf webber	Larva web together the leaves and skeletonise them.	Caterpillar	Mere presence	Collect and destroy damaged leaves with different stages of pest. Spray Birds eye chilli-cows urine extract.

B. Diseases

Disease	Pathogen	Symptoms of damage	EIL	Management
Amaranthus leaf blight	Fungus	Straw coloured lesions in leaf which later coalesce. Shot hole symptoms.	Mere presence	Mixing green and red variety will reduce spread. Grow tolerant varieties like Co1, Co2. Avoid splashing during irrigation. Apply Baking soda - turmeric- asafoetida mixture.

3.2.6.10 COOL SEASON VEGETABLES

A.PESTS

Pest	Symptoms of attack	Stage of attack	Management
Cabbage butterfly	Defoliation	Caterpillar	Hand picking and destruction of eggs and larvae.
Diamond black moth	Skeletonisation and defoliation.	Caterpillar	Nylon nets as barrier in the early stages.
Leaf caterpillar	Defoliation	Caterpillar	Spraying Dipel@0.2% at 15 days interval after 22-25 DAT.

B.DISEASES

Disease	Pathogen	Symptoms of damage	Management
Black rot	Fungus	V-shaped lesions appear along the tips of the leaves. Veins turn black or brown.	Field sanitation. Use disease free seeds and seedlings. Control weeds.
Damping off	Fungus	Seeds rot in the ground before emergence. Seedlings topple and die.	
Black leg	Fungus	Ash grey spots speckled with tiny black dots on the leaves and stem. Plants wilt and die.	Apply lime to acid soils.
Leaf spot	Fungus	Brown circular spots with concentric rings on leaves. Later turn yellow and drop.	Planting to be done on raised beds to facilitate drainage.

Downy mildew	Fungus	Infected plants develop a grey mould on lower leaf surface. Leaves wither and die.	Drench the soil with Dithane M 45 (0.2%)or Bavistin (0.1%) to control damping off.

Practical Activity

Aim - To familiarize with the major pests of vegetable crops, its nature of damage and application of control measures.

Materials required: specimens of pest, chart, CDS, damage symptoms.

Procedure - Visit nearby vegetable field and vegetable garden in the school, collect, observe pests and symptoms of damage and record relevant information.

3.2.6.11 CARDAMOM

A.Pests of cardamom

Pest	Symptoms of attack	Stage of attack	Management
Cardamom thrips	Panicles become stunted with shedding of flowers and immature capsules. Pods become undersized, malformed and show scabbed skin and fetch lower premium in market.	Adults and nymphs	Regulation of shade. Removal of collateral host plants like Colocasia sp. Remove dry leaves/ leaf sheaths, old panicles and other dry plant parts immediately before the application of insecticide. Spray Quinalphos 0.025%or Fenthion or Phosalone 0.07% during March, April, May, August, September.
Shoot/ Capsule borer	Drying up of affected parts. Dead heart symptom produced by late stage larvae. Holes plugged with excreta on capsules. Conspicuous oozing out of frass material at the point of larval tunnelling.	Caterpillar	Collection of adult moths with nets during day time Remove tillers showing dead heart symptoms Spray Fenthion 0.075%
Hairy caterpillar (sporadic)	Leaves are eaten up extensively.	Caterpillar	Collection and destruction of adults by luring them using light traps. Apply Quinalphos 0.05%.

Rhizome weevil	Drying of leaves and breaking of stem at the base (serious in secondary nursery during Nov- Jan).	Grub	Destruction of infested rhizomes along with immature stages of the pest. Drenching the base of the clumps with 0.075% Chlorpyriphos.
Root knot Nematode	Stunted growth, chlorosis, yellowing and drying of leaves and production of narrow, brittle abnormal leaves. Shedding of immature capsules.	All stages	Use of nematode free healthy seedlings. Pruing of roots before transplanting . Fumigation of primary and secondary nursery with Methyl Bromide @ 500g/10 sq.m

B. Diseasesofcardamom

Disease	Pathogen	Symptom	Control
Katte/Mosaic Vector: Banana aphid	Virus	Discontinuos stripes of pale green and dark green areas running parallel to veins from midrib to leaf margins. Leaves, leaf sheaths and psudostems show characteristic mosaic patterns. The infected clumps will be smaller in size with few tillers. 70% of yield reduction within three years of infection.	Destroy infected plants. Control vector using chemicals. Rogue out alternate host.
Azhukal disease (occurs during rainy season)	Fungus	Water soaked lesions appear first and rotting and shedding occurs thereafter. Finally affected leaves break at the base of the petiole and remain hanging. Infected capsules decay emits a foul smell and fall off within 3 days. Infection spreads to panicle and in severe cases to rhizomes and tillers also.	Remove and destroy infected clumps. Spray 1% BM. Drench with 1%BM @3L/plant.
Clump rot or Rhizome rot	Fungus	Yellowing of leaves and decay of tillers starting at the collar region. The decay extends to rhizomes and roots and finally results in the death of the plant.	Drench with BM or cheshunt compound.

Chenthal disease	Fungus	Appearance of rectangular linear reddish brown lesions mainly on the lower surface of leaves. Severe in areas which do not have proper shade.	Provide adequate shade.

3.2.6.12 GINGER

A.Pests

Pest	Symptoms of attack	Stage of attack	Management
Leaf roller	Larvae cut and fold the leaves, remain within and feed on them.	caterpillar	
Rhizome scale (Turmeric)	Plants wither and dry. In storage, infestation results in shriveling of buds and rhizomes. Severe infestation adversely rhizomes.	Adults and nymphs	Dip the rhizomes in affects sprouting of quinalphos before storage.

B.Diseases

Disease	Pathogen	Symptom	Control
Rhizome and Soft Rot	Fungus	Yellowing of leaves which starts from lower leaves. Partial or complete drying of leaves. The collar region turn soft and shoots can be easily pulled out. Infection spread from roots to rhizomes causing soft rot. In advanced stages the rotten rhizomes emit foul smell.	Avoid water logging. Before onset of monsoon spray and drench with 1% BM.
Bacterial Wilt	Bacteria	First conspicuous symptom is mild drooping and curling of leaf margins of the lower leaves which spread upwards. Plants exhibit severe yellowing and wilting symptoms in advanced stages. Vascular tissues show dark streaks Affected pseudostems and rhizome when pressed gently extrudes milky ooze. Rhizomes rot ultimately.	

Practical Activity

To familiarize with the major diseases of cardamom and ginger, symptoms and application of control measures.

Materials required: diseased specimens, chart, CDs, photographs.

Procedure - Visit nearby garden, observe photographs and CDs. Collect and observe diseased specimens, symptoms and record relevant information.

3.2.6.13 MANGO

A.Pests

Pest	Symptoms of attack	Stage of attack	Management
Mango hopper	Infested flowers shrivel, turn brown,dry and ultimately fall off. Sooty mould forms on leaves and inflorescence due to the excretion of honey dew by hoppers. Reduces fruit set considerably.	Nymphs and adults	Two sprays of carbaryl 0.1% or malathion 0.1% (at panicle emergence and at pea nut stage of fruits).
Mango Fruit Fly	Rotting of fruits rendering them unfit for human consumption.	Maggots	Collection and destructon of infested and dropped fruits. Ploughing of orchards. Pheromone traps (methyl euginol).
Mango Stem Borer	Branches and stem dries and dies. Bore holes in stem with sap and frass coming out. Shedding of leaves and drying of branches.	Grub	Padding with Quinalphos 25 EC 10ml in 2.5cm per tree soaked in cotton.
Shoot midge	Drying of terminal shoots. Infested flower buds and fruits show minute exit holes and drop. If young plants are attacked they are often prevented from growing due to continuous killing of new shoots.	Maggot	Spray 0.05% dimethoate
Shoot webber	Webbing together of clusters of leaves and feeding on them leaving only the midribs webbed leaves dry up.	Caterpillar	

B.Diseases

Disease	Pathogen	Symptom	Control
Anthracnose	Fungus	Leaves show oval/irregular grayish brown spots which later coalesce and dry and shred. Girdling and drying of affected stem. Die back of twigs. Infected flower parts ultimately sheds resulting in complete or partial de blossoming. Ripening fruits show typical anthracnose- black sunken spots on fruits which coalesce.	Crowding in orchards should be avoided. Affected twigs should be pruned and apply BP. Spray 1% BM or captan 0.3%.
Powdery mildew	Fungus	Whitish/grayish powder area on tender foliage and inflorescence Infection covers the floral axis. young leaves and stem. The affected fruits drop off prematurely or show malformation and discolouration.	Apply sulphur dust (350mesh) in the early morning to protect new flush or spray wettable sulphur 0.2%.
Die back	Fungus	Discolouration and darkening of bark some distance from tip. Twig or branch dies, shrivels and falls.	

Practical Activity

1. To familiarize with the major pests of mango, its nature of damage and application of control measures.

   Materials required: specimens of pest, chart, CDs, damage symptoms etc.

   Procedure - Visit nearby orchard. Collect and observe pest and symptoms of damage and record relevant information.

2. To familiarize with the major diseases of mango, symptoms and application of control measures.

   Materials required: diseased specimens, chart, CDs, photographs

   Procedure - Visit nearby mango orchard, observe photographs and CDs. Collect and observe diseased specimens, symptoms and record relevant information.

3.2.6.14 RUBBER

A. Pests

Pest	Symptoms of attack	Stage of attack	Control
Scale insect	Severely affected petioles and tender shoots dry up and die.	Nymphs and adults	Dimethoate@ 0.05%
Stem borer	Branches and stem dries and die. Shedding of leaves. Bore holes with sap and frass coming out from them.	Grubs and adults	Padding with Quinalphos 25 EC 10ml in 2.5cm per tree soaked in cotton.

B.Diseases

Disease	Pathogen	Symptom	Control
Abnormal leaf fall (During SW Monsoon)	Fungus	First the fruit rot, later infected leaves fall in large numbers prematurely either green or after turning coppery red. Black lesion develop on the petiole with a drop of latex. Heavy defoliation may lead to considerable loss of crop and die back of terminal twigs.	Prophylactic spray of 1% BM before monsoon.
Powdery Mildew	Fungus	Tender leaves with ashy coating curl, crinkle and edges roll inwards and fall leaving the petioles attached to the twigs like a broom stick. Die back of twigs. White patches on older leaves reduces photosynthetic efficiency. Infected flowers and tender fruits are shed.	Dusting with sulphur 3-5 rounds at weekly / fortnightly intervals.
Pink disease (more damaging for plants in the age group of 2-12 yrs)	Fungus	Main seat of infection is the fork region. White or pink coloured cobweb mycelia growth on the bark surface with streaks of latex oozing out from the lesions. Rotting, drying up and cracking of affected bark follow. Distal portion of branches dry and dried leaves stick to the dead branches.	Regular inspection during July- September. In early stages of infection apply BP upto 30cm above and below the affected region. In severe cases prune off and burn the dried up branches.
Patch canker/ Bark Canker	Fungus	The bark rots and a coagulated rubber disseminating a foul smell is seen in between the wood and the rotting bark.	Tapping cut near bark should be washed with mancozeb (0.375%) at weekly intervals. Rotten bark to be scraped off and apply with fungicide .

Practical Activity

To familiarize with the major diseases of rubber, symptoms and application of control measures.

Materials required: diseased specimens, chart, CDs, photographs.

Procedure - Visit nearby rubber plantation, observe photographs and CDs. Collect and observe diseased specimens, symptoms and record relevant information.

3.2.6.15 CASHEW

A.Pests

Pest	Symptoms of attack	Stage of attack	Control
Tea mosquito bug	Appears with the emergence of new flushes and panicle. Drying of inflorescence. Dieback of shoots.	Nymphs and adults	Spraying carbaryl0.1% or Quinalphos 0.05% thrice-with emergence of new flushes, with panicle emergence and at fruit set initiation. Oct-Nov, Dec-Jan and Jan- Feb respectively.
Stem and root borer	Branches and stem dries and die. Yellowing and Shedding of leaves Bore holes with sap and frass coming out from them.	Grubs and adults	Remove the dried twigs and dead trees and burn them. Prophylatic treatment by swabbing the tree trunk upto 1 metre height from the ground with a suspension of Carbaryl 0.2%.

B.Diseases

Disease	Pathogen	Symptom	Control
Pink disease	fungus	Appearance of white patches on branches followed by die back.	Regular inspection during July- September. In early stages of infection apply Bordeaux Paste upto 30cm above and below the affected region. In severe cases prune off and burn the dried up branches.

Practical Activity

1. To familiarize with the major pests of cashew, its nature of damage and application of control measures.

   Materials required: specimens of pest, chart, CDs, damage symptoms etc.

   Procedure - Visit nearby orchard. Collect and observe pest and symptoms of damage and record relevant information.

2. To familiarize with the major diseases of cashew, symptoms and application of control measures.

   Materials required: diseased specimens, chart, CDs, photographs.

   Procedure - Visit nearby cashew plantation, observe photographs and CDs. Collect and observe diseased specimens, symptoms and record relevant information.

3.2.6.16 PAPAYA

A.Pests

Pest	Symptoms	Stage of attack	EIL	Control
Papaya mealy bug	Mealy bugs colonise lower side of the papaya leaves along the veins and later cover the fruits. Younger plants killed out right.	Nymphs and adults	Mere presence	Release @ 25-50 numbers per plant of parasitoid (Acerophagus papayae).

B.Diseases

Disease	Pathogen	Symptom	EIL	Control
Damping off	Fungus	Rotting of seedlings in nursery.		Drenching with fungicides.
Leaf curlVector: white fly	Virus	Curling, crinkling and distortion of leaves. Downward rolling of leaf margin.	Mere presence	Control of vector. Destruction of affected plants

3.2.6.17 TEA

A.Pests

Pest	Symptom	Stage of attack of pest	Management
Nematodes (Meloido gyne spp.)	These microscopic worms infest roots, which develop to knots or galls. Affected roots become defunct and devoid of lateral roots. Plants exhibit chlorosis and stunted growth.	All stages	**Nursery** Heat treatment: Spread soil sand mixture (5 cm thick) on a G.I. sheet. Heat it from below. Sprinkle water periodically. Mix the soil thoroughly by turning. Optimum temperature is 60-65ºC. Soil should not be too hot to hold in the hand. Over heating of soil will lead to manganese toxicity.

			Mature tea Neem cake 2 kg per bush is recommended.
Mites	Several species of mites attack tea plants. They are dry weather pests mostly attacking mature foliage except pink and yellow mites.	Nymphs and adults	If infestation is more, quinalphos will be effective.
Thrips (Scirtothrips bispinosus)	This is a major pest in all tea growing countries. Feeding causes lacerations of tissue and appears as streaks. Leaf surface becomes uneven, curled and matty. Feeding marks in bud appear as parallel lines on either side of mid-rib when leaf unfolds. Leaf margins turn yellow.	Nymphs and adults	Phosalone, quinalphos and dimethoate can be used for the pest control.
Tea mosquito bug	Adults and nymphs suck the sap from buds, young leaves and tender stems. Due to intensive feeding, leaves curl up, badly deform and shoots dry up.	Nymphs and adults	Chemical control involves spraying quinalphos + dichlorvos at spray intervals depending on the intensity of incidence

B.Diseases

Disease	Pathogen	Symptom	Control
Blister blight	Fungus	The fungus affects only tender leaves and stems (pluckable shoots). Translucent spots occur in three to ten days and well developed lesions are seen in two weeks. Lesions are sunken on the upper surface and convex at lower surface. Affected leaves are distorted and irregularly rolled. Stem infection leads to goose-neck shape, dieback and snapping at the point of infection	Copper oxychloride 350g+ plantomycin 70 g per ha at 3 to 4 days interval can control the disease.

3.2.6.18 COFFEE

A.Diseases

Pest	Symptom	Stage of attack of pest	Management
Coffee berry borer	Grubs and adults	Coffee berry borer is the most serious pest of coffee. The female beetle bores into the berries through the navel region and makes tunnels in the hard bean and lays about 15 eggs. The larvae feed on the beans, making small tunnels.	Timely and complete harvest, collection of gleanings, burying the infested berries and maintaining optimum shade and good drainage can control the pest.

		A typical pinhole at the tip of the berries indicates the presence of the pest, and it damages young as well as ripe berries. In case of severe infestation, 30 to 80 per cent berries may be affected resulting in heavy crop loss.	Spraying quinalphos 0.05 per cent along with wetting agent 120-150 days after flowering (Aug-Sept. for arabica and Sept-Oct. for robusta) can control the pest.
Shot hole borer	Grubs and adults	This is a major pest in robusta coffee affecting the secondary and tertiary branches causing considerable damage. Injury to the coffee plants is primarily by the extensive tun-neling within the branches, which limits the flow of sap. The affected branches dry up. The presence of withering and dead branches with shot holes is the symptom of attack.	1. Prune the affected twigs 5-8 cm beyond the shot hole and burn. This operation should commence from September onwards, as soon as the first symptom of attack like dropping of leaves is noticed, and continued as a routine measure at regular intervals 2. The pest prefers to breed in the suckers during dry period. So remove and destroy all the unwanted/ infested suckers during summer..
Mealy bugs	Nymphs and adults	Mealy bugs damage coffee plants by sucking the sap from the tender branches, nodes, leaves, spikes, berries and roots leading to the debilitation of the plant. In case of root infestation, plants (especially young) become weak, leading to death.	The mealy bug can be controlled by spraying quinalphos. In addition, the biological control agents like *Cryptolaemus montrouzieri* (ladybird beetle) and the parasitoid Leptomastix dactylopii have been found effective. Indirect control of the disease can be made by controlling the ants, which spread the infestation.

B.Diseases

Black rot	fungus	The affected bushes have blackening and rotting of leaves, twigs and developing berries. There will be defoliation and berry drop in the affected branches. The entire block affected looks totally debilitated with heavy damage to crop.	Centering and handling of the bushes prior to the onset of monsoon and protecting endemic patches with spraying Bordeaux mixture 1 per cent. If incidence is observed during the monsoon, remove the affected twigs and burn them. Spray with Bordeaux mixture 1per cent during break in the monsoon.

Practical Activity

To familiarize with the major pests of spices, its nature of damage and application of control measures.

Materials required: specimens of pest, chart, CDs, damage symptoms.

Procedure: Visit nearby field, collect, observe pests and symptoms of damage and record relevant information.

3.2.6.19 Tuber crops

i.Tapioca

A.Pests

Red spider mites and scale insects	Under field conditions light infestation of mites can becontrolled effectively by spraying the crop with water at 10 days interval from the onset of mite infestation. In thecase of very severe infestation, spray *Clerodendron* decoction of 2% strength at monthly intervals from the time of appearance of mites. In the case of very severe infestation, the crop can be protected by spraying 0.05 per cent dimethoate at monthly intervals from the time of appearance of mites. The stem maybe sprayed with 0.05 per cent dimethoate before storing as a prophylactic measure against the scales.
Termites	To control termites infesting planted setts, sprinkle a little of Carbaryl 10 per cent or Chlorpyrifos in the mounds prior to planting.

B.Diseases

Cassava mosaic disease (CMD) white fly	Virus	The disease is transmitted by a Bemisia sp. As a rule, only stem cuttings from disease free plants should be used for planting to minimize the spread of the virus disease. For this purpose, tagging of disease free healthy plants for selection as planting materials must be practised from September to December. All plants showing even very mild symptoms must be rejected. Mosaic tolerant varieties such as H-97 may be used to minimize economic loss of tubers.	Production of disease free planting material of tapioca through nursery techniques.
Leaf spot	Fungus	Brownish round spots on leaf which eventually drop.	Spray 0.2 per cent zineb or 1 per cent Bordeaux mixture for control of leaf spot.

Bacterial blight	Bacteria	Angular water soaked spots on leaves, heavy defoliation.	Use of resistant or tolerant varieties is the only method of control. Among improved varieties, H-97, H-226, H-1687 and H-2304 are tolerant to the disease while H-165 is highly susceptible. Among the local varieties, M-4, Paluvella, Pichivella, Parappilppan, Anamaravan etc. are tolerant to the disease.

C. Management of storage pests of cassava

Treating chips with granular salt (3 per cent), sun drying thoroughly and storing in gunny bags in godown are very effective against Araecerus fasciculatus and Sitophilus oryzae.

ii.Sweet potato

A.Pests

Pest	Symptoms of attack	Stage of attack	Control
Sweet potato weevil	Vines dry up. Tubers become unfit for consumption. Continues in storage also.	Adults and grubs	Remove and destroy crop residues. Rotate or fallow fields. Use healthy, weevil free planting materials. Apply Eupatorium odoratum leaves as mulch @ 3 t/ ha at 30 DAP. Dip the vines in 0.05% . Fenthion for 5-10 minutes prior to planting. Drench with 0.05% Fenthion or Fenetrothion at 65 DAP and earthing up at 80 DAP. Trap adult weevils using sweet potato pieces 50 to 80 DAP at 10 days interval. Use Pheromone traps.

3.2.6.20 Diagnosis and management of pests and diseases of ornamental plants:-

Name of Pest	Stage of attack	Symptoms of attack	Management measures
Pests of Anthurium and Orchid			
1. Snails and slugs	All stages	Feed on the tender young shoots, roots and buds.	1. Use metaldehyde 2. Hand picking.
Pests of Rose			
1. Aphids	All stages	Yellowing and drying of tender shoot.	Spray Dimethoate 30EC 2ml/l
2. Scales		Drying of plants.	Spray Malathion 2ml/l
Pests of Jasmine			
1. Bud worm	Larva	Buds with bore holes and webbed with silken threads	Spray Monocrotophos 2ml/l

Diseases of Anthurium and Orchid

Disease	Pathogen	Symptoms	Management measures
1.Bacterial blight	Bacteria	Blackening of stem and decay of leaf axil.	Spray a mixture of turmeric powder and sodium bicarbonate in the proportion 10:1 @0.15% at weekly intervals.
2. Anthra cnose	Fungus	Tiny circular black spots appear on leaf and spadix.	Spray Mancozeb 0.3%.
Diseases of Rose			
1.Black spot	Fungus	Circular black spot with an irregular thread like border on leaf, stem and flowers.	1. Destroy fallen leaves. 2. Spray Captan 0.2%.
Diseases of Jasmine			
1. Leaf blight	Fungus	Leaves become brown and dry up.	Spray Mancozeb 0.2%.

Practical Activity

To familiarize with the major pests of rose, orchids and anthurium, its nature of damage and application of control measures.
Materials required: specimens of pest, chart, CDs, damage symptoms.
Procedure: Visit nearby field, collect, observe pests and symptoms of damage and record relevant information.

3.2.7 PESTS OF STORED PRODUCTS

A huge amount of produce in storage godowns are infested by different pests. As a result losses occur both in quality and quantity. The organisms responsible for storage in godowns are insects, mites, rodents etc. In order to reduce these losses we should

understand about different pests and suitable control measures that should be taken to control them.

The losses caused by insects are divided into two categories namely Quantitative and Qualitative losses.

a. Quantitative loss/ Weight loss

Insects during storage may cause weight loss by directly feeding on the grains.

b. Qualitative loss

Degradation of quality occurs as a result of attack. It includes destroying the germs of grain kernel, loss of nutrients, contamination with body products, contamination by pathogens, loss of seed viability etc.

Grain insect pests may be divided into Primary grain pests and Secondary grain pests.

1. Primary grain pests

These pests attack whole , unbroken grains.

2. Secondary grain pests

These pests attack only damaged grains, dust and milled products.

Name of the pest	Damaging stage of the pest	Nature of damage and symptom of attack
Rice Weevil (attacks grains of rice, wheat, corn and various seeds)	Adult and grub	Female weevil makes a hole on the surface of the grain and deposits eggs. The larvae feed on the starchy material inside grains. Adult comes out through the hole
Lesser Grain Borer (rice, wheat , maize, dried fruits)	Adult and grub	The adults and grubs bore into husk of the grain and feed on the internal contents and turn it into chaff. The attacked grains show round holes made by the pest
Angoumois Grain Moth (rice, ragi, maize etc)	Caterpillar	Eggs are laid on the grain. The larvae bore into the kernels and feed within. Mature larvae eat upto the outer portion of the grain, leaving only a thin layer of outer seed coat intact.
Rice Moth (rice, wheat, barley, dry fruits, cashew nuts, cocoa beans etc)	Caterpillar	Eggs are laid on broken grains products. Larvae contaminate the food grains with dense webbing, excreta and hairs. Whole grains are bound into lumps.
Pulse Beetle (Pulse grains)	Adult and grub	Adults cut out circular black holes in seeds. Grubs bore into the seeds and feed the entire content leaving only the seed coat behind. Sometimes infestation starts in the field and is carried into store after harvest.

Red Flour Beetle (milled grain products like flour , cereals, biscuits, dry fruits)	Adult and grub	Adults and larvae feed on grain dust and broken kernels. Particularly injurious in warehouses and in factories making starch products. Infested flour has a greyish colour and has a pungent odour resulting in loss of quality
Indian Meal Moth (cereal food products, whole grains, powdered milk , dried fruits, chocolates etc)	Caterpillar	Damage is caused by larvae spinning silken threads and webbing food particles together.
Khapra Beetle	Grub	Larvae feed inside the kernel making the grain hollow leaving only the husk behind. Infested grains have frass, cast skins of larvae and excreta which results in quality deterioration of grains
Saw Toothed Grain Beetle (wide variety of food, wheat,barley, milled and processed foods, dried food, packaged food)	Adult and grub	Feed on slightly damaged grains not on sound kernels. Grubs chew into unopened paper/ cardboard boxes, plastic, foil wrapped packages etc. They contaminate more food than they consume.
Flat Grain Beetle (processed cereals, oilcakes, dried fruits)	Adult and grub	They contaminate the products with frass and dead bodies
CigaretteBeetle/ Turmeric Beetle/ Tobacco Beetle (tobacco products, raisins, figs, dates, ginger, pepper, chilli powder, curry powder,wheat bran, rice meal etc)	Adult and grub	Eggs are laid on the substrate and larvae bore and feed into it. It carries a symbiotic yeast with it. They also damage leaves and bindings of books
Tamarind Beetle	Grubs	Grubs bores into preserved tamarind and spoil it

3.2.7.1 Managementofstored products pests

The management measures should be both PREVENTIVE and CURATIVE.

i. Preventive measures

- The store house or vessels of storage should be thoroughly cleaned and made free from insects, loose grains, chaff, bran etc.
- The materials to be stored should be cleaned and dried.
- The bags should be stacked in such a way so as to allow proper ventilation and moving space for periodic inspection.

- Malathion 15 EC @ 15ml/4.5 L of water may be sprayed as a thin film on bags.
- The new arrivals should not be stored along with old or infested stocks in godowns.

ii. Curative measures

- The stocks of grains should be periodically examined and if insects are noticed the stock should be removed, sun dried and cleaned.
- Heavily infested material should be fumigated with Aluminium Phosphide-One tablet/tonne. Expose for six days.
- Electrical energy, gamma rays, UV rays, X rays etc are found to be best for pest control in storage. But they are very costly.
- Certain storage pests like rice meal moth can be controlled using pheromone traps.
- Seed material may be mixed with insecticides like Malathion at 1:200 by weight. This make stock insect free for about a year.
- Inert materials like Aluminum oxide, Magnesium oxide, silica, fine sand, clay dust, lime, wood ash, diatomite, vegetable oils can be mixed with seeds. They abraid the insect cuticle and part of the cuticle breaks. Insect dies due to moisture loss from the body.

3.2.7.2 Storage conditions in FCI

- The stacks should be arranged in wooden crates. There should not be direct contact with the floor.
- Stacking should be done 0.6 m away from the walls.
- Proper ventilation facilities should be there.
- Alleyways should be left in between.
- Spraying and fumigation operations should be done in periodic intervals. Fumigation can be done with Aluminium Phosphide or Methyl Bromide.
- The temperature, humidity and moisture inside the godowns should be under control.
- The building should be pucca concrete one with proper roofing.

Practical Activity

To familiarize with important pests of stored products.

Materials required: Specimens of pests, damaged stored products, class notes etc.
Procedure: collect grains and pulses infected with storage pests, familiarize with the insect causing damage to stored products. Sketches can be prepared in record.

Assessment Activity

A farmer complaints about storage pest incidence in his farm house storing paddy. Your teacher asked you to prepare an investigatory project regarding the incidence. Prepare a write up including possible pests that may cause damage to the stored paddy and precautions to be taken to avoid such incidence in future.

TE questions

1. Analyse the first word pair and complete the second one.

   BLB : Bacteria

   Udbatta : …….

2. Banana plants are showing brittle nature, mottling and rosetting of leaves, stunted growth and fails to produce bunches. Identify the disease and suggest suitable control measures.
3. Suggest a chemical suitable for fumigation of godowns.
4. How will you identify the attack of rice bug and case worm in paddy field.
5. Identify the method of control in the following pest control practices.

   i) Covering bittergourd fruits with paper cover

   ii) Foreign quarantine
6. Prepare an article on different methods of weed control.
7. How will you identify and control the attack of pollu beetles in pepper.
8. On a field inspection you have noticed coconut palms with flaccidity, yellowing and necrosis. Moreover leaflets were showing ribbing symptoms and yield was low. Identify the disease and suggest suitable management practices to improve and sustain production.
9. A farmer would like to know about "flame cultivation" as a weed control as a weed control method. Briefly explain the principle with an example.
10. You are experiencing the attack of different storage pests in your home. Suggest suitable control measures for the management of those pests.
11. The following symptoms were noticed on brinjal during a field visit. Identify the pest and suggest suitable control measures in each case.

a) Leaves are seen skeletonized.

b) Fruits show bore holes and young shoots show withering.

12 . Choose the correct choices from B and C which relates with those in A.

A	B	C
Rice	Pollu	Aphid
Coconut	Dead heart	Bugs
Pepper	Bunchy top	BPH
Banana	Deformed nuts	Beetles
	Hopper burn	Mites

13. Identify a bio control agent used against yellow stem borer in paddy.

Trichogramma, Bordeaux Mixture, Trichoderma, Baculovirus

14. A farmer cultivating pepper is anticipating quick wilt infection and would like to take preventive measures. Advice him to do the same.

15. Mention the name of plant protection method involved in each of the following.

a) Use of resistant varieties.

b) Hot water treatment of seeds.

c) Use of Bordeaux mixture.

d) Roguing of infected plants.

16. A farmer cultivating coconut approaches you with immature nuts showing triangular yellowish patches below the perianth region and asks for your help. As an agricultural student, identify the pest, its nature of damage and suggest suitable control measures.

Unit - 3
AGRO-BIO PHARMACY

An outlet for supply of organic inputs is referred to as Agro-Bio pharmacy. The organic inputs include nutrient supplying materials like organic manures, biofertilizers and growth promoting organic mixtures like panchagavya, fish amino acid, egg aminoacid, plant protection inputs like botanicals, bio pesticides, pheromone traps, Yellow traps, light traps. The method of preparation, mass production, packing, storage, marketing and field application of some important organic mixtures, biopesticides will be covered.

Learning Outcomes

The learner :

- definesagro biopharmacy and explains the concept.
- prepares botanicals and practises their methods of application.
- prepares permitted fungicides for organic farming like Bordeaux mixture and Bordeaux Paste.
- prepares organic nutrient solutions.
- defines the biofertilizers and categorises them into biofertilizers for nitrogen, phosphorus and potassium.
- practises application methods of biofertilizers.
- identifies the bio control agents.
- explains the method of laboratory production of Trichoderma including media preparation,inoculation and formulation.
- practices the mass multiplication of Trichoderma and its field application.
- identifies the common entomopathogens.
- explains the common pheromone traps used for insect control.
- practises the methods of production of low cost pheromone traps for fruitfly management.

3.3 Agro- biopharmacy

Agro- biopharmacy is aimed at providing inputs required for organic agriculture. These are outlets for supplying organic inputs like botanicals, bio-pesticides, bio-

control agents, biofertilizers, organic nutrient solutions, pheromone traps etc. The biopharmacy concept is promoted throughout the state of Kerala as the organic farming policy of the government envisages the phasing out of chemical pesticides and fertilizers from the farming sector to convert Kerala into an entirely organic state in five to ten years.

3.3.1 Botanicals

Botanical pesticides are agricultural pest management agents which are based on plant extracts. These are naturally occurring chemicals extracted or derived from plants. In general they act quickly, degrade rapidly and have low mammalian toxicity. In modern times these have been used as alternatives to synthetic chemicals in organic pest management.

3.3.1.1 Neem based botanicals

The active principle of these botanicals is azadirachtin which is capable of controlling a large group of insects.Neem and neem products are non -toxic to warm blooded animals.

i.Neem oil emulsion

Dissolve 60g bar soap in 500ml water. This should be thoroughly mixed with 1 litre of neem oil. Dilute with 15 litres of water and apply. For pulse crops 16 litres of water should be added. This is effective against sucking pests , mites and epilachna beetle.

ii.Neem oil garlic emulsion (2%)

To prepare 10 litres of 2% neem oil garlic emulsion, 200 ml neem oil, 200 g garlic and 50 g ordinary bar soap are required. Slice the bar soap and dissolve in 500 ml luke warm water. Grind 200 g of garlic and take the extract in 300 ml water and sieve it . Pour the 500 ml soap solution in 200 ml neem oil slowly and stir vigorously to get a good emulsion. Mix the garlic extract in the neem oil soap emulsion. Dilute this one litre stock solution by adding 9 litres of water to get 10 litres of 2% neem oil garlic emulsion. It is effective against sucking pests and mites.

iii.Neem seed kernel extract

This is very effective as a repellent/deterrent against locusts, grasshoppers and other chewing insects particularly lepidopterans. The kernel should be ground into a coarse powder. The effective concentration of NSKE ranges from 0.1 to 0.3%. For obtaining 0.1% concentration, 1g of powdered neem seed is required per litre of water. The required quantity of the coarse powder should be put in a small muslin cloth bag and

dipped in water for about 12 hours. Thereafter, squeeze the cloth bag repeatedly so that the out-flowing fluid turns light brownish. The NSKE is now ready to be sprayed as such on crops. It can be effectively used against aphids, shoot &fruit borers, pod flyand American Serpentine Leaf miner of vegetables (ASLM)

iv.Other botanicals from Neem *(Azadirachta indica)*

Preparation	Dose	Pest
Neem leaf	250 g/plant	Nematodes of bhindi, brinjal
Leaf Extract	2 - 5%	Leaf feeders and leaf webber of amaranthus, aphids of vegetables
Neem Twig	Plant neem twigs in coconut gardens after receipt of monsoon rains during April-May	Root grubs.
Neem Cake	250 Kg/ha	Shoot & fruit borer of bhindi, brinjal
Neem Cake extract	10%	Root knot nematode of vegetables

3.3.1.2 Tobacco decoction (Due to toxic nature of tobacco, not recommended for organic farming)

Nicotine, the alkaloid present in the leaves of tobacco has insecticidal property. This is very effective for controlling aphids and other soft-bodied insects (jassids, mealy bugs, hoppers) infesting vegetable crops. Tobacco decoction can be prepared by steeping 500 g of tobacco waste in 4.5 litres of water for 24 hours. Dissolve 120 g of ordinary bar soap separately in another vessel. The soap solution is added to tobacco decoction under violent agitation. Dilute this stock solution 6-7 times before spraying.

3.3.1.3. *Andrographis*-Garlic mixture

Extract one litre juice from leaves and tender shoots of *Andrographis* (Kiriyath or King of bitters). Dissolve 60 g bar soap in 500 ml water and thoroughly mix it with the exract. Dilute with 10 times water. Add 330 g garlic paste to this solution. This is effective against sucking pests like thrips, chilli aphids, whitefly and mites.

3.3.1.4 Papaya leaf extract

Soak 500g of chopped papaya leaf in water for 12 hours. The leaf extract is squeezed out and filtered and sprayed against caterpillars after diluting three to four times.

3.3.1.5 Birds eye chilli- cows urine extract

Grind 20 g birds eye chilli and mix with one litre of cows urine. Dilute this mixture with ten litres of water. This is effective against caterpillars attacking cucurbits, amaranthus etc.

3.3.1.6 Baking soda- turmeric- asafoetida mixture

40 g asafoetida gum is dissolved in 10 l of water. Add 8 g soda powder and 32g turmeric powder to this solution and mix well. Effective against plant diseases like amaranthus leaf blight.

3.3.1.7 Leaf / plant extract -preparation of 5% extract

Macerate 50g of leaf / plant in a mixie. Soak the macerated product in 1 litre of water for 24-48 hours. Strain the solution and spray.

3.3.1.8 Other botanical preparations for pest control

Custard apple Seed Extract	2-5%	Lepidopteran pests like Epilachna beetle of Brinjal & Bitter gourd Pea Aphid, Stem Borer, Bugs
PeruvalamPlant extract	4-8%	Tobacco caterpillar, Epilachna beetle of brinjal, cucurbits, Leaf roller of okra
Peruvalam fresh plant or shade dried powdered plant mixed with cow dung	1:10	Rhinoceros beetle of coconut
Naatta poochedi plant extract	10%	Aphid and soft bodied pests of vegetables
Communist pacha *(Chromolaena)* leaf	15 t/ha two Mulching3 t/ha at 30 days after planting	Nematodes of Vegetables, Sweet potato Weevil
Tulsi plant	Handful of crushed ocimum + 10 g jaggery (fruitfly trap)	Fruit fly of cucurbits, mango

Practical Activity

Prepare the common botanical insecticides used for pest control.

3.3.2 Preparation of permitted fungicides for organic farming

a. Bordeaux mixture (1%)

- Dissolve 1 kg of powdered copper sulphate crystals in 50 litres of water.
- In another 50 litres of water, prepare milk of lime with 1 kg of quick lime.
- Pour the copper sulphate solution into the milk of lime slowly stirring the mixture all the while.
- Test the mixture before use for the presence of free copper, which is harmful to the plants, by dipping a polished knife in it.
- If the blade shows a reddish colour due to the deposits of copper, add more lime till the blade is not stained on dipping.
- Always use wooden, earthen or copper vessels for the preparation of Bordeaux mixture. Use the fungicide in the same day of preparation.
- In order to improve the sticking qualities, rosin washing soda mixture may be added.

c. Bordeaux paste(10%)

- Dissolve 100 g of copper sulphate and 100 g of quick lime each in 500 ml of water
- (The rest procedure is same as that of Bordeaux mixture)

3.3.3 Preparation of organic nutrient solutions

a. Panchagavya

- This is a nutrient solution which is widely used by farmers as an organic fungicide.
- Cow dung (7 kg) and cow ghee (1 kg) are mixed in a clean container thoroughly both in morning and evening hours and kept aside for 3 days.
- After 3 days, cow's urine (10 litres) and water (10 litres) are added.
- The mixture is kept for 15 days with regular mixing both in morning and evening hours.
- After 15 days, add cow milk (3 litres), cow's curd (2 litres), tender coconut water (3 litres), jaggery (3 kg) and well ripened poovan banana (12 nos.)
- Panchagavya can be prepared in a wide mouthed mud pot or concrete tank or plastic can.
- It is stored in shade covered with a wire mesh or plastic mosquito net to prevent

houseflies from laying eggs and the formation of maggots in the solution.

- Precautions.
- Keep the container open under shade.
- Stir the contents twice a day both in morning and evening.
- The Panchagavya stock solution will be ready after 30 days.
- Do not mix buffalo products.

b. Dasagavya

- Dasagavya is also an organic nutrient solution.
- Dasagavya is Panchagavya + plant extracts.
- Plants used are *Azadirachta indica, Calotropis sp ,Tephrosia purpurea, Vitex negundo, Datura metel, Jatropha curcas, Adathoda vasica* and *Pongamia pinnata*.
- The plant extracts are prepared by separately soaking the foliage in cow urine in 1:1 ratio for ten days.
- The filtered extracts of all the plants are then added @ 1 litre each to 5 litres of the Panchagavya solution.
- The mixture is kept for 25 days and stirred well, meanwhile, to ensure thorough mixing of Panchagavya and the plant extracts.

c. Fish amino acid

- Growth promoter.
- Cut the fish into small pieces (1 kg). Fresh or rotten fish can be used.
- Add 1 kg of powdered jaggery.
- Mix well and keep in air tight containers.
- Sieve the juice.
- Used for vegetables and ornamentals@2ml/litre of water.

d. Egg amino acid

- Growth promoter.
- Put 15 eggs (from local bred hens) in lime juice (1.5 kg of lime needed).
- Keep for 15 days in a closed container.
- After 15 days pour the contents of the egg into the lime juice.

- Discard the egg shells.
- Add 0.5 kg of melted jaggery and keep for another 10 days.
- Used for vegetables and ornamentals @ 2ml/ litre of water at weekly intervals.

3.3.4 Biofertilizers

Bio-fertilizers are defined as preparations containing living cells or latent cells of efficient strains of microorganisms that help plants to uptake nutrients by their interactions in the rhizosphere when applied in the soil. They are ready to use live formulations of beneficial microorganisms which on application to seed, root or soil mobilize the availability of nutrients by their biological activity and help build up micro flora and soil health in general.

Advantages

- Cost effective.
- Supplement to fertilizers.
- Eco-friendly.
- Reduces cost towards fertilizer use.
- Increase crop yield by 25%.
- Activate soil biologically and restore natural soil fertility.
- Stimulate plant growth.
- Provide protection against drought and some soil borne diseases.

3.3.4.1 Classification

A. Nitrogen fixing bio fertilizers

a. *Rhizobium* (Bradyrhizobium and Azorhizobium)

- It induces better root nodulation and stem nodulation (Azorhizobium) in inoculated plants.
- Brings down the requirement of nitrogen fertilizer for the cultivation of pulses, oil seeds and legume green manures.
- Commercially it is available as carrier based inoculum.
- Method of application is seed treatment.

b. *Azotobacter*

- Suitable only for upland crops like vegetables, tapioca, plantation and orchard crops. It is available as carrier-based inoculum.

- If fixes N about 15-20kg/ha under ideal upland conditions and thereby reduces the requirement of nitrogen fertilizers by 10-20 per cent.
- Methods of application are seed treatment, seedling dip and direct soil application in organic manure.

c. *Azospirillum*

- It is suitable for both upland and wetland conditions and is available as carrierbased inoculum.
- It fixes N about 20-25 kg per ha under ideal conditions thereby effecting a reduction of 25 per cent in the quantity of N fertilizers required.
- Treatment with *Azospirillum* also induces better root formation in inoculated plants. Hence this biofertilizer is also recommended for root induction in polybag raised seedlings of plantation and orchard crops and also for vegetables.

d. *Acetobacter*

- This is associated with sugarcane crop and it fixes upto 200kg N/ha.
- Produces auxins and antibiotic type substances that promote plant growth.

e. Blue-Green Algae(BGA)

- The BGA forms a symbiotic association with *Azolla* (Aquatic fern) and fixes atmospheric nitrogen.
- Mainly recommended for wetland rice cultivation.
- The use of this biofertilizer is not feasible in acidic soils with pH below 6.0.
- It is available as carrier based inoculum and it fixes N about 25-30 kg/ha under ideal conditions.
- Direct broadcasting in the rice fields @ 10 kg/ha one week after transplanting the seedlings.

f. *Azolla*

- It is suitable for wetland rice cultivation.
- *Azolla* is a free living organism and uses energy derived from photosynthesis to fix atmospheric nitrogen (autotroph) and fixes N about 25 to 30kg/ha .
- It also produces growth promoting substances.
- Apply fresh *azolla* @ 10 t/ha before transplanting the rice seedlings at the time of ploughing.

B. Phosphorous solubilising microorganisms (PSM)

- Phosphorous solubilisers namely *Bacillus, Aspergillus, Penicilllium, Trichoderma.*
- Phosphate absorbers namely AMF (Arbuscular Mycorrhizal fungi)
- Only 15 to 20 % of phosphorous is recovered by the crops and remaining gets fixed in the soil. A group of heterotrophic microorganisms solubilise the fixed phosphorous by producing organic acids and enzymes and make them available to plants.
- Seed treatment and direct application in organic manure.

Arbuscular Mycorrhiza (AMF)

- It is mostly recommended for upland especially for raising container and tissue culture plantlets and transplanted crops.
- It mainly improves the uptake of available P by inoculated plants.
- It also enhances absorption of water and other nutrients such as N and K and certain micronutrients.
- It induces better resistance against certain soil born plant pathogens.
- It is commercially available as granular inoculum consisting of infected roots and soil with mycorrhizal spores. It is given as soil application.

C.Potassium solubilising biofertilizer

- *Frateuria aurentia* is a potash mobilising bacteria that has been identified for commercial application.

D.PGPR mix I I

- It is a compatible consortium of N, P and K biofertilizers and helps to save 25% N, P and K fertilizers.

3.3.4.2 Application techniques of biofertilizers

i. Seed treatment

- Five hundred grams of the inoculum is required for treatment of seeds for one hectare area.
- Mix 500g of the inoculum in 1.25 liters of water.
- The stickiness of the bioferilizer on seed surface can be improved by using 10% jaggery solution or 5% sugar solution supplemented with 40% boiled and cooled gum Arabic solution or rice - gruel water.

- The required quantity of seed material is then gently mixed with this slurry without damaging the seed coat.
- The treated seeds are spread evenly over a gunny bag dried in shade and sown immediately in moist soil.
- The treated seeds should not be exposed to direct sunlight for a longer period of time since the UV rays of solar radiation will reduce the population of inoculated bacteria on seed surface.

ii. Seedling treatment.

- This method of application is mainly recommended for transplanted crops.
- The roots of seedlings to be transplanted are dipped in loose water slurry of the biofertilizer (500 g in 2.5 liters of water) for 20 minutes, prior to transplanting.

iii. Soil application

- Soil application is generally recommended for all types of biofertilizers except *Rhizobium, Bradyrhizobium and Azorhizobuim.*
- The biofertilizer are applied after mixing with dried FYM,compost or vermicompost @ 1:25.
- The recommended dose is 1-2 kg/ha (for crops upto 6 months duration). This can be increased to 2-4 kg/ha for crops more than six months duration. For perennial crops, 10 to 25 g of the biofertilizer is to be applied in the root zone during the first year and 25 to 50 g during subsequent years.
- This can be done at the time of sowing, transplanting or during intercultivation.

3.3.5 Biological control

- When a particular species of pest is controlled by a living organism which is introduced, encouraged and disseminated by man , is called biological control.
- Biopesticides includes in a broader sense pesticides of biological origin.They include naturally occurring substances that control pests (biochemical pesticides), microorganisms that control pests (microbial pesticides) and pesticidal substances produced by plants containing added genetic material (plant - incorporated protectants) or PPIs.

3.3.5.1 Biocontrol agents

There are three categories of natural enemies of insect pests

- Predators

  Insects are an important food for many vertebrates including birds, amphibians, reptiles , fish and mammals. Important insect predators include lady bird beetles, ground beetles, rove beetles, predatory bugs,spiders, some species of mites etc.

- Parasitoids

Parasitoids are insects with an immature stage that develops on or in an insect host and ultimately kills the host.

- Pathogens

  Insects are affected by bacteria, fungi, protozoans and viruses that cause disease. These disease may reduce the rate of feeding, and growth of insect pests, slow or prevent their reproduction or kill them.

3.3.5.2 Fungal and bacterial pathogens (mycoparasitic and antagonistic)

The micro organisms used in the control of plant pathogens are called as antagonists.

a. Arbuscular Mycorrhizal Fungi (AMF)

Inoculation with AMF at the time of planting in the nursery or main field improves the growth and tolerance of crop against root pathogens and nematodes .

b. *Trichoderma*

Trichoderma spp. is a group of broad-spectrum biocontrol agents effective against the quick wilt of pepper, rhizome rot of cardamom and ginger

c. Fluorescent Pseudomonads

- Fluorescent Pseudomonads are a group of bacteria very effective for disease management and for growth promotion of crop plants.
- This is found highly effective for the management of foot rot and fungal pollu of black pepper, sheath blight and bacterial leaf blight of paddy, bacterial wilt of solanaceous vegetables, bacterial leaf blight of anthurium and rhizome rot of ginger.

Method of application of *Pseudomonas*

- Seedlings / cuttings are treated with *Pseudomonas* culture by dipping the root/ tip of cuttings in slurry of Pseudomonas (250g in 750ml for 20 minutes).
- For seed treatment in paddy use 10g talc-based *Pseudomonas* culture for 1 kg of seed. Suspend *Pseudomonas* in water used for sprouting. This helps in the control of fungal and bacterial diseases.
- For transplanted crop, dip the roots at the time of transplanting, and one spray may be given at 30th day after transplanting.

d. PGPR mix II (Plant growth promoting rhizobacteria)

It is a consortium of highly compatible rhizobacteria having broad spectrum of inhibitory property with different mechanisms. It is effective against all fungal and bacterial plant pathogens of crop plants. Application method and schedule are similar to that of *Pseudomonas fluorescens*.

3.3.5.3 Mass production of *Trichoderma viride*

- Preparation of mother culture

Molasses yeast medium is prepared as detailed below.

Molasses	:	30g
Yeast	:	5g
Distilled water	:	1000 ml

The medium is prepared and dispensed into conical flasks and sterilized at 15 lb pressure for 15 minutes in an autoclave. After the medium is cooled it is in inoculated with 10 days old fungal disc of *T. viride* and then incubated for 10 days for fungal growth. This serves as mother culture.

- Mass multiplication in the laboratory.

Molasses yeast medium is prepared in fermentor and sterilized as described earlier. Then after the medium is cooled, the mother culture is added to the fermentor @ 1.5 lit / 50 lit of the medium and incubated at room temperature for 10 days.Then the incubated broth containing the fungal culture is used for commercial formulation preparation using talc powder.

- Preparation of formulation.

The fungal biomass collected from fermentor is mixed with talc powder at 1:2 ratio. The mixture is air dried in shade and mixed with carboxy methyl cellulose (CMC) @ 5 g / kg the product. It is packed in polythene bags and should be used within 4 months.Moisture content of the final product should not be more than 20%

3.3.5.4 Mass multiplication of *Trichoderma* (on farm)

- Dry neem cake and cowdung are powdered and mixed to get a coarse texture and then moistened by sprinkling water.
- Add the commercial preparation of *Trichoderma spp*. @ 1-2 kg per 100 kg of neemcake - cow dung mixture.
- After thoroughly mixing, cover it with a perforated polythene sheet or ordinary newspaper and keep it in shade for 4-5 days for multiplication.
- Again mix well and keep for three more days for further multiplication.
- This preparation is ready for incorporation in the soil.
- Cow dung alone can also be used as the food base; but, since neem cake is found to be a better substrate, the incorporation of neem cake to cow dung at the ratio of 1:10 (w/w) is better than using cow dung alone. If cow dung alone is used, mixing has to be done at 5 days interval and it will be ready for use only on the 15th day. This *Trichoderma* incorporated neemcake-cow dung mixture can be used in the potting mixture in nursery beds and in the field; i.e. wherever cow dung is used as a manure.

3.3.5.5 Entomopathogens

The various micro organisms that cause diseases in insects are called entomopathogens. These include bacteria, fungus, virus, protozoans and nematodes. The use of microbial pesticides as one of the major components of IPM is gaining

acceptance as they are generally specific, apparently harmless to the beneficial insects, animals and human beings with no residue problems and environmental hazards.

1. Entomopathogenic fungi

Entomopathogenic fungi are fungal species that can act as parasites of insects and kill or seriously disable them.

a. *Lecanicilium lecanii*

It is known as white-halo fungus. It is effective against sucking insect complex and nematodes. It is applied @ 5ml/L or 20 g/L.

b. *Beauvaria bassiana*

It is known as white muscardine fungus. It is effective against caterpillars, rhizome weevil,ASLM, diamond back moth of cabbage etc.It is applied @ 5ml/L or 20 g/L.

c. *Metarrhizium anisopliae*

It is known as green muscardine fungus. It is effective against rhinoceros beetle of coconut, termites, leafeating caterpillars, beetles etc.

2. Entomopathogenic bacteria

a. *Bacillus thuringensis (Bt)*

This is a gram positive bacteria . When ingested by the insect larvae , the insect body becomes softer and darker in colour. Bt is widely used to control lepidopteran, dipteran and some coleopteran insect pests

b. *Bacillus macerance*- It is used against rootknot nematode.

c. *Pseudomonas fluorescens*-It is used against rootknot nematode

3. Entomopathogenic virus

These viruses are highly specific and hence do not affect beneficial insects, and are safe to fish and mammals. Nuclear Polyhedrosis Virus (NPV) and Cytoplasmic Polyhedrosis Virus (CPV) are used against lepidopteran larva and Baculovirus (OBV) is used against rhinoceros beetle.

3.3.5.5.1 Biopesticides available in the market

Generic names and formulations	Trade name
Bacillus thuringiensis	Dipel-8L,Kurstaki ,Halt,Biobit,Biolep, Delfin
Trichoderma viride	Ecoderma
Trichoderma harzianum	Niprot
NPV of Helicoverpa armigera	Helicide
NPV of Spodoptera litura	Spodocide
Pseudomonas fluorescens	Biocure B
Lecanicilium lecani	Biocatch , Biovert
Beauveria bassiana	Biopower

3.3.6 Commercially available pheromone traps for insect pest control

Name of trap	Pest managed	Quantity required
Sleeve trap	Rice stem borer	20 per ha
Rhinolure/Sime RB (Placed in buckets outside the garden)	Rhinoceros beetle	1 per 2 ha
Ferrolure (Placed in buckets outside the garden)	Red palm weevil	1per 2 ha
Cosmolure	Banana rhizome weevil	4 per ha
Cue-lure	Cucurbit fruit flies	10 per ha

3.3.7 Methods of preparation of some traps

Sl No	Name of trap	Name of pest managed	Procedure
1	Coconut log trap	Red palm weevil	Coconut log traps with pineapple or sugarcane activated with yeast or molasses attract and trap floating populations of weevil.
2	Pseudostem Banana trap	Rhizome weevil, Pseudostem weevil	Pseudostem,50 cm long, split longitudinally and inoculated with Beauveria bassiana placed in the garden @ 100 traps/ha
3	Yellow	White flies	Empty tins painted yellow outsides and Sticky traps smeared with castor oil are hoisted on poles upside down in the garden. Yellow polythene sheets smeared with castor oil hoisted as flags can also be used. Yellow Sticky traps@one trap per 5 cents
4	Blue sticky traps	Thrips	Blue sticky traps@one trap per 5 cents. Method of preparation is same as above (instead of yellow, blue color is used)
5	Banana trap	Fruit flies	Banana trap: Take 20 g of ripened banana fruit pulp in 100 ml of water. 10 g melted jaggery and two drops of insecticide Malathion are added. Transfer to a 500 ml polythene closed bottle provided with four

6	Fish meal trap	Fruit flies	holes large enough for the adult flies to enter. These bottles are suspended in trellies. Place 10 g of moistened, powdered dried fish in a coconut shell. Add two drops of Malathion and suspended in trellies.
7.	Rice gruel water trap	Fruit flies	Take 20 ml rice g ruel water in a coconut shell and add 5 g jaggery, two /three carbosulphan granules and two/three capsules of yeast. The shells containing the preparation are hung in the garden
8.	Ocimum trap	Fruit flies	Take extract of a handful of ocimum leaves. Add some water, 10 g Jaggery and half a gram of Carbosulphan. The shells containing the preparation are hung in the garden.

3.3.8 Low-cost Traps for Fruit fly Management:

- Take a water bottle of one litre capacity and remove the wrapper.
- Make 3 windows with a knife at 3 inches from top. Each window should be of 1 inch size. (fig 1)
- Make a small hole in the cap with needle. (fig 2)
- Take ½ inch thick cotton rope & cut the rope into 2 inches size, tie the cut ends with thin wire. Dip the cut cotton rope pieces in Methyl Eugenol / Cue lure for 24 hours.(fig.3, 4)
- Cover the lures with aluminium foil until use.
- The 120 ml mixture can be used for preparing 30 lures i.e. @ 4ml / lure..
- Take a thin wire of 10 inches length, make a knot at the centre, insert the wire from inside to outside the cap and make a loop for hanging the bottle & other end make a hook for tying lure inside the bottle (fig.5, 6).
- Hang the bottle in shade at least 3-4 feet above ground level at different locations.
- Cost of ME and Cue lure is approximately Rs.35/- for one bottle trap. 6 -10 traps/acre are required to be used for best control.
- Lures are to be replaced once in 30-40 days.

Fig.(1)

Fig.(2)

Fig.(3)

Fig.(4)

Fig.(5)

Fig.(6)

Fig.(7)

Preparation of lures

Methyl Eugenol: Mix Ethyl Alcohol-60 ml + Methyl eugenol-40ml + Malathion/ DDVP (pesticide)- 20ml (i.e. in the ratio of 6:4:2). It can be used for control of fruit flies in Mango, Guava, Papaya, Citrus and other fruit crops.

Cue Lure: Mix Ethyl Alcohol-60 ml + Cue lure (p-Acetoxyphenylbutanone-2)- 40ml + Malathion/ DDVP (pesticide)- 20ml (i.e. in the ratio of 6:4:2). It can be used for control of fruit flies in Cucumber, Gherkin, Melon, Pumpkin, Bitter gourd, Snake gourd, Mango etc.

Time of setting traps:

Methyl eugenol lure can be used in all types fruit crops from fruit set to harvest. Cue lure can be used in cucurbitaceous and solanaceous vegetable crop fields from flowering till harvest. For effective monitoring one trap/15 cents can be used after harvest.

Assessment Activity

Prepare a seminar report on the various bio agents used in pest management. Use the following hints.

- Suitable caption
- Different bio agents, use
- Application methods
- Factors which limit their use.

TE questions

1. Your neighbour is in need of 10 litres of neem-oil garlic emulsion for spraying his coconut. Provide him step by step instructions to prepare the same..
2. Prepare a neat chart presentation of Bordeaux Mixture preparation
3. Using the relationship given, find out the missing ones.
   Nicotine - Tobacco
   …… - Neem
   …… - Derris
   …… - Chrysanthemum
4. Choose the odd one out
   (Delfin, Dipel, Spikthurin, Neemazal)

UNIT - 4
PLANT PROTECTION EQUIPMENTS

The objective of pest management is to keep the pest under check. Pesticide application plays an important role in pest management. The success of any pest control operation depends on the proper technique of application and the equipment used for applying it. The students are to be familiarized with different plant protection equipments like Hydraulic sprayers, Air compression sprayers, centrifugal sprayers, other sprayers -Aerosol sprayers, Fogging machine-power operated knapsack motorized duster, tractor mounted duster-Granule applicators .The components and working principles of important equipments are to be covered. Field level application of pesticides using these equipments is to be practiced.

Learning outcomes

The learner :

- identifies and explains the parts of a sprayer
- identifies and practices the handling of different types of sprayers
- classifies dusters and mentions about other PP equipments.
- identifies the different types of rat traps.
- practices the maintenance of various PP equipments,analyses the problems and suggest suitable remedial measures

Concepts in detail

The main purpose of pesticide application is to cover the target with maximum efficiency and minimum efforts to keep the pest under control. So proper selection of application equipment, knowledge of pest behaviour and skillful dispersion methods are needed.

Pesticides may be applied as sprays, mists, aerosols, fogs, smokes, vapour, dust or granules. The important plant protection equipments are sprayers, dusters, fumigators, rat traps , bird scarer etc.

3.4.1 Sprayers

Sprayers are mechanical appliances which atomises the spray fluid (which may be a suspension, an emulsion or a solution) into a small droplets and eject it with little force for distributing it properly. It also regulates the amount of pesticide to avoid

excessive application that might prove wasteful or harmful. The droplet size varies from 30 to 400 micron depending upon the type of sprayer.

3.4.1.1 Parts of a sprayer

The important parts of a sprayer are tank, pump, agitator, power source, pressure gauge, valves, filter, pressure chamber, hose, spray lance, cut-off device, booms and nozzles.

1. Tank - it is a vessel made of corrosion resistant material like metal, glass or polythene, to hold the spray fluid. The sprayer may have built-in tank as in the case of knapsack sprayer or a separate container as in the case of peddle pump for holding the spray fluid. The capacity of tank varies from less than 1 litre to over 2000 litres.
2. Pump - A pump is necessary for the atomization of the spray fluid. It helps to develop the pressure required for spraying. Pump is the most vital and expensive component of a sprayer.
3. Agitator - The pesticide formulations are rarely soluble in water. The wettable powders even if thoroughly mixed with water are susceptible to separation and may cause plugging or uneven distribution. Most of the sprayers are provided with agitators for keeping the pesticide uniformly dispersed in the spray fluid.
4. Filter - A strainer made of wire gauze should be fitted beneath the tank filler cap to filter the spray fluid as the tank is being filled. Dirt in the fluid may cause abrasion, interfere with the function of valves and may cause blocking of nozzles.
5. Power Source - Petrol engines coupled with the equipment or any separate engine provides power to the power operated sprayers.
6. Pressure gauge - It is fixed on the discharge line to adjust the pressure required for spraying.
7. Valves - important in a sprayer because they maintain the direction of flow of the spray fluid.
8. Hose - Hose is used to conduct the spray fluid from the spray tank to the lance.They are made of rubber, synthetic rubber, nylon or plastic tubes capable of withstanding high pressure.
9. Spray lance or Gun - It is a detachable brass tube made of high corrosion resistant material, usually 90cm long. The nozzle will be screwed on to its end. It is used for directing the spray fluid to the desired target.

10. Spray cut - off device /Trigger cut off device) - A device in the lance to control or stop the flow of the liquid.
11. Nozzle - It is an important component of the sprayer as it breaks up the spray fluid into droplets and spread them as a spray. The size of the droplet varies with the design of the sprayer and type of the nozzle. Nozzle is attached to the lance.
12. Booms - Usually a lance is provide with only one nozzle. A number of nozzles can be arranged in a horizontal tube called the boom or spray bar. It is normally coupled with power sprayers. Booms are used for treating row crops.

3.4.1.2 Types of sprayers

A.Manually operated hydraulic sprayers

1.Hand Sprayer

Thehandsprayerisasmall, lightandcompact unit. Thecapacityofthecontainervariesfrom 500 to 1000 ml. Thisisgenerallyusedforsprayingsmallareas like kitchen garden and experimental laboratoryplots. It is a hydraulic energys prayer. It has a hydraulic pump inside the container, with cylinder, plunger and a plunger rod. By operating the plunger up, the spray fluid in the container is sucked into the cylinder through a ball valve assembly and then pressurised during the downward stroke. The pressurised fluid is then let out through a nozzle, and sprayed into fine droplets.

2.Hydraulic Knapsack sprayer

Any sprayer which is carried on the back of the operator is called a knapsack sprayer. The commonly used manually operated knapsack sprayer will have one hydraulic pump working inside the container. The plunger works inside the replacement well attached at the bottom of the container, for easier maintenance.The pump can be operated through the appropriatelinkages by oscillating the handle, with the sprayer carried on the back. An agitator is also provided with the pressure chamber to agitate the fluid so that the particles in suspension will not be allowed to settle down. A delivery tube is attached on the other end of the pump which carries the pressurises fluid to the spray lance.The flow to the nozzle is controlled by a trigger cut-off valve.

3.Rocker Sprayer

The rocking sprayer has a pump assembly, fixed on a wooden platform with an operating lever, a valve assembly with two ball valves, a pressure chamber, suction hose with strainer and delivery hose with spray lance.When the plunger is pulled

behind by pulling the lever way from the pump, the spray fluid from the container is sucked through the strainer and pushes the bottom ball valve above and enters the pump.The movement of the lower ball is arrested by the upper valve seat. When the lever is pushed towards the pump, the sucked fluid is forced to enter the pressure chamber by opening the upper ball valve.The operation is continued till the entire suction pipe, ball valve assembly, delivery hose and a portion of pressure vessel is fitted with spray fluid and the pump operator finds it difficult to push the piston forward, due to the downward pressure developed by the entrapped compressed air in the pressure vessel. There after, the trigger cut off valve will be opened to allow the spray fluid to rush through the nozzle and get atomized. Usually 14 to 18 kg/cm^2 pressure can be built in the pressure chamber and hence can be conveniently used for free spraying.

4. Bucket Sprayer

The bucket sprayer is designed to pump the spray fluid directly from, the open container, usually a bucket. The hydraulic pump will be put inside the bucked and held properly with the help of foot rest. As the plunger is pulled up, the fluid enters through the suction ball valve assembly and when the plunger is pressed down, the suction valve closes and the fluid enters the pressure chamber through a ball valve assembly. As the plunger is continuously worked, pressure is built in the pressure chamber and the delivery hose.As soon as the required pressure is built up, the spraying will be done.A pressure of 4 kg / cm2 is developed in most of the models

5. Foot Sprayer

The foot sprayer is a modified version of rocker sprayer. The pump is fixed in a vertical position with necessary braces. The plunger moves up and down when operated by the pedal. A ball valve is provided in the plunger assembly itself to allow the fluid to cross the plunger and getting pressurized in the pressure vessel. During the upward motion of the piston fluid is sucked in and pressurized into the pressure vessel and during downward movement, the sucked fluid crosses the plungers and enter the pump. The pressure developed is about 17-21 kg/cm2

B. Manually operated Compression/Pneumatic Sprayers (Sprayers with air pump)

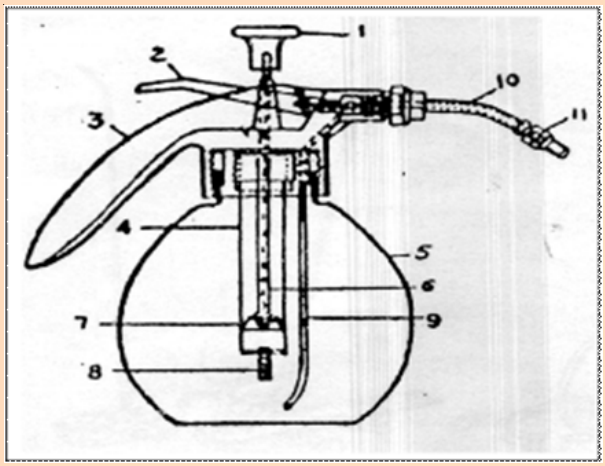
These are called pneumatic sprayers or compression sprayers because air pressure is employed for forcing the liquid through nozzle for atomization. The tank of these sprayers should not be filled completely with the spray fluid. Usually 3/4 th of the tank is filled so that adequate air pressure can be developed over the spray fluid in

the tank. They don't have agitators and hence are not used for spraying materials which settle down quickly.

1.Pneumatic/ Compression Hand sprayer

This sprayer has a tank having a capacity of 0.5 - 3.5 ltr.. The tank is filled to about 3/4thof its capacity and the pump is worked to force air into the space to build sufficient pressure up on the spray fluid. The air pressure forces the liquid up the outlet and through the nozzle in the form of a sprayer

If pressure to be built inside the container an air pump with cylinder, plunger and plunger rod is required. When the plunger is pulled up, the air is sucked into the cylinder and when pushed down the air bubble is releases into the container with 80% of its volume filled with the fluid.The air reaches the space above the free fluid surface and presses the fluid. The pressurised fluid is drawn up through a trigger cut of valve to the nozzle, where is atomized and sprayed.



1. *Piston Handle*
2. *Trigger*
3. *Handle*
4. *Pump Barrel*
5. *Tank*
6. *Piston rod*
7. *Piston*
8. *Air check valve*
9. *Delivery tube*
10. *Spray lance*
11. *Nozzle*

Pneumatic Knapsack sprayer

It consist of a strongly built brass cylindrical tank, a vertical air pump passing through the top and tightly fixed to it and a delivery tube with a spray lance. Water is filled to 2/3 rd of the tank capacity and air is pumped into the tank moving the plunger rod up and down inside the pump barrel. Compressed air creates pressure on the surface of the liquid. The liquid moves up the nozzle and get broken up into fine droplets.

In the case of compression knapsack sprayer, an air pump is used to build air pressure above the free surface of the spray fluid in the container and normally the pumping of the air will be done by keeping the unit on ground and then sprayed til the air pressure comes down.The unit is again brought back to the ground for pumping air any agitation only can be sprayed by using this type of sprayers.

C. Power Sprayers

Suitable for spraying large area of field crops. Consists of a spray tank (10-12 l capacity), a two stroke petrol engine, fuel tank, blower assembly, pleated hose, delivery tube etc. The fan in the blower is connected with the two stroke engine. A liquid delivery pipe from the tank provides the liquid at the end of pleated hose. Another hose from the blower is connected to the tank in such a way that a small portion of air enters the tank on the surface of the liquid. This air provides some agitation and creates constant pressure on the top of the liquid pushing the liquid to the end of the hose. The air blast is created by the blower and divides the liquid as micronised droplets. Power operated sprayers can be of following types.

- Motorised Knap sac sprayers
- Hand/stetcher carried type
- Tractor mounted types

Battery operated power sprayer

1.Battery or ULV sprayer

ULV sprayers were invented to reduce the quantum of chemical carried by the man for application and to eliminate the water as a medium to carry the chemicals. In ULV spraying the quantity of spray fluid required is < 5L per ha.

3.4.2 Dusters

The mechanical appliances that are used for distributing the dust formulations of pesticides are called as dusters. Depending on the source of power dusters can be classified as manually operated dusters and power operated dusters.

The important parts of a duster are :

- A hopper with an agitator
- A fan that produces air current for ejection of dust
- A fed mechanism to control flow of dust
- A rotating mechanism which produces air current and feed dust to nozzle
- A nozzle
- A device to control quantity of dust feeding

The manually operated dusters are

(i) package dusters
(ii) plunger dusters
(iii) bellow dusters and
(iv) rotary dusters.

3.4.3 Other PP equipments

A.Granular applicator

It is a machine that applies granular fertiliser and pesticides such as slug pellets. Granular applicators are used for precision application of solids to improve crop yields and quality. Application rates are often controlled electronically to improve accuracy.

B.Electro static Sprayers

The air-assisted electrostatic sprayers produce droplets 900 times smaller than those produced by conventional or hydraulic sprayers. The tiny droplets are atomized, electrical charged and carried deep into the plant canopy in a turbulent air-stream. This results in twice the deposition efficiency of traditional hydraulic sprayers and foggers.

C.Controlled droplet applicators (CDA's)

They are also called rotary spray nozzles, use centrifugal force rather than hydraulic pressure to form spray droplets. Centrifugal force is supplied by a spinning cup or disc powered by a small electric motor.

D. Fogging Machine

The fluid contained in the fluid tank of the fogging machine is forced through a heat exchanger by a high pressure pump. The heat exchanger can heat up to as high as 400 degrees Fahrenheit. This causes the fluid to become a vapor. This vapor then travels through the nozzle of the fog machine and is emitted into the atmosphere. When the vapor comes in contact with the relatively cooler atmosphere it instantly turns into what we see as fog or smoke.

Parts of a fogging machine.

Pump- The pump usually a piston pump delivers the fluid from the fluid tank to the heat exchanger.

Heat Exchanger- The heat exchanger is a block of metal, with a heating element built into it.

Nozzle- It is usually made of brass, and has a small opening that emits the vapour under high pressure.

Remote Control- Many fog machines today come with a remote control. Hold down the button to release fog. Release the button to stop the fog.

Fog Machine Fluid (fog juice)- Most fluid today is water based. Usually made up of a mixture of glycol and water.

3.4.4 Site specific spraying

It is the technique of spraying the chemicals only on target. Two types of sprayers are available -Vision guided and GPS guided.

In vision guided spraying system, high quality video camera collects crop information from the field and these images or signals will be analysed by the microprocessor and activate individual spray guns accordingly. In GPS guided system, the primary crop data from the field is collected from satellite imagery or remote sensing techniques, analysed by the microprocessor and activate individual spray guns by combining the Global Positioning System and Geographical Information System (GIS).

3.4.5 Rat traps

1. Automatic traps - These are indented to catch more than one rat in a setting. When an animal enters this type of traps its weight makes it fall into a cage below. Eg: wonder trap.
2. Remote triggered trap - These work by upsetting a delicate balance when the bait stick is disturbed or when the bait is put on at treadle. eg: Box trap or Cage trap.
3. Pot traps - These traps are extensively used for catching rice field rats. This trap consists of a wooden plank, a mud pot of 10 inch diameter, a metal strip which carry bait and a 'Y shaped wooden peg to which needle is tied. eg: Moncompu trap.
4. Snap trap - These kill the rats instantly by snapping when the rat nibbles the bait placed in the middle of the open trap. These are variously called as "break back traps, 'spring traps' Saw toothed traps" and 'bamboo traps' depending up on the material used in making them.
5. Glues - A form of trapping in which a sticky substance entangles the animal.
6. Kerosene tin trap - It is made by cutting the top of the tin and filling it with water up to 15 cm from the top. Chaff is floated on the water surface so that the rat cannot see water. Attractive and strong smelling bait like dry fish, fried coconut etc is pinned on to a piece of cork or lightwood and floated on the chaff. A plank is leaned against the side to enable the rat to climb to the top. Seeing no water and eager to get the bait the rat jumps on to the chaff and gets drowned.

3.4.5 Maintenance of plant protection equipments

Points to be taken care while handling plant protection equipments.

1. Follow the instructions of manufacturers for maintenance of equipment.
2. Clean the equipments properly and store in a dry place.
3. Drain the tank of a sprayer and flush it with clean water, wash the pump, nozzles, strainers, lances, hoses, etc, with clean water.
6. Empty the hopper and clean with a cloth in case of dusters.
7. Replace the worn out parts, grease and oil the moving parts, eg. Cylinder,piston, plungers, washers, valves, etc. when not in use.
8. Do not bend rubber hoses at angles
9. At end of season clean sprayer thoroughly, drain all water from engine, pump and tank, disconnect hose and run lubricating oil through pump. Drain oil from engine and pump and replace with new oil.
10. Do not through the nozzles and delivery tubes of dusters on bare ground
11. Always keep sufficient stocks of spare parts and tool kits
12. Drain the spray solution to avoid clogging of nozzle.

3.4.6 Field problems and remedies for plant protection equipments

1. Knapsack sprayer

Sl. No	Problem	Rectification
1	Nozzle block	If a nozzle blockage occurs while spraying, the nozzle tip and filter should be replaced with clean points. The blocked nozzle should be cleaned and spares should be taken to the field. When spares are not available, water or a solvent should be taken to the site of operation to clean the blockage. The occurrence of blockages can be reduced by filtering the spray liquid while filling the chamber.
2	Pressure drops quickly	Check that the filler cap or lid gasket is in good condition and the cap is properly secured. Ensure that all connections and washes are proper.
3	Trigger cut- off valve is leaking	Dismantle the trigger cut off valve and check the ring washer. If damaged replace.

2. Rocker Sprayer

Sl. No	Problem	Rectification
1	No spray blocked nozzles	Nozzle block, follow procedure for cleaning
2	Suction do not result	If suction valve stuck, clear it
3	Leakage through plunger rod	Either piston worn out or it is loose. Check the piston if it is loose lighten the screw
4	Liquid not entering into the delivery tube	Delivery valve gets stuck clear it.

3. Dusters

Sl. No	Problem	Rectification
1	Dust not coming out	Check whether the hopper is empty? Check whether the valve is open?

Practical activity

Familiarisation with different plant protection equipments, its working principles, field use and maintenance.

Materials required: Sprayers, Photographs, CDs.

Procedure - identify different types of sprayers and dusters, its working principles, prepare sketches and record relevant information.

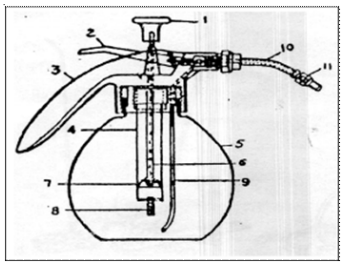
Assessment Activity

Visit a nearby agro service centre and prepare an assignment on the different plant protection equipments you have seen there.

Hints:(Name of equipment, Group to which it belongs, Working principle, Use, Pictures and Maintenance)

TE questions

1. Identify the sprayer and label its parts



2. Name the sprayer most suitable for tall crops like coconut
3. The spray solution required for ULV spraying is about 1-5 litres/ha. ULV is ……

List of extented activities - Module 3

Unit 1- Pest and disease diagnosis

Creating awareness among people/ farmers in the locality on variouspests and disease diagnosis softwares.

Unit II- Integrated pest and disease management of major crops of kerala

Creating awareness among people/ farmers in the locality on the diagnosis and management of pests and diseases of the most commonly cultivated crops in the locality (distribution of leaflets, organizing seminars).

Running of weekly Crop health clinics in school.

Unit III- Agro- biopharmacy

Organizing classes on the relevance of the use of environmentally safe, botanicals, bio-pesticides in crop production.

Organizing classes and method demonstration of the preparation of effective botanicals.

Preparation and sales of botanicals to the local people.

Unit IV- Plant protection equipments

Expo.

List of practical activitites - module 3

Unit 1- Pest and disease diagnosis

1. Collect and observe various pests affecting agricultural crops and classify them into different groups
2. Identification of different groups of insects
3. Identification of types of mouthparts of insects and their feeding habits
4. Familiarization with the methods of collection of insects , equipments used for collection and methods of preservation
5. Familiarization with important disease causing organisms and symptoms of diseases seen in major crops
6. Preparation of herbarium showing different disease symptoms in plants.
7. Familiarization with ooze test.

8. Familiarization with disease forecasting models and interctive softwares.
9. Familiarization with pest and disease diagnosis softwares.
10. Familiarization with mechanical weed management - brush cutter.

Unit 2 - Integrated pest and disease management of major crops of kerala

1. Familiarization with major pests and diseases of crops of Kerala, their symptoms and management- Rice, Coconut, Banana, Pepper, Vegetables, cardamom, ginger, mango, rubber, cashew, cassava, sweetpotato, tea, coffee and ornamentals.
2. Familiarization with important pests of stored products.

Unit 3- Agro- biopharmacy

1. Preparation and field application of Neem based botanicals - Neem oil emulsion, Neem oil -Garlic emulsion -2%, neem seed kernel extract.
2. Preparation and field application of extracts of plants like Andrographis, Hyptis, Chlerodendron.
3. Preparation and field application of papaya leaf extract, bird chilli-cow's urine extract.
4. Preparation and field application of fish amino acid and egg aminoacid.
5. Preparation and field application of permitted fungicides for organic farming- Bordeaux mixture and Bordeaux paste.
6. Familiarization with formulations of bio-fertilizers, practicing seed treatment of rhizobium and its field application.\
7. Preparation of organic nutrient solutions- Panchagavya and Dasagavya.
7. On farm mass multiplication of Trichoderma and its field application.
8. Field application of Pseudomonas.
9. Preparation of Yellow or Blue sticky trap and its field installation.
10. Method of production of low cost pheromone trap against fruit fly.

Unit 4- Plant protection equipments

1. Familiarization with different types of sprayers
2. Operation and maintenance of hand sprayer and pneumatic knapsack sprayer
3. Familiarization with different types of rodent traps.

MODULE - 4
HITECH FARMING

Speciality agriculture is gaining popularity to yield desired high productivity of crops and economic return. Protected cultivation is one of the speciality agriculture where high input (land, water, seeds and chemicals) use efficiency on account of better protection against abiotic and biotic stress is obtained besides off season production of crops. Recent trends in soil less cultivation (aquaponics and hydroponics) is also covered. Non judicious use of pesticides have an illeffect on the health of non targeted organisms and on environmental health. In this context it is inevitable to understand the illeffects caused and methods to overcome them. This module throws light into one of the important ways of getting healthy, safe and pesticide free agricultural products and ensuring sustainability in production through organic certification. In this era of technological boom many agricultural related extension softwares are available which can help the farmers to make speedy and timely decisions in farming. This module will give the students knowledge on various ICT enabled services.

Unit - 1
PROTECTED CULTIVATION

After the advent of green revolution, more emphasis is laid on the quality of the agricultural products along with the quantity of production to meet the ever-growing food and nutritional requirements. Both these demands can be met when the environment for the plant growth is suitably controlled. The need to protect the crops against unfavourable environmental conditions led to the development of protected agriculture.

Protected cultivation is mainly being considered for the production of horticultural crops like vegetables and ornamental foliage and flowers. With advancement of technology it has been possible to grow plants without soil with alternate substrates like sphagnum moss, cocopeat, coir dust, perlite, vermiculite,etc. not only horizontally but vertically also which is referred to as hydroponics. The additional advantage of such farming is that it can be done at any space available even in flats. Various types of polyhouse structures, list of crops commonly cultivated, their agronomic practices and plant protection methods are discussed. Precision agriculture is a farming management concept based on observing, measuring and responding to inter and intra field variability in crops. The holy grail of precision agriculture is an ability to define a decision support system for whole farm management with the goal of optimizing returns on inputs while preserving resources.

Learning outcomes

The learner :

- defines protected cultivation and explains the scopes and benefits of protected cultivation.
- analyses the factors emphasizing the need of Hitech horticulture in Kerala.
- compares and classifies the different types of protected cultivation structures based onshape of structure, use of structure, covering material, type of ventillation, environmental control and cost.
- identifies the different parts of a greenhouse.
- enlists the commonly cultivated crops in protected cultivation structures.
- explains the principle and practices to be followed in protected cultivation.
- explains the climate control inside green houses including automation and enlists the equipments for measuring climatic parameters.
- explains the micro irrigation system and its components in protected cultivation.
- explains fertigation, enlists the characteristics of fertilizers used and advantages and disadvantages of fertigation.
- analyses and interprets major pests, diseases and nutritional disorders seen in crops under protected cultivation and their management.
- explains preventive approaches adopted in general integrated management for green house crops.
- explains curative approaches adopted in general integrated management for green house crops.
- explains the crop protection equipments in protected cultivation.
- defines and explains soil less cultivation practices like hydroponics and aquaponics and enlists its advantage and disadvantages.

4.1.1 Definition

Protected cultivation can be defined as a cropping technique wherein the micro climate surrounding the plant body is controlled partially or fully as per the requirement of the crop species. The cultivation of crops is done in a climatologically isolated structure. Here, climatic factors such as solar radiation, temperature,CO2 concentration, humidity and air movements are controlled.

Benefits of protected cultivation

- Better quality of produce.
- High productivity.
- Nursery raising and hardening of plants.
- Better insect and disease control and reduced use of pesticides.
- Off season cultivation.
- Efficient use of resources.

Scope of protected cultivation

- Any crop can be grown at any time and at any place.
- Protection of plants from wind, rainfall, excess solar radiation, temperature etc.
- Yield 10-12 times higher than that of open field.
- Modern techniques of hydroponics, aeroponics etc are possible.
- Reduce pesticide use.
- Water and fertilizer requirements are limited and easy to control.

4.1.2 Factors emphasizing the need of hitech horticulture in Kerala

- As protected cultivation is more remunerative, not much laborious and following advanced technology , it attracts educated unemployed youth of Kerala.
- Labour wages in Kerala is 3-4 times higher than neighbouring states. Labour saving due to adoption of micro irrigation and fertigation (66-77%).
- Open well based homestead farms in Kerala. Hence quality of water is excellent.
- Average land holding size varies from 0.01 to 0.025 ha. Most of the farmers are wage seekers. Hitech horticulture with less labour involvement is easily adaptable to literate farmers in the State.
- Adoption of micro irrigation in coastal areas facilitates the chance of using saline water for irrigation without much loss in production.
- Fertigation and microirrigation facilitates effective utilization of water and nutrients and avoid contamination of ground water.

Assessment activity

1. Make a group discussion on scope and benefits of protected cultivation consideringpresent scenario of Kerala Agriculture.
2. Prepare a chart on the factors emphasising the need of Hitech horticulture in Kerala.

4.1.3 Different types of protected structures

Traditionally the green houses were constructed using wooden frames where glass was used as the cladding material. Later glass was replaced by polythene. Being the most popular green house material, the green houses were renamed as polyhouses. The modern green houses are built on a steel frame and covered with plastic. In general, flowers, vegetables and fruits are produced in a green house. It is a frame work structure covered by transparent material inorder to protect the crops from adverse climate conditions such as wind, rain, radiation , rainfall etc. It provides a microclimate surrounding the crops that helps for maximum production. It also provides higher CO2 concentration to increase the production.

Classification of protected structures

Based on the structural material

1. Wooden Structure

- Wood (*Casuarina* poles commonly used)or bamboo is used for making frames over which poly ethylene sheet is fixed.

2. Mild Steel Sructure (MS structure)

- Structures made using mild steel.
- Comparitively cheap but liable to corrosion, hence should be painted with white or aluminium paint.

3. Galvanised Iron Srtucture (GI structure)

- Structure made of GI. This will last for 15-20 years.

  Green house structure made of GI pipe covered with UV stabilized poly ethylene sheet is most economical.

Based on shape of the structure

1. Gable shape

- Most basic structure similar to a hut.
- Here glass is used as the covering material.
- The structure with straight side wall and a gable(triangular end) roof is the most common shape.

- Suited to Kerala condition since it assures lesser air temperature compared to other shapes .

2. Quonset shape

- Straight side wall and arch shaped roof.
- Economic utilization of material possible than gable shape.
- Temperature inside will be more than gable shape.

3. Gothic shape

- Condensed water can flow off better than other arch shaped structures. So only a small amount of water falls on crops.

4. Arc shaped

- Maximum light transmission
- Temperature inside will be more than the gable shape

5. Ridge and furrow type

- Multispan green houses and gutter connected green houses are synonymous
- Commercially used as constructed with minimum expenses

6. Saw tooth type

- Suited to warm climate
- Roof consists of a series of vertical surfaces separated by a series of slopping surfaces
- Provision for natural ventilation at the ridge , hence lesser temperature inside the green hose

7. Lean-to type

- When green house is placed against the side of an existing building
- Erected mostly on south facing side.

Based on the use of structure

1. Poly tunnels or mist chamber

- Poly ethylene film is used as the covering material
- Most simple and easy to construct
- High strength with light frame
- Temperature and RH (>80%) inside will be more
- Commonly used for hardening nursery plants, grafting or budding and to grow leafy vegetables commercially

2. Plastic low tunnels/Row covers

- Structures laid in open fields to cover rows of plants with transparent poly ethylene (30-40 micron) film without UV stabilisation

- Used in cooler regions for vegetable production especially cucurbitaceous crops

3. Floating Covers

- Structures laid in open fields to cover rows of plants in hot season
- Covering materials used are woven polyester wind-break nets and insect proof screens

4. Rain Shelters

- Low cost structures made of bamboo /arecanut /casuarina/concrete post/MS pipes/GI pipes
- Roof covered with UV stabilized poly ethylene sheets and the sides will be open
- Protect the plants that could not be cultivated during rainy season
- Protect the plants from high temperature,cold,wind,frost,uv rays,pests,birds

5. Shade Net houses

- Covered with shade nets of (different colours and grades).
- These are perforated plastic materials used to cut down solar radiations and to prevent scorching or wilting of leaves.
- Roofs are usually horizontal or arch shaped.
- Used for raising nurseries.
- Leafy vegetables and ornamental plants are grown.
- Protect the plants from high temperature, cold, wind, frost, pests, birds.

Based on the type of covering material

1. Glass house

- Clean transparent glass is used for maximum light transmittance.
- Brittle and can break with minimum shock.
- High maintenance cost.

2. Acrylic house

- Long service life.
- Good light transmittance.
- Moderate impact resistance, but prone to scratches.
- Not preferred being inflammable and costly.

3. Corrugated/multi wall poly carbonate sheet house

- Available in single or double walled sheets of different thickness.
- Good light transmittance which reduces with age.

- Excellent impact resistance.
- Low inflammability.
- High cost.

4. Fibre glass reinforced plastic (FRP) house

- Polyester resins, glass fiber stabilisers used.
- High light transmittance.
- High impact resistance.

5. Poly house

- Clear new poly ethylene sheet having high light transmittance used (88%).
- Higher strength and low cost made it most popular replacement for glass.

4.3.5 Based on the type of ventillation

1. Naturally ventillated

- Low cost with side and roof ventilators.
- Most of the commercial green houses in India come under this.

2. Mechanically ventillated

- Cooling made by using exhaust fans and pads
- Used for cultivation of exotic ornamental plants and for propagation units.
- Not popular in India due to high initial investment and lack of continuous power supply.

4.3.6 Based on environmental control

1. Fully controlled

- Sophisticated structures with provision to control the level of CO2, light, temperature, RH.
- Commonly used in temperate countries having extreme climate.

2. Partially controlled

- Temperature and relative humidity is controlled with fan and pad system.

3.Naturally ventillated

- Temperature and relative humidity is partially controlled with roof and side ventillators.
- Most of the commercial green houses in India come under this.

Practical Activity

Familiarization with different types of protected cultivation structures based on shape, construction and covering material.

4.1.4 Important parts of Green House

1. Roof: transparent cover of a green house.
2. Gable: transparent wall of a green house.
3. Cladding material: transparent material mounted on the walls and roof of a green house.
4. Gutter: collects and drains rain water and snow which is placed at an elevated level between two spans.
5. Column: vertical structure carrying the green house structure.
6. Purlin: a member who connects cladding supporting bars to the columns .
7. Ridge: highest horizontal section in top of the roof.
8. Girder: horizontal structure connecting columns on gutter height.
9. Bracings: To support the structure against wind.
10. Arches: Member supporting covering materials.
11. Foundation pipe: Connection between the structure and ground.
12. Automatic climate control systems.
13. Fertigation unit.

Assessment Activity

Make a neat labelled sketch of a green house.

4.1.5 Crops recommended for cultivation in protected cultivation

Vegetables	Tomato, cherry tomato, salad cucumber,onion,cabbage, cauliflower, yard longbean, bellpepper, chilli, okra, radish, broccoli, melons, frenchbean, amaranthus, palak, lettuce, egg plant.
Fruits	Strawberry, grapes,citrus,banana, watermelon.
Ornamental plants	Rose,Gerbera,Carnation,Orchids,Anthurium, Chrysanthemum, Potted plants, Lilly.
Others	Tobacco, nurseries, fresh herbs

4.1.6 Principles and practices to be followed in greenhouse vegetable cultivation

Orientation

The location and orientation of the greenhouse should avoid falling of shadow on the adjacent greenhouses. To avoid the shading effect from one green house to another greenhouse these should be oriented East to West. However, the wind direction and latitude are also to be considered.

Size of the greenhouse

The dimension of naturally ventillatedgreen house should not be more than 50 m x 50 m. Bigger the greenhouse more will be the temperature build up due to poor ventillation. The length of evaporative cooled greenhouse should not be more than 60 m.

Spacing between greenhouses:The spacing between naturally ventilated green houses should be 10 to 15 m so that the exhaust from one greenhouse should not enter the adjacent greenhouse.

Height of greenhouse

The maximum height can be up to 5m for 50m x 50m green house and this can be reduced as per the reduced size of the green house. Higher is the greenhouse more is the wind load for structure and glazing. The side ventilation can be of 2 m width and roof ventilation is 1m in width.

Land preparation

- In protected cultivation, crops can be planted in soil or soilless media such as cocopeat, vermiculite, perlite etc.
- The sterilization of soil should be done using physical or chemical methods.
- After soil sterilization, beds are to be prepared properly according to the crop to be planted and greenhouse structure.
- Leave sufficient space for main pathway.

Planting

- Select high yielding hybrid seeds.
- Crops selected should be suitable for protected cultivation.
- Vertical growing crops are most suitable for protected cultivation. e.g. salad cucumber, tomato, cowpea, capsicum.
- Grafted vegetable seedlings can also be used.

Fertigation

Application of fertilizers along with irrigation water is called fertigation. The fertilizer should be highly soluble in water.

Intercultivation

- Proper irrigation should be done.
- Weed growth should be controlled by plastic mulching.

Plant protection

Plant protection is a very important aspect with respect to protected cultivation. Pest or disease incidence in one crop may severely affect the entire crops. The various strategies are:-

- Cultural methods
    1. Follow strict quarantine measures.
    2. Practice IPDM.
    3. Use insect proof nets.

       Each polyhouse should have a double door to prevent entry of insects and diseases.
    4. Use pest and disease free planting materials.
    5. Use resistant varieties.
    6. Crop rotation.
    7. Maintain proper spacing.
- Mechanical and physical methods

i. Scouting-to detect the presence of any pest

ii. Pheromone trap

iii. Soil solarisation

iv. Sticky traps

v. Hand picking

- Biological control

  a. Use of natural enemies.

  b. Use of botanicals.

- Chemical control

Media preparation

For cultivating crops in green house proper media need to be prepared. Mix red soil (70%), FYM (20%), Rice husk / sand(10%) and irrigate for 3 days. Also other organic manures such as neemcake, bonemeal, basal dose of fertilizers according to crops is to be added before bed preparation.

Soil sterilization

- It is a process of destroying pests, diseases and weeds.
- Micro organisms can be killed, inhibited or removed by physical (steam sterilization/sun radiation) or chemical methods (Formaldehyde@ 8L/100m2 / methylbromide @ 20g/m2).

Requirement for 1008m2 green house

- Formalin- 80L
- Water- 800 L
- Plastic barrel - 200L capacity
- 100 micron black plastic sheet

Procedure

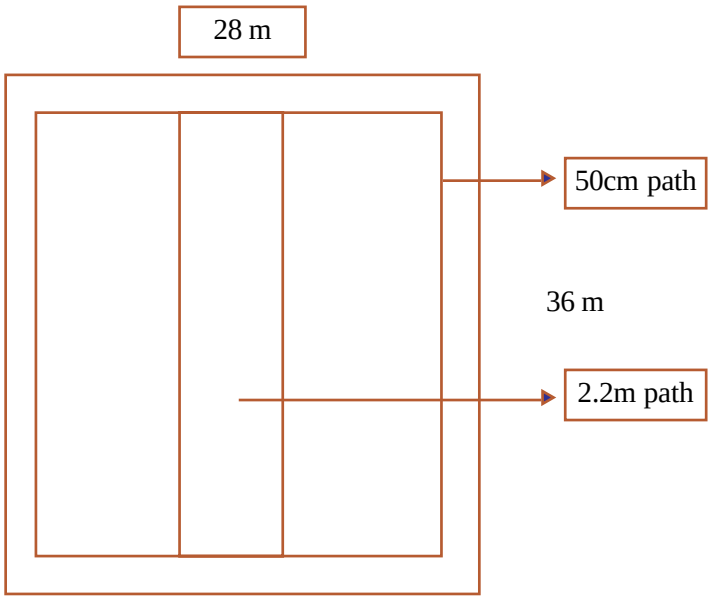
- Loosen the soil.
- Wet the soil inside the green house upto the field capacity.
- Close the green house completely.
- Cut the plastic into 4m size.
- Drench the soil media with formalin and cover it immediately with black polythene sheet and leave it for 5 days.
- On the 6th day open the side ventilation and remove the plastic.
- Irrigate the soil with water 100 L/m2 and leave it for 3days.
- Planting is done 2 weeks after drenching.

Note: Not used in a standing crop.

Practical Activity

1. Preparation of growth media used in protected cultivation.
2. Demonstrate soil solarization and physical methods of soil sterilization. Show the materials used in sterilization of media.
3. Preparation of beds .

Bed preparation



Practical Activity

Demonstrate bed preparation in hitech farming.

4.1.7 Climate Control inside the green house

Equipments for measuring climatic parameters.

Sl No	Parameter	Measuring equipments
1	Light/Radiation	Radiation meter, Lux meter
2	Temperature	Glass thermometer, Infra Red thermometer, Bimetal thermometer.
3	Relative Humidity	Psychrometer, Hygrometer, Electric moisture meter.
4	CO2 concentration	CO_2 meter,CO_2 analyser.
5	Wind speed	Anemometer
6	Wind Direction	Wind vane
7	Rain/Precipitation	Rain gauge, Rain indicator

Automation in climate control

All the climatic parameters inside the greenhouse can be controlled automatically by using suitable control systems. We can coordinate all the sensors used in the equipments installed inside and outside the greenhouse by a proper software program. The software uses all the environmental parameters as inputs from these sensors .

A green house monitor provide integrated control of temperature, humidity, CO_2, light, shade, irrigation, fertigation. It also controls devices inside he green house like vents, fans, valves,curtains and lights.

Assessment Activity

1. Prepare a picture album showing different protected cultivation structures based on type of cladding material used, structural material used, shape of structure, ventilation and environmental control.
2. Familiarization with various equipments used for measuring climatic parameters inside green house.

4.1.8 Irrigation

Microirrigation can be considered as an efficient irrigation method which is economically usable, technically feasible and socially acceptable. Drip Irrigation is the common method of irrigation used in protected cultivation.

The main components of a micro irrigation system are :

1.Water Source

The source of water should be open wells, borewells, canals, rivers, reservoirs etc.

2.Pumpset

The water from the source has to be supplied under appropriate pressure and discharge using pumps.

3.Main and submain pipes

1. Main Line

Main line in drip system is made up of either PVC (Poly Vinyl Chloride) or HDPE (High Density Poly Ethylene).The size of the pipe depends on the water reqired for the crop and the distance between the plot and the water source.

2. Sub main line

Sub main line in drip system is made up of either PVC (Poly Vinyl Chloride) or HDPE (High Density Poly Ethylene).The size of the pipe depends on the the number of drippers on the laterals

4. Lateral pipes

The laterals are made up of LDPE(Linear Density Polyethylene).The laterals are available in 12mm,16mmand 20mm size.In green houses 16 mm size is ideal.

5. Filters

The filters are heart of the drip irrigation system. The filters remove sand, soilparticles, algae, fertilizers, chemical residues etc in order to avoid clogging of the drippers. Filters are mainly of two types.

- Primary Filters- Sand filters and Hydrocyclon filters
- Secondary filters- Screen filters and Disc filters

6.Drippers

Dripper or emitter is a component from where the water comes out of the system.The drippers are of two types.

a. Online dripper – Onlinedrippers are attached to the laterals from outside. These drippers are commonly used for long spaced crops,seasonal crops and for unevenly spaced crops.

b. Inline dripper - In this method,the drippers are attached to the laterals from inside at fixed distance at the time of manufacturing of laterals.For each dripper, a separate filter is attached to avoid clogging.For green house cultivation it is suggested to use inline drippers.

7. Pressure Guage

Pressure has an important role in operating the drip irrigation system. Pressure is measured by using Pressure guage.It is fixed at the inlet and outlet of filter and also at the starting point of the main line.

Maintenance of Drip Irrigation System

- Flush the laterals everyday.
- Flush the mains & submains once in a week.
- Clean the screen / disc filter everyday after irrigation is over.
- Backwash of sand filter once in a week.
- Cleaning of water tank once in 6 months.

8. Misters/Foggers

Misting/fogging in green houses helps to reduce temperature and increase the humidity. Misters/foggers produce very small droplets of water in the air and get evaporated before falling in to the crop canopy.The operating pressure of mister/fogger varies between 2.5 to 5.5 kg/cm^2.The pressure operated for fogger is more than that of mister. The foggers/misters can be operated between 10.30am and 3.30 pm. It can be operated upto 3 to 4 times in an hour. Operating foggers after 4 pm is strictly avoided. If the fogger is operated more time after 4 pm, plants may be affected by fungal attack. The foggers are placed over the head or in the paths while the misters are placed in the paths only.

4.1.9 Fertigation

It is the method of applying fertilizers, soil amendments and other water soluble products required by the plant along with water during its growth stages through drip system.

Characteristics of fertilizers used for fertigation

- They must avoid corrosion of GI pipes, softening of plastic pipes and clogging.
- They must be safe for field use.
- They should increase crop yield.
- The chemicals should be completely soluble under field temperature.
- They should have high nutrient content readly available to plants.
- They should not cause clogging of filters and emitters.
- they should be compatible with other fertilizers.

Commonly used fertilizers in greenhouse

19:19:19, 12:6:18, Urea, Magnesium nitrate, Ferrous sulphate, Zinc sulphate, Borax.

Advantages of fertigation

- Ensures a regular flow of water and nutrients resulting in higher yields.
- Improves nutrient availability and uptake by the roots.
- Safer application method.
- Simpler and more convenient saving time, labour, equipment and energy.
- Improve fertilizer use efficiency.
- Major and micro nutrient can be applied in one solution.

Disadvantages

- Over or under fertilization.
- Corrosion or softening of pipe system due to wrong selection of chemical.

Practical Activity

Familarization with irrigation system and fertigation requirements in protected cultivation.

Assessment Activity

Prepare a model of a protected cultivation structure with drip irrigation system.

4.1.10 Nutritional disorders of crops

Nutrient	Deficiency symptoms	Management measures Use N fertilizers in soil Foliar spray of Urea
Nitrogen (N)	Leaves become pale yellow and narrow with irregular margins	Application of P fertilizers like superphosphate.
Phosphorus(P)	Reddening or purpling of leaves, reduced growth of plant, delayed maturity	Use of K fertilizers like MOP in soil.
Potassium(K)	Yellowish/ brownish /whitish spots starting from leaf margin may be seen. In severe cases death of foliage may occur.	Foliar application of magnesium sulphate (Epsum)
Magnesium (Mg)	Vein of leaves remain green and interveinal chlorosis. Symptoms appear on older leaves.	Spraying 0.5% Ferrous sulphate on foliage
Iron(Fe)	Yellowing of new leaves. General chlorosis	Foliar or soil application of copper sulphate.
Copper(Cu)	Tip of leaves may turn white	Soil application of zinc sulphate @ 20 - 25kg/ha
Zinc(Zn)	White leaf becomes rusty brown in colour, stunted growth	Use Calcium carbonate or calcium hydroxide in soil.
Calcium (Ca)	Terminal bud dies. Leaves wrinkled. New leaves show pigmentation.	Use gypsum.
Sulphur(S)	The whole leaf in plants has light green color.	Foliar application of Sulphur or sulphates. Application of S containing fertilizers.

Plant protection in polyhouses

Common pests in polyhouse crops

Pest	Damage	Management
White fly	• Present in lower leaf surface. • They feed and cause yellow spots on leaves.	• Removal of old and heavily infested leaves. • Use of yellow sticky traps. • Using predator *Chrysoperla carnea* • Use entomopathogenic fungi *Lecanicilium lecanii*, *Beauvaria bassiana* • Use botanical pesticides like neem oil garlic emulsion. • Use of fish oil rosin soap
Thrips	• Found in buds, flower petals, axils of leaves etc. • Both the nymphs and adults suck the sap from leaves and flowers. • Commonly seen in cowpea.	• Use of yellow/blue sticky trap. • Apply entomopathogenic fungi *Lecanicilium* and *Metarrhizium* • Use Botanicals like 2% neem oil emulsion.
Aphids	• Feeding on young leaves results in chlorotic spots. • Commonly seen in cucumber.	• Use yellow/ blue sticky traps. • Spray Dimethoate 2ml/l
Spider mite	• Mites suck sap from leaves and result in speckles. • Under severe infestation, leaves dry and fall off. • Commonly seen in chillies and capsicum.	• 50% humidity control will reduce the mite attack. • Frequent watering / misting to bring down greenhouse temperature should be done. • Remove heavily infested plants. • Use Predatory mite *Phytoseiulus persimilis*. • In case of heavy infestation use safe acaricides.
Leaf miners	• Maggot feed on leaf tissues making irregular tunnels and disfigures the plant.	• Use a yellow sticky card • Use healthy planting material. • Disposal of crop residues. • Use botanicals like neem oil emulsion.
Nematodes	• Infested plant appears stunted and tend to wilt on warmer days. Root galls are seen.	• Drenching the soil with 0.5 per cent formalin at 100 ml/Kg soil followed by covering with polythene tarps for two weeks before sowing/ planting • Growing cowpea (trap crop for root-knot nematode) closely to the main crop and removing the plants out of polyhouse at 45 days after sowing.

		• Raising marigold (antagonistic to nematodes) and incorporating in situ after plucking flowers. • Adding well decomposed farm yard manure @ 20 tonnes per hectare to enrich soil. • Incorporating neemcake@ 250 Kg/ha soil two weeks before sowing/planting. • Filtering irrigation water using mesh sieves before usage. • Applying *Pseudomonas fluorescens*/ *Trichoderma viride* @ 2.5 Kg/ha mixed with 50 kg farmyard manure ten days before sowing/ planting and use chemical pesticides like carbosulfan 6G. • Grow resistant varieties.

Insect and mite pest management in crops under protected environment

Pests	Host plants	Degree of infestation in Kerala
Aphids	• Capsicum	• Moderate
Caterpillars	• Capsicum, tomato, cucumber	• Mild to moderate
Leaf miner	• Tomato, cucumber	• Very severe
Mites	• Capsicum, cucumber, tomato	• Moderate to heavy
Whiteflies	• Capsicum, tomato, cucumber, beans	• Moderate to heavy

Diseases in polyhouse crops

Disease	Pathogen	Symptom	Management
Downy mildew	Fungus	• Angular chlorotic lesions on leaves. • Downy growth on under surface of leaves. • Leaves turn brown and drop.	• Spray Mancozeb 3g/l
Powdery mildew	Fungus	• White powdery growth seen on top leaves. All parts are infected.	• Wettable Sulphur spray (2g/l). • Not used in Cucumber.

Disease	Pathogen	Symptom	Management
Foot rot	Fungus	• Withering and yellowing of foliage. Plants wilt. • Roots turn yellow to brown and base of stem may rot.	• Basal application of FYM enriched with *Trichoderma*. • Periodic drenching with *Pseudomonas* 20g/l. • Crop rotation. • Drenching with Mancozeb (2g/l).
Fusarium wilt	Fungus	• Lower leaves become yellow • Withering of leaves • Finally the branches wilt.	• Basal application of FYM enriched with *Trichoderma*. • Periodic drenching with *Pseudomonas* 20g/l. • Crop rotation. • Drenching with Mancozeb 2g/l.
Fruit rot	Fungus	• Soft, wet rot of flowers and the blossom end of fruits. • Infected fruits decay and become watery.	• Apply Mancozeb 2g/l.
Bacterial wilt	Bacteria	• Wilting of youngest leaf during the hottest part of the day. General witling and yellowing of foliage and eventually plant dies.	• Use resistant varieties. • Periodic spray/ drench of *Pseudomonas* 20g/l. • Crop rotation.

General integrated management procedures

1.1.11 Preventive approaches

This approach includes avoidance of the pest by exclusion techniques. Some of the exclusion techniques are :

a. Quarantine measures to avoid the entry of pest

b. Maintain sanitation by sterilizing implements, manures, media, planting materials, etc. Those engaged in work should maintain cleanliness.

c. Use of physical barriers

- Use of insect proof screens and nets

Exclusion by screening and netting prevents the movement of pests into the greenhouse from outside.

- Provision of double door structures with anterooms

- UV radiation absorbing sheets.
- Sanitation and cultural practices.
- Inspection up on arrival.

d. Scouting and surveillance

- When the crop is young, it is important to check all the leaves on the plantbecause majority of arthropod pests prefers the underside of the leaf. It is important to turn the leaves and check.
- Scouting the plants during dusk and dawn as well as during night is important.
- Use of traps.

For thrips blue coloured sticky traps can be used. Yellow sticky traps are used for white flies.Check the sticky traps during scouting visit and record the total number of white flies, aphids, thrips, leaf miners etc and record them.

Pheromone lure traps can be used for detecting moths of borers for their accidental introductions eg. Tomato fruit borer, bhindi and brinjal fruit and shoot borer.

e. Trap crops or Indicator plants

- Planting *Portulaca oleraceain* rose as a trap crop for tobacco caterpillar under protected environment.

Wild bhindi and castor for caterpillar pests, early planted mustard plants for aphids and leaf miner pests in cool season vegetables are some of the insect trapping plants grown in protected houses.

4.1.12 Curative approaches

Biological control

In order to reduce the overload of chemical pesticides within the protected systems, it is always better to rely upon botanical pesticides as preventive treatments or as prophylaxis.

Neem based botanical pesticides against insect pests in protected cultivation.

Neem based formulations	% Azadiractin
Neemazal	5
Achook	0.03
Uttamneem	0.03
Bio neem	0.03
Multineem	0.03
Eco neem	0.3
Rakshak	0.15
Neemicide	10
Neem gold	10

Homemade botanical pesticides for pest management in green houses

Botanicals	Dosage (%)	Quantity	Target pests	Frequency	Remarks
Neem leaf decotion	5-10	50-100 g	Defoliators, Sucking insects.	Weekly once	With wetting agents during evening hrs
Neem seed kernel extract	0.5-5	5-50	Leaf webber, shootborer, Biting & chewing pests	Fortnightly once	No wetting agent needed
Neem oil soap emulsion	0.5-2	5-20	Sap sucking insects	Once in 10-15 days	Soap solution @ 5g/l as emulsifier
Neem cake extract in water	5-10	50-100	Plant nutrient cum pest defendant	Weekly once	Repellant
Tobacco decotion with soap/alkaline products	1-5	10-50	Soft bodied insects, leeches,slugs	As and when required	Good knock down action.
Karinotchi (Vitex), Kiriyathu *(Andrographis)*, Panal(*Glycosmis)*	2.-5	25-50	Defoliators, sap sucking insects	Weekly once	With wetting agents during evening hours

Entomopathogenic fungi useful in protected cultivation

Entomopathogenic fungi	Host Insects	Crop
Beauveria bassiana	Fruit &Shoot Borer	Pulses, Bhindi, Brinjal
Lecanicilium lecanii	Aphids,Scales, Mealybugs	Pulses, Bhindi, Brinjal, chillies, tomato
Metarrhizium anisopliae	Leaf and plant hoppers, Thrips,White flies	Pulses, Bhindi, Brinjal, chillies, tomato
Nomurea rileyi	Gram caterpillar	Tomato, cowpea, cucurbits
Paecilomuces fumosoroseus	Red spider mites, yellow mites	Cucurbits, Bhindi, Brinjal, chillies, tomato
Fusarium palidoroseum	Cowpea aphid	Cowpea, peas

Bt based products for IPM in polyhouses

Entomopathogenic Bt formulations	Crop pests	Host plants
Dipel SL	Diamond Black Moth	Cabbage and cauliflower
Thuricide/Biocontrol-WDP	*Helicoverpa*	Peas,cowpea,tomato,chilly
Biobit-WDP	*Leucinodes, Spodoptera*	Bhindi,brinjal,tomato
Biolep-WDP	*Heliothes*	Bhindi, tomato, chillies
Delfin WG	*Helicoverpa, Earias sp, Spodoptera, Plutella*	Tomato, bhindi, cabbage, cauliflower
Halt WDP	*Plutella*	Cabbage, cauliflower

Chemical control

Insecticides are one of the important selective tools to check pest population. A sensible approach is needed in this regard and instead of following routine preventive applications need based judicious use of insecticides is suggested

List of pesticides and other options for management of pests and diseases in polyhouses

Name of pest/ disease	Chemicals/ Botanicals
Caterpillar	Emamectin benzoate @ 4ml/10L Chlorantranilipole@ 3 ml/10 L Pheromone traps, Bt formulations
Leaf miner	Chlorantranilipole@ 3 ml/10 L
Thrips	Thiamethoxam @ 0.3 g/L
Mites	Spiromesifen@ 1ml/L
Downy mildew	Mancozeb@2 g/L

4.1.13 Crop protection equipments

a. Manually operated spraying equipments

Hand rotary duster, knap sack sprayer, rocker sprayer

b. Power operated spraying equipments

Single piston, Double piston, HTP and ULV sprayer

Practical Activity

Diagnosis and management of common pests and diseases seen in protected cultivation

ArcGIS : Monitoring software for Polyhouse/greenhouse.

Practical Activity

Visit to commercial Hi-tech farm.

Assessment Activity

1. Conduct a field visit to a high-tech farm and prepare a report on practices followed in a hitech farm. Hints (pests , diseases and nutritional disorders, way of management).
2. Interview a hitech farmer and fill the prepared questionnare. (Questions should cover all aspects which will give a detailed overview of his farm).

4.1.14 Soil less cultivation

Hydroponics

It is the method of growing of plants using mineral nutrient solution without soil. Terrestrial plants will be grown with roots in the mineral solution only or in an inert medium such as perlite or gravel.

Advantages

- Distributes nutrients evenly to each plant.
- There are no weeds to pull.
- Hydroponic plants grow faster.
- Their roots don't have to push through heavy, chunky soil to compete for nutrients.
- Ripen earlier and give up to ten times the yield of soil-grown plants.
- Control over soil borne pests and diseases.

Basic material needed for setting up a hydroponic system

1. **Container** for the nutrient solution.

Container of any shape can be used .The best could be a Styrofoam which holds the temperature of the nutrient solution nicely. Depth should be at least 20 cm to provide enough space for the oxygen absorbing roots.

2. **Covering material** for the box. This is generally a netting material with a spacing of about 3 mm× 2.5 mm. This covering will protect the plants from insect damage and also keeps rainwater from entering the nutrient solution.
3. **Nutrient solution** the most important aspect of the technology . The solution is made up of many basic chemicals which provide the macro as well as micro nutrients.
4. **Seedling medium** like smoked rice hull. This is the rice hull that has undergone a smoking process. Ordinary rice hull isnot effective as a seedling medium. Soil is not recommended either. If smoked rice hull is not available, vermiculite or similar types of seedling medium can be used.

Setting up a hydroponic system

- To begin the box for planting, fillit first about ¾ full of the nutrient solution.
- Prepare the pots for planting. Place a piece of netting on the bottomof the pots.
- This helps to prevent the seedling medium from coming down and separating the root system.
- It also helps in the uptake of oxygenand the absorption of the nutrient solution.
- Net tray rather than pots can be used to plant large root plants such as onions or radishes.
- Fill the pots about three fourth full of seedling medium.
- Then place the pots into the perforated lid of the box.
- Check to make sure that the pots are placed so that the solution is 2-3 cm above the bottom of each pot. Sow the seeds and cover lightly with more smoked rice hull.
- Remember to cover the box with the netting to prevent insect invasion. When it is raining, cover it with plastic to keep out the rainwater. Leave the plants to grow with little care.
- As the plants grow the roots develop in the box. The roots which are exposed to the air are called the O roots and the roots which are submerged are called the WN roots.
- The success of the hydroponic system is dependent on the rapid growth and quantity of these O roots.

Basic requirements for a hydroponic system

a. **Light:** is essential to carry on photosynthesis, without which the cultivation of vegetables is not possible, irrespective of the nutrients you provide.

b. **Oxygen -Nutrient Ratio**: Oxygen maintains a healthy root system and allows the plant to absorb nutrients. In a hydroponic system, the water is a medium through which nutrients and oxygen are fed to the roots.

c. **Nutrient Strength:** Nutrients must be solely designed for hydroponics. Hydroponic systems require solubility as the nutrient delivery system is based upon that factor.

d. **Growth Medium** : In hydroponics, the growing medium, not soil, holds moisture and anchors roots.Composed of inert mineral matter, it won't decompose or harbour potential soil-borne problems. All the plant's nutritional requirements are filled by the nutrient mixes you add to your garden reservoir.

e. **pH - alkalinity and acidity**: pH is the level of acidity or alkalinity of the nutrient solution. Most nutrients in common tap water will be within the range of 6 to 6.5 pH, which is suitable for hydroponic systems.

f. **Temperature:** Requirements for plants in a hydroponics system are the same as out of a hydroponic system.

g. **Air:** Plants require carbon dioxide. Poor ventilation will kill plants. Proper aeration for the roots is important.

h. **Water Quality:** In most situations tap water is just fine for hydroponics systems, may get some mineral build-up, but this is not a major cause for concern. Excessive salinity or high zinc content could be harmful to the hydroponics garden.

Crops cultivated

Almost any plants can be grown. Leafy vegetables such as lettuce, tomatoes, cucumbers, peas, strawberry and herbs.

AQUAPONICS

Integrated farming of fish and farm crops mainly rice, vegetables and flowers is called aquaponic farming. Fish farming coupled with soil less hydroponics is done. This is because fish waste enriches water with plant nutrients and plants provide natural filter for the water in which the fish lives. Microbes present in the media convert ammonia from fish waste into nitrates which plants can easily absorb. Plants are grown organically. In Kerala the vegetables that are successfully grown are

vegetables like lettuce, broccoli, spinach, mint, tomato, ladies finger and brinjal. Two or three vegetables can be taken in a year. Tilapia and Carp fish are best suitable for aquaponics. Prawns, catfish, fresh water mussels can also be grown under this system. Fish feed generally account for a significant part of expenditure in aquaponics which can be reduced by using natural feeds like rice bran, coconut cake, groundnut cake etc.

A small scale aquaponic unit meant for a family having 10000 L water in 435 sq. feet area cost Rs. 50000. From this one can breed 200 Kg fish and can harvest 800 Kg vegetable per annum.

Practical Activity

Familiarization and practicing of Hydroponics.

Assessment Activity

Prepare a comparison chart between hydroponics and aquaponics

TE sample questions

1. "Hitech farming is welcome proposition in Kerala agriculture scenario". Do you agree? Justify.
2. Prepare a table on the classification of polyhouse based on covering material. Give a writeup on any one type.
3. _____ is a type of cultivation in which we can ensure production during offseason.
4. Help a progressive farmer by giving him a list of vegetables which he can cultivate in his new polyhouse.
5. Explain a low cost protected cultivation structure that can be recommended to those farmers who cannot afford the high expenditure incurred in the establishment of high cost protected structures.
6. Prepare a leaflet on plant protection practices to be taken in protected cultivation. (Hint: Major pest and diseases and their management)
7. Climate control is an inevitable aspect of automated protected cultivation. Name the parameters controlled and their respective measuring equipments.
8. Prepare an assignment on type of irrigation followed in protected cultivation.
9. Hydroponics, aquaponics are emerging trends in agriculture. Compare these techniques with examples.
10. Is soil less cultivation of crops a reality. Comment on it with suitable examples.
11. The way of supplying nutrients to crops in protected cultivation is _____.

UNIT 2

PESTICIDES & PESTICIDE RESIDUE MANAGEMENT

Environmental contamination, toxic hazards, terminal residues in food and biomagnification due to misuse and overuse of pesticide is the major problem due to the use of pesticdes. Thus knowledge on pesticides is needed in plant protection for their judicious and responsible usage . This unit will help the students to use the chemicals according to recommendation observing all precautionary principles. The residue left in food products long after their application is pesticide residue. Continuous ingestion of such food stuffs may even lead to diseases like cancer due to the accumulation of such chemicals in our body tissues. People are conscious about the ill effects of pesticide residue in the present scenario of deadly diseases. Hence it is essential to make the people aware of different practical methods to decontaminate the residues from agricultural products. This unit gives an insight into such aspects

Learning outcomes

4.2 Pesticides & pesticide residue management

The learner :

- categorises pesticides and classifies insecticides based on mode of entry, mode of action and chemical nature and enlists the common insecticides.
- compares and classifies the common fungicides and herbicides.
- compares and categorises different formulations of pesticides and pesticide adjuvants.
- enlists new generation pesticides and banned pesticides with their substitutes.
- calculates pesticide formulations for field application.
- classifies pesticide toxicity into acute and chronic and categorises them.
- analyses and interprets the labelling of pesticides and identifies pesticide labels and mentions the Legal regulatory measures regarding pesticide handling.
- describes concept of biomagnification, residual toxicity, maximum residue limit and waiting Period.
- analyses and recommends the precautions to be taken while handling pesticides.
- describes and practices simple methods to decontaminate vegetables from pesticideresidues.

4.2.1 Pesticides

Definition

A pesticide can be defined as any substance used for controlling, preventing, repelling or mitigating any pest. Many chemicals such as attractants, repellents, chemosterilants, hormonal agents etc are also legally designated as pesticides.

4.2.1.1 Classification of Pesticides

- Insecticides – used for killing insects. eg - Ekalux
- Fungicides – used for killing insects. eg - Mancozeb
- Acaricides – used for killing mites. eg - Dicofol
- Weedicides/ Herbicides – used for destroying weeds eg- Glyphosate
- Nematicides – used for killing nematodes eg:- Carbosulphan
- Molluscides – used for killing slugs and snails, eg. Metaldehyde
- Rodenticides – used for killing rodents. eg:- Zinc phosphide
- Algicides- used for killing algae
- Avicides-used for killing birds
- Bactericide- used for killing bacteria
- Piscicide-used for killing fish
- Antibiotics – These are substances which are produced by micro organisms and which act against micro organisms. eg:- Streptomycin.

4.2.2 Classification of Insecticides

Insecticides are classified into certain groups.

- based on mode of entry.
- based on mode of action.
- based on chemical nature.

4.2.2.1 Based on mode of entry into insect system, insecticides are of four types.

i. **Stomach Poison** - It is a toxicant which is ingested by insect and kills the insects by action on digestive system. It is used mainly on chewing insects. These are to be applied on plant parts which become food to insects. Eg - Arsenicals, Fluorides.

ii. **Systemic Poison** - Systemic insecticide is one in which the toxicant penetrates into the plant tissue and get transported in insecticidal quantities from the point of application and making the plant insecticidal. Systemic insecticides are used for control of sucking, insects, leaf miners, tissue borers etc. Eg: - Organo-phosphorus compounds like quinalphos, carbosulfan.

iii. **Contact Poison** - It is a chemical which kills insect by means of contact to the body wall and getting absorbed and penetrated in to body to certain vulnerable sites such as sutures, base of setae etc. eg:- Carbaryl

iv. **Fumigants** - These are chemicals which in its gaseous form enter tracheal system of insects through spiracles and kill the insects. Fumigants are applied to control pest in storage and nematodes which are seen in soil. eg :- Aluminium phosphide (celphos tablets), methyl bromide,hydrogen cyanide etc

4.2.2.2 Based on mode of action, insecticides are of four types

i. **Physical poison** - It is toxicant which brings about lethargy and kills insect by exerting physical effect. The insect will die due to the lack of air or due to the dehydration caused by breaking of cuticle. eg.:- heavy oils, tar oils, Silica Gel, Aluminium powder

ii. **Protoplasmic poison** - It is the chemical which causes precipitation of protoplasm, especially destroys the cellular protoplasm of mid gut epithelium. eg.:- heavy metals like mercury and fatty acids.

iii. **Respiratory poison** - These chemicals block cellular respiration and also inactivates enzymes involved in respiration. eg:- HCN, carbon monoxide, phosphine gas etc.

iv. **Nerve poison** - It is a toxicant which inhibits the nervous system. These chemicals inhibit the enzyme acetyl cholinesterase, which cause continuous stimulation and death of insects. Eg. Nicotine, O. P. compounds.

4.2.2.3 Based on chemical nature, insecticides are of two types

4.2.2.3.1 Inorganic insecticides - are those which do not contain carbon.

i. **Arsenicals** - Arsenicals are stomach poisons They are used as poison baits.eg. lead arsenate,calcium arsenate, sodium arsenate, paris green etc.

ii. **Sulphur compounds**- it is used mainly as acaricide or fungicide. They are prepared as dust and are contact poisons . Powdery mildews, scales, mites and aphids can be controlled by this compound. eg. Wettable Sulphur, lime sulphur etc.

iii. **Flourine compounds**-eg.sodium fluoride, sodium fluo silicate etc.

iv. **Zinc phosphide**- it is used for controlling rodents.

v. **Borax** – it is used for fly maggot control.

4.2.2.3.2 Organic insecticides - are those which contain carbon in their structure.

A. Organic insecticides of plant origin (Botanical insecticides)

i. **Nicotine** - Tobacco was used as an insecticide from 1763. The alkaloid, Nicotine extracted from the leaves of the tobacco plant, *Nicotiana tabacum* is having insecticidal property.It is a nerve poison. Tobacco decoction is used against soft bodied insects with sucking mouth parts(aphids, thrips).

ii. **Pyrethroids:** Chief source of pyrethroids is the plant *Chrysanthemum*. Insecticidal properties are due to the presence of esters pyrethrum and cinerin.

iii. **Rotenones** - Toxic substance contained is rotenone. This is extracted from the roots of a plant *Derris*. It is stomach and contact poison.

iv. **Azadirachtin** – Neem plant is the chief source. Insecticidal properties are due to the presence of alkaloid azadirachtin. Neem seed kernel suspension is sprayed to control locusts. It causes a repellent action. Neem oil and neem oil cake are also having insecticidal properties.

B. Organic insecticides of animal origin

i. **Neries toxin** is separated from marine annelid *Lumbriconeries heteropoda*

C. Hydrocarbon oils

eg. Mineral oil, tar oils etc. Heavy oils are used as a physical poison to control scale insects.

D.Synthetic Organic Chemicals (Modern synthetic chemicals)

- Organochlorines – eg. D.D.T., B.H.C., Dicofol.
- Organophosphorus compound – eg. Dimethoate, Malathion, Quinalphos.
- Carbamates – eg. Carbaryl, Carbosulphan, Thiodicarb.
- Synthetic pyrethroids – Eg. Permethrin, Cypermethrin.
- Fixed soaps and oils – eg. Fish oil soap.
- Fumigants – eg. – Aluminium phosphide.
- Other miscellaneous organic compounds.

i. Organic Chlorine insecticides

- Main constituents are carbon, hydrogen and chlorine. eg. D.D.T(restricted use), B.H.C. (banned).
- D.D.T is a stomach and contact poison. It has longer persistence and residue effect. It affects sensory organs and nervous system of vertebrates and invertebrates. D.D.T. has got affinity towards fatty tissues and lipid tissue. If animals are fed with foliage on which D.D.T. is sprayed it accumulates in the fatty tissues and secreted through milk. D.D.T. cannot be used on cucurbits because it causes phytotoxicity. Use of D.D.T. is banned now.
- Endosulphan (banned) -Stomach and contact poison. It controls aphids, caterpillars, plant bugs and borers. It is not much harmful to honeybees.

ii. Organophosphorus Compounds (OPs)

- Most of the OP compounds are contact and stomach poison. Some have fumigant action also.
- Broad spectrum action. i.e, their action is towards a number of pests, not specific.
- Some of the OP compounds are highly toxic to mammals also. eg – Quinalphos

iii. Carbamates

- Contact and stomach poisons,
- Neurotoxins action similar to O. P. compounds.
- eg. Carbaryl, Carbosulphan etc.

4.2.3 New Generation Pesticides

New molecules of pesticides with comparatively low toxicity to non-target organisms and with better eco – toxicological profile are available now. Many of these 'New generation' pesticides are effective in very low doses and categorized into slightly toxic and moderately toxic groups in toxicity classification. When chemical pesticides have to be recommended for pests and disease control, as far as possible, the green and blue labelled pesticides shall be preferred.

- **Neonicotinoids** eg : Imidacloprid, Acetamiprid.
- **Nereis toxin analogues** eg : Cartap hydrochloride (effective against borers, leaf eaters and sucking insects).
- **Spinosyns and spinosoids** eg: Spinosad.

- **Avermectins :** eg: Emamectin (effective against leaf eating caterpillar, leaf miners, thrips).
- **Ivermectins** : Antiparasitic used against nematodes and ectoparasites in animals.
- **Milbemycins** : Acaricide.
- **Phenyl pyrazoles** : eg: Fipronil (lepidopterans and orthopterans).
- **Oxadiazines** : Indoxacarb- considered as "reduced risk pesticide". Used in cockroach baites.
- **Diamides** : Flubendiamide (leaf miners, feeders, borers), Chlorantraniliprole (leaf feeders).

4.2.4 Insect Growth Regulators

- Chitin synthesis inhibitors –inhibits chitin formation of insects leading to abortive moulting.
- Juvenile hormone mimics – larva moult into superneumerary instars.
- Moulting hormone agonists-disrupt the hormonal balance required for growth, development and metamorphosis.

4.2.5 Insect Chemosteriants

It is a chemical compound which causes reproductive sterility in an organism.

4.2.6 Attractants

Attractants are chemicals which will induce movement towards their source. When insects come they may be killed by insecticides. Eg. Molasses.

4.2.7 Pheromones

It is a chemical produced by an organism which is capable of changing the behavior of another organism of the same species**.** eg. Cuelure.

4.2.8 Insect Repellants

These are chemicals which cause insects to move away from the source. Action is opposite to that of attractants. Eg. Naphthalene, Neem oil etc.

4.2.9 Antifeedants

A chemical agent that causes a pest to stop eating that substance eg: Neem.

4.2.10 Common insecticides

Chemical Name	Trade Name & Formulation	Remarks
Organo-phosphorus compounds 1) Mercaptothion	Malathion 50% EC (BLUE)	Stomach and contact action safe insecticide for controlling pests of vegetables.
2) Quinalphos	Ekalux 25% EC / AF (YELLOW)	Broad spectrum toxicity; particularly effective against mealy bugs and scale insects.
3) Dimethoate	Rogor 30 EC (YELLOW)	Systemic insecticide cum nematicide
5) DDVP	Nuvan 100% EC/AF (YELLOW)	Contact and fumigant, less residual; toxicity lasts for only 24 hours; safer to be applied on vegetables.
Carbamates 1) Carbaryl	Sevin 5% DP (BLUE)	Effective against a wide range of pests. Not recommended for control of mites. Should not be sprayed in crops at flowering.
2) Carbosulphan	Marshal 6 G (YELLOW)	Systemic insecticide cum nematicide
Nereis toxin analogues Cartap hydrochloride	Padan 4% GR (YELLOW)	Rapid knockdown action
Diamide Flubendiamide	Fame, Takumi (GREEN)	Effective against caterpillars (1ml/10L)
Neonicotinoids Imidacloprid	Confidor (YELLOW)	Effective against sucking pests
Thiomethoxam	Actara (BLUE)	Effective against sucking pests

4.2.11 Antibiotics

Antibiotics are substances which are produced by micro-organisms and which act against other micro-organisms. The important antibiotics for the control of plant diseases are Streptocyclin (antibacterial), Aureofungin (antifungal) *etc*.

4.2.12 Fungicides

Fungicides are chemical agents that kills or inhibits the development of the fungus spore or mycelium.

Fungicides are divided in to two.

A. **Inorganic** – contains no carbon eg; Bordeaux mixture, Bordeaux paste, cheshunt compound, Sulphur, Copper oxychloride *etc*.

B. **Organic compounds** – contains carbon. eg synthetic organic fungicides like Carbendazim, Ziram, Mancozeb *etc*.

4.2.12.1 Common fungicides

Generic names	Formulations	Required concentration of spray formulation	Remarks
Copper based products			
Copper oxychloride	Blitox 50 W Fytolan 50 W	0.3-0.4 %	For foliar spray
Copper based products			
Sulphur	Thiovit 80 WP	0.2-0.5 %	For foliar spray against powdery mildew. Also effective against mites.
Carbamates and others			
Mancozeb	Dithane M-45 Indofil M-45	0.2-0.4	Foliar fungicide
Organophosphorus compounds			
Ipropenphos	Kitazin-P 48% EC	0.05% of the formulated products	For foliar spray against blast and sheath blight.
Chlorinated nitrobenzene			
Dinocap	Karathane 25% WP Karathane 48% EC	0.05% spray of 48 EC or 300 g/ha of 25 WP	For foliar spray for powdery mildew control of cucurbits and rose

Heterocyclic nitrogen compounds			
Captan	Captan 75% WP	0.1%	For seed treatment at 1.5 g per kg seed
Systemic fungicides			
Carbendazim	Bavistin 50%WP	500 g/ha	Effective against powdery mildew diseases in ornamental plants; and blast, sheath blight and sheath rot of rice.
Hexaconazole	Contaf 5 EC	750 ml/ha	For foliar spray against sheath blight
Propeconazole	Tilt 25 EC	0.5 to 0.75 ml	For foliar spray against sheath blight
Potassium	Akomin 40%	0.3 %	Effective against Phytophthora foot rot of pepper
Phosphonate Tridemorph	Calixin 80% EC		Coconut stem bleeding
Antibiotics			
Antifungal material	Aureofungin sol	50 g/ha (R)	For foliar spray
Antibacterial material	Agrimycin-100 Plantomycin Paushamycin Streptocycline	750 g in 500 l water (R, OC 15 g in 300 l water (R, OC)	For foliar spray
Validacin 3L	Validamycin A 3%	2 m/l	Control of sheath blight

4.2.13 Herbicides

Chemicals used for weed control.

4.2.14 Classification of herbicides

4.2.14.1 Based on the point of application

i. Soil herbicides.

ii. Foliar herbicides.

iii. Aquatic herbicides.

4.2.14.2. Based on mode of action

i. **Contact herbicides** : They kill the plant or the plant part that comes into contact with the chemical. Eg., Propanil etc.

ii **Systemic / Translocated herbicides** : - These herbicides enter a plant and move within the plant and kill the tissues at a distance from the point of entry (application). eg: 2,4 –D, Glyphosate.

4.2.14.3 Based on time application

i. Pre-plant herbicides - These herbicides are applied to the soil before the crop is planted as they are likely to produce a toxic effect on emerging crop seedlings eg : Calcium cynamide, vapam.

ii. Pre-emergent herbicides – These herbicides are applied after sowing, but before the actual emergence of the crops or weeds. Eg. Butachlor, diuron,atrazine, oxyflurfan etc.

iii. Post-emergent herbicides – These herbicides are applied after the emergence of the weeds. eg. Paraquat, Glyphosate.

4.2.14.4 Based on selectivity

i. **Selective herbicides** - They are selective in action and kill plants of only certain species while plants of all other species survive. eg. 2,4-D (effective on broad leaved plants), dalapon(controls grassy weeds).

ii. **Non-selective herbicide** – They include chemicals which are not selective and controls plants of all species. eg. Glyphosate.

4.2.15 Common Herbicides

Common names	Commercial formulations and concentration	Recommended dose, kg ai/ha	Product per ha	Crops recommended	Hints on time and method of application
a. Selective herbicides					
2,4-D sodium salt	Fernoxone 80% WSP	0.8-1.0	1.0 - 1.2 kg	Rice - for control of broad leaved weeds and sedges.	Apply at 20-25 DAS / DAT
Butachlor	Machete 5% G			Rice - wet sown and transplanted.	Broadcast evenly on soil surface at 7 DAS or at 4- 8 DAT
Oxyfluorfen Cyhalofop butyl	Goal 23.5% EC Clincher 10% EC	0.15 0.08	0.641 800 ml	Rice – dry sown Banana Rice - for control of *Echinochloa* sp.	0-3 DAS Pre-emergent spray Spray 18-20 DAS
b. Non–selective herbicides					
Glyphosate	Roundup 41% SL (Glycel 41% SL Weed All 41%SL	0.8	2.01	Land preparation- Rice, plantation crops, pine apple, banana	For clearing weeds before land preparation

4.2.16 Formulations

Insecticide manufactured in pure form is called technical grade material or active ingredient (a.i). We require a very small amount of technical grade insecticide for a large area. But to apply over a large area it is to be diluted. There fore the pure form is formulated. What we get in the market is the formulated products. Formulation is the processing of a pesticide compound by any method which will improve the properties of storage, handling and safety of the pesticide.

4.2.17 Types of formulations

Formulations are of mainly two types.

4.2.17.1 Dry/ solid formulations

1) **Dust (D or DP- Dustable Powder**) - Dust is prepared by mechanical mixing of technical grade material and carrier compound or by impregnation of the technical grade by very fine powdered carrier. Concentration varies from 1%

to 25%. eg. Sevin 10% Dust

Disadvantage: - it causes drift problem

2) **Granules (G) or (GR)** - are prepared by applying carrier materials and technical grade material on surface of granules. eg:- Quinalphos 5%GR ., Carbosulphan 6%G.

Advantages :

- No problem of drift.
- No residue problem.

Disadvantages:

- Granular formulations are not as effective as others to crawling insects.
- If the concentration is more scorching on burning of leaf occur.

3) **Wettable Powder (W.P.)** - It is prepared by blending technical grade material and carrier with a wetting agent. If the wetting agent is not there, the powder does not mix with water.

4) **Water Dispersible Powder (W.D.P)** - It is like wettable powder. But during spraying agitation is required, otherwise it settle down to bottom.

5) **Water Soluble Powder (S.P) or (WSP)** - Here technical grade material is finely powdered and the formulation is water soluble.

6) **Tracking powders**

These are used for monitoring and controlling rodents and insects. For rodent control, it consists of finely ground dust combined with stomach poison. Rodents pick it up on their feet and fur while walking and ingest it when they clean themselves.

7) **Wettable granules/ Water Dispersable Granules (WG/WDG)**

Once in water , the granules break apart into fine particles similar to wettable powders. This requires constant agitation to keep it suspended in water.

Eg. Fipronil 80 WG

4.2.16.2 Liquid formulations

1) **Emulsifiable Concentrate (E.C)** - It contains toxicant + solvent + emulsifying agent. When E.C is sprayed, solvent evaporates leaving deposits of toxicant.

2) **Ultra low Volume concentrates (U.L.V)** - The technical grade material is dissolved in minimum quantity of solvent so that there is no need of further dilution.

3) **Oil Solution** - It is an oil concentrate which diluted with water before application.

4) **Invert emulsions**

Unlike, EC these are water in oil emulsions. These are thick concentrated emulsions and are generally herbicide formulations.

5) **Solution concentrates (SC)/ Soluble liquids (SL)**

This is made when the technical grade material is miscible with water or alcohol. This formulation ressembles ECs, but do not form milky suspension swhen diluted with water and the spray fluid will be a clear solution.

Eg: Spinosad 2.5% SC

6) **Flowables (F)/ Flowable suspensions (FS)**

Inert substances like clay are ground and impregnated with toxicant. The powder is then suspended in a small amount of liquid . The product is thick and creamy. This formulation is diluted with waterand applied as spray and require moderate agitation.

Eg: Imidachlorpid 48% FS

7) **Foggingconcentrates**

These are used in public health programmes for controlling adult flies and mosquitoes.

4.2.16.3 Other formulations

1.Aerosols

Minute particles suspended in air, as a fog or mist. Toxicant is dissolved in liquefied gas and released through small hole. So toxicant particles float in air with evaporation of released gas. These are the most common of all formulations for home use and are available as ready to use (RTU) low concentration solutions.

2.Fumigants

Insecticides in gaseous state. Usually formulated liquid under pressure, sometimes available in the form tablets. eg:- Celphos tablets, used in godowns. Fumigants are used for the control of stored product pests, soil insects, nematodes, weed seeds, rodents etc. eg: Aluminium phosphide. eg:- Celphos tablets, used in godowns.

3.Insecticide Cum Fertilizer Mixture

This is formulated by mixing granules with chemical fertilizers. It gives nutrients as well as protects plant.

4. Micro en-Capsulated Materials

Insecticides are wrapped in tiny beads made up of poly vinyl or plastic covering when applied insecticides are released at a slow rate for a long time. The plastic coating breaks down and slowly releases the toxicant. Dry or liquid pesticides are covered with plastic coating. This is mixed with water and sprayed.

5.Slow release insecticides

These are very recent formulations.The pesticide incorporated in strips volatalises slowly and control pests over a long period of time. In India, simple adhesive strips are used in UV traps for killing flies, mosquitoes and other flying insects.

6.Water soluble packets

Precise amounts of wettable powder or soluble powder formulations are packaged in special type of plastic bags. When these bags are dropped in water inside spray tanks, plastic dissolves and contents are released.

4.2.17 Pesticide Adjuvants

A pesticide adjuvant may be defined as any substance that when combined with a pesticide increases its sticking, spreading or wetting qualities, makes it safer, aids in its dilution or uniform dispersion and increases its toxicity to the target pests.

- **Sticking Agents**

These substances have the function of increasing the retention of spray or dust deposits on plants. eg - milk products, blood albumin and gelatin.

- **Spreaders and Wetters**

These are substances that lower the surface tension of a spray and therefore increase its spreading and penetrating power.

- **Emulsifying Agents**

Many pesticides are not soluble in water. Since these organic solvents will not normally mix and stay dispersed in water substances known as emulsifiers must be used with them to form stable, milky suspensions of the pesticide. Such a spray is called an emulsion. Emulsifying agents reduce the tendency of an emulsion to break up into its component parts.

- **Safeners or Correctives**

These are substances that are added to sprays to prevent loss of effectiveness or to reduce the danger of foliage injury.

- **Synergists**

These are compounds when used in conjunction with a pesticide; increase the toxicity of the mixture over the sum of the toxicities of its components. Some synergists in use are piperonyl butoxide and sulfoxide.

- **Diluents or Carriers**

A carrier may be any material used to dilute or decrease the amount of active ingredient in any spray or dust. Sulphur is valuable both as a diluent and as a fungicide in many dust formulations.

4.2.18 List of banned pesticides with substitutes

Name of chemical banned	Present Recommendation	Substitute chemicals recommended against banned chemical
Endosulfan (Yellow)	Not recommended by KAU	1. Carbaryl 50%WP 2. Quinalphos 25% EC
Carbofuran (Red)	**Rice** Stem Borer, Gall Midge, BPH, GLH, Hispa, Nematodes	1. Carbosulfan 6 % G 2.Chlorantraniliprole 0.4% G 3. Thiamethoxam 25% WG 4. Flubendiamide 39.35% SC
	Banana Aphid	Dimethoate 30 EC
	Nematodes	Carbosulfan 6% G
	Brinjal (sucking pests)	1. Azadirachtin 1%EC 3. Spinosad 45% SC
	Cardamom Nematodes	Carbosulfan
Phorate (Red)	Rice (Stem Borer, Gall Midge, BPH, GLH, Hispa, Nematodes)	1. Carbosulfan 6% G 2. Chlorantraniliprole 0.4% G 3.Thiamethoxam 25% WG 4.Flubendiamide 20% WG
Methyl Parathion (Red)	**Rice** (BPH, Thrips, Hoppers, bugs, leaf folder)	1. Quinalphos 5%G 2. Thiamethoxam 25% WG 3. Acephate 75 SP
	For stem borer and folder	1. Chlorantraniliprole 18.5%SC 2. Flubendiamide 39.35% SC 3. Flubendiamide 20% WG 4. Acephate 75 SP

Monocrotophos	**Rice** (BPH, Stem borer, Leaf Folder)	1. Quinalphos 25 % EC 2. Chlorpyrifos 20% EC 3.Fipronil 5%SC 4. Thiamethoxam 25% WG
	For Stem borer and leaf folder	1 Fipronil 80% WG Yellow 2 Chlorantraniliprole 18.5%SC 3 Flubendiamide 20% WG
Triazophos (Yellow)	Rice Leaf folder	1. Chlorantraniliprole 18.5%SC 2. Flubendiamide 39.35% SC
Fungicides		
Ediphenphos (Red)	Rice blast, Rice sheathblight, Brown leaf spot, Rice sheath rot	1.Carbendazim 50%WP 2.Kresoxim Methyl 44.3%SC 3. Tebuconazole 25.9%EC
Tricyclazole Yellow	Rice blast	1.Carbendazim 50%WP 2. biocontrol with Pseudomonas
Herbicides		
Paraquat (Yellow)	Non crop situation	1.Glyphosate 41%SL
Anilophos(Yellow)	Rice	1. Butachlor 50%EC 2.Pretilachlor 50%EC
Atrazin (Blue)	Sugarcane	1.Diuron 80%WP
Thiobencarb (Blue)	Rice	1. Butachlor 50%EC 2.Pretilachlor 50%EC

Practical activity

1. Familiarization with common insecticidal formulations.

Materials required : Different insecticide formulations like Dust, Wettable Powder, Emulsifiable Concentrate, Granules, Water Soluble Concentrates, Aqua Flowable etc.

Procedure – Identify and tabulate different formulations of insecticides available in the laboratory.

Conduct a survey to near by insecticide traders and whole sale shops and collect information regarding the chemicals available in the market and tabulate the information.

Complete the following table .

Sl. No	Generic name	Trade name	Formulation & strength	Physical State	Colour code	Toxicity	Chemical group	Manufacturer
1								
2								

4.2.19 Pesticide calculation

4.2.19.1Insecticides

Calculation of quantity of commercial formulation required for given area

a) For all formulations except granules

$$\text{Quantity of commercial formulation} = \frac{\text{Quantity of spray fluid} \times \text{Concentration of spray fluid}}{\text{Concentration of commercial formulation}}$$

b) For granular formulation

$$\text{Quantity of commercial formulation} = \frac{\text{Rate of Application per Ha} \times \text{Area in Ha} \times 100}{\text{Concentration of commercial formulation}}$$

Example :

Calculate the Quantity of Ekalux 25EC required to spray rice cultivated in an area of 2Ha at a concentration of 0.025%?

Volume of spray fluid for 2Ha of rice = 2x500 = 1000 L

Concentration of spray fluid = 0.025%

Concentration of commercial formulation = 25%.

$$\text{Quantity of commercial formulation} = \frac{\text{Quantity of spray fluid} \times \text{Concentration of spray fluid}}{\text{Concentration of commercial formulation}}$$

$$= \frac{1000 \times 0.025}{25}$$

= 1 L

4.2.19.2 Fungicides

For calculations the active ingredient concentration of all commercial fungicides is taken as 100%

Quantity of commercial formulation = (Volume of spray fluid × Recommended conc. of spray fluid in %)

Example

A farmer wants to spray Bavistin 50% WP in the rice field against sheath blight. Prepare 10 lit of 0.3 % spray solution.

Quantity Commercial formulation = Volume of spray fluid × Recommended Conc. of spray fluid in %

Quantity of Bavistin $= \frac{10\ L \times 0.3}{100}$

= 10 x 1000 x 0.3 / 100 (conversion from litre to ml)

= 30gm

4.2.19.3 Herbicides

$$\text{Quantity of herbicide required} = \frac{\text{Rate of application in kg ai / ha} \times \text{Area in ha} \times 100}{\text{Strength of commercial product}}$$

1. Calculate the quantity of Fernoxone 80% WSP required to control broad leaved weeds in 2 ha of rice field at a recommended rate of 1kg ai/ha.

Practical Activity

Calculation and preparation of insecticide solutions for field application.

To develop the ability to find out the quantity of commercial insecticide formulations required for field application through calculation.

Materials required: insecticidal formulation, container, measuring jar, water and sprayers.

Procedure – write down the formulae for the calculation of quantity of pesticides and calculate the required quantity of commercial formulation for field application.

1. Calculate the quantity of Bavistin 50 WP require to prepare 10 L of 0.3% spray solution.
2. Calculate the quantity of Hinosan 50 EC required to prepare 500 l of 0.1% concentrated spray solution.
3. Calculate the quantity of Indofil M -4 5 75% WP required to prepare 1000 litres of 0.2% spray solution.
4. A farmer would like to spray coconut palms infected with Bud rot with Blitox 50 WP at a concentration of 0.3%. He needs 100L of spray solution. Calculate the quantity of fungicide required?

4.2.20 Pesticides and Toxicity

Toxicity of a pesticide is the measure of its ability to cause injury or harmful effects on the target and non- target organisms. It is determined by subjecting test animals to varying dosages of the toxicant and its formulated products for varying lengths of time.

4.2.20.1 Acute toxicity

It refers to the pesticide's ability to cause injury/ adverse effects to man or animal from a single exposure/dose or from multiple exposures in a short span of time(less than 24 hrs) by any of the four routes ie. Oral, dermal, inhalation or eyes. It is measured as LD 50 or LC 50 values.

4.2.20.2 Chronic toxicity

Chronic toxicity refers to the adverse health effect of a pesticide upon repeated exposure often at low levels over long period.

The harmful effects are known as chronic effects which include birth defect, toxicity to foetus, production of malignant or benign tumours, genetic change, blood disorder, nerve disorder, impaired liver function, endocrine disruption, reproduction effects etc.

4.2.21 LD 50 (Lethal Dose) value

of an organism is the amount of poison per unit weight of the organism required to kill 50 % of the population and is usually expressed as milligram per kilogram(mg/ kg) body weight.

4.2.22 Toxicity Categories

Based on the toxicity to higher animals, pesticides are classified into four categories.

4.2.23 Pesticide Labels and labelling

4.2.23.1 Label - means any printed, written or graphic matter on the immediate package or any such material accompanying the insecticide.

Label	Name	Level of toxicity	Oral lethal dose mg per kg body weight of test animal	Listed chemicals
	Red label	Extremely toxic	1-50	Monocrotophos, zinc phosphide, ethyl mercury acetate, and others.
	Yellow label	Highly toxic	51-500	Endosulfan, carbaryl,[2] quinalphos,[2] and others.
	Blue label	Moderately toxic	501-5000	Malathion, thiram, glyphosate,[2] and others.
	Green label	Slightly toxic	More than 5000	Mancozeb, oxyfluorfen, mosquito repellant oils and liquids, and most other household insecticides.

According to the provisions of the Insecticides Act, 1968, it is mandatory that all pesticides should possess a label. Every pesticide manufactured/ formulated in India should be packed in a safe container and provided with a label displaying all the relevant information regarding the pesticide.

4.2.23.2 Manner of labeling

The label should contain information like,

1.Name of the pesticide

There are 3 distinct names for every pesticide.

i) Common name (Generic Name) : It is a name given to a pesticide to identify it globally. The common name should give an indication about the chemical identity of the product. Eg: Mancozeb, Quinalphos, Imidacloprid.

ii) Trade Name, brand name or commercial name; It is the name given by the manufacturer / formulator of the product highlighting their interests.

iii) Chemical name(scientific name): It is the name given to a pesticide indicating clearly the chemical nature of the product. Eg: Carbaryl- 1-Naphthyl –methyl-carbamate.

2. Name of manufacturer.
3. Registration Number.
4. Kind and name of active ingredient and its percentage contents.
5. Net content/Volume.
6. Batch No.
7. Expiry date.
8. Antidote statement *etc.*

4.2.24 Legal regulatory measures regarding pesticide handling

According to the Insecticide act 1968, Insecticide rules 1971 and its amendments in 1977, no person is permitted to stock, exhibit for sale or distributes any insecticide unless it is packed and labelled in accordance with the provisions of the act.

4.2.25 Biomagnification

Biomagnification is the bioaccumulation of a substance up the food chain by transfer of residues of the substance in smaller organisms that are food for larger organisms in the chain. It occurs when a chemical becomes more and more concentrated as it moves up through a food chain.

Eg. DDT, cyclodienes, like aldrin, endrin, chlordane, heptachlor.

For the biomagnification to occur, the pollutant must be long-lived,mobile,soluble in fats and biologically active.

4.2.25.1 Bio magnification Hazards

There are three main types of hazards associated with fresh produce.

- Biological hazards (caused by food borne microorganisms).
- Chemical hazards (Pesticides, fertilisers, antibiotics, heavy metals, oils).
- Physical hazards (foreign bodies like residual soil and stone, remains of packaging, glass and sharp objects).

4.2.25.2 Ill effects of biomagnification

- Insect resistance to pesticides.
- Shell-thinning in birds, particularly carnivorous birds.
- Life threatening diseases.

4.2.26 Residual toxicity:

Residual toxicity is the presence of pesticide residue in any specified substances in food, agricultural commodities, or animal feed resulting from the use of a pesticide. The term includes any derivatives of a pesticide, such as conversion products, metabolites, reaction products, and impurities considered to be of toxicological significance. The concentration is generally expressed in parts per million (ppm) or parts per billion (ppb).

The toxicity of a pesticide is its capacity to cause injury to a living system, may be a human body, or parts of the body (such as the lungs or the respiratory system); a pond, a forest and those creatures that live there.

The toxicity of a pesticide is dependent on a number of factors.

1. Dose: It is the quantity of a pesticide that a surface, plant, or animal is exposed to.
2. Time: How often the exposure occurs.

Thus, the how much of the substance is involved and how often the exposure to the substance occurs gives rise to two different types of toxicity - acute and chronic toxicity.

4.2.27 Maximum residue limits (MRL)

Maximum residue limit may be defined as the maximum levels of pesticide residue present in or on a produce when pesticide is used under supervision following Good Agricultural Practices (GAP). The concentration is expressed in milligrams of pesticide residue per kilogram of the commodity. Pesticide residues on crops are monitored through the use of **Maximum Residue Limits** (MRL), which are based on the analysis of the quantity of a given chemical remaining on food product samples.

4.2.28 Waiting period (WP)

It is the time gap between the application of a pesticide and harvest of a produce to reduce its toxicity to a safe level. It is the period of time given for a pesticide to degrade and reduce its level of toxicity to a safer level after its application. Waiting period depends on the chemical, crop treated, dose and method of application.

Pesticide	Crops	WP
Quinalphos	Bhindi	3 days
	Bittergourd	5 days
	Black pepper	12 days

4.2.29 Precautions to be taken while handling plant protection chemicals

Most of the poisoning results from careless handling of pesticides. Accidents can be avoided if safety measures are strictly followed.

1. Keep the insecticide in closed and properly labeled container in a dry and cool place, away from food, fodder *etc*. and in a place where children and animals cannot reach.

2. Use insecticide according to the instructions given on the container or leaflet and adhere to the dosages recommended.
3. Children or domestic pets should not be allowed near the mixing place and do not mix the chemicals near open wells used for drinking purposes.
4. Persons handling insecticide should avoid contact of the insecticide with their skin and inhalation of dust, vapours or mist. The minimum precaution of wearing rubber gloves and covering the eyes and nose should be taken.
5. The operators must not smoke, eat or drink anything while applying the chemical.
6. Empty bottles should be destroyed immediately after use by burying in soil.
7. After finishing the work they should take a bath or wash their hands and face with soap and water thoroughly and change their cloths.
8. The cloths worn by them during spraying operations should be washed properly and seperately.
9. Spraying or dusting must not be done when the wind is high.
10. Clogged nozzles or hoses must not be blown out with mouth for clearing.
11. Workers regularly engaged in spraying oprations must under go frequent medical checkups.
12. If any symptoms of poisoning is noticed immediately contact doctor.

4.2.30 Pesticide residue decontamination

The following practices/ treatments were evaluated for their efficacy in removing residues of the insecticides detected in fruits and vegetables.

- Common salt 2% (20 g of common salt dissolved in one litre of water).
- Tamarind 2% (20 g of preserved tamarind pulp extracted in one litre of water).
- Vinegar 2% (20 ml of vinegar diluted in one litre of water).
- Slaked lime 2% (20 g of hydrated lime dissolved in one litre of water).
- Baking soda 2% (20 g of baking soda ($NaHCO_3$) dissolved in one litre of water).
- Turmeric 1% (10 g of turmeric powder dissolved in one litre of water).
- Scrubbing for 2 minutes.
- Washing in water and steaming for 10 minutes.
- Washing in water for 10 minutes.
- Peeling/Removal of skin of fruits and vegetables.
- Use of u.v radiation.

Fruits of the crops harvested can be dipped in the decontaminating solutions for 20 minutes and then washed in running water.

4.2.30.1 Simple methods to remove pesticide residues from vegetables

i. Coriander leaf

Cut and remove roots with basal portion of the stem and keep in the refrigerator inside a plastic container covering the leaves with tissue paper or wide threaded cloth. Immerse in diluted vinegar (20 ml of vinegar in one litre of water). Or salt solution (20 g salt in one litre of water) for10 minutes and wash in water repeatedly before use.

ii. Carrot, Drumstick, Beetroot

Wash repeatedly and keep in a container with holes overnight for draining water. Wipe off moisture and keep in the fridge covering the vegetables with cotton cloth. Scrape off the skin and wash again before use.

iii. Curry leaf, Mint leaf, Chillies add other Capsicum spp

Immerse in diluted vinegar(20 ml of vinegar in one litre of water), tamarind water (20g tamarind in one litre water and filtered) or tamarind paste mixed in water (two table spoon tamarind paste in one litreof water) for ten minutes. Wash repeatedly and keep in a container with holes overnight for draining water. Keep in the refrigerator inside a plastic container covering the leaves with tissue paper or wide threaded cloth. Remove the stalks of chillies and other capsicum spp. before keeping in fridge.

iv. Cowpea, Bean, Snake gourd,Bitter gourd, Bhindi

Wash repeatedly by scrubbing the surface using a soft scrub pad. Immerse in diluted vinegar, tamarind or tamarind paste water for ten minutes. Wash again repeatedly, wipe off moisture and keep in the fridge.

v. Amaranthus

Cut and remove roots with basal portion of the stem and immerse in diluted vinegar, tamarind or tamarind paste water for ten minutes. Wash again repeatedly, wipe off moisture and keep in the fridge.

vi. Gooseberry, Coccinia

Immerse the fruits in diluted vinegar, tamarind or tamarind paste water for ten minutes. Wash again repeatedly, wipe off moisture and keep in the fridge.

vii. Cabbage, Onion

Remove outer skins/leaves and wash repeatedly in water before use. (the vegetables can be kept in containers with holes for short durations if fridge is not available)

Assessment Activity

1. Prepare a brochure to create awareness on chemical and bio magnification hazards.
2. Prepare an article on safe practices in handling pesticides for a leading Agricultural magazine

Practical Activity

1. Preparation of labels for pesticides.

Materials required – Pesticide samples, Class note, CDs etc.

Procedure - Observe the pesticide samples to get an idea about the details to be incorporated to a label, and then prepare your own labels with following details.

Name of insecticide (both generic/chemical name and trade name).

Name of manufacturer.

Toxicity label.

Kind and name of active ingredient, formulation and its percentage contents.

Net content/Volume.

Required graphics.

Precautions

Antidote statement etc.

2. Familiarisation with common new generation pesticides and their formulations available in the market.

Materials

Insecticides, fungicides, acaricides, weedicides

Activity

Conduct a visit to nearby pesticide shop, collect information on new generation pesticides, classify them into different groups and complete the table.

Details of plant protection chemicals collected.

Sl. No	Trade name	Generic name	Formula	Colour code	Toxicity level	Type of pesticide	Chemical group	Manufacturer
1								
2								

TE sample questions

1. Pesticide residue toxicity and its ill effects on environment is a topic of serious discussion in media nowadays. Give your views on this.
2. Biomagnification has resulted in banning of many popular effective insecticides used in crops previously. Explain it with a suitable example.
3. A firm would like to manufacture 50 EC formulation of a slightly toxic insecticide. Design a label for the product.
4. The waiting period of Quinalphos 50EC in Bitter gourd is 5 days. Explain it to a farmer.
5. The maximum permissible level of an insecticide on a food stuff is termed as…….

   (Residual toxicity, waiting period, maximum residual limit, ETL).
6. Prepare a leaflet on "precautions to be taken on handling of pesticides" to distribute among farmers.
7. You are entrusted to make a powerpoint on the ways to eliminate pesticide residue on vegetables and fruits. Prepare the same.

Assessment activities

1. Prepare a chart on classification of insecticides based on mode of entry, mode of action and chemical nature
2. Survey to a pesticide shop to get familiarized with the pesticides, pesticide labels and their formulations available in the market and prepare the list of pesticides with their price.
3. Prepare a chart on different types of formulations of pesticides
4. Prepare a chart showing list of new generation pesticides and banned pesticides with their substitutes
5. Picture album of ten different labels of pesticides and classify them according to their toxicity.

UNIT 3
Organic certification

Organic certification addresses a growing worldwide demand for organic food. To assure quality and prevent fraud organic certification is necessary. For organic producers certification identifies suppliers of products. Since organic certification regulates and facilitates the sale of organic products it can definitely it is a definite solution for tackling the illeffects arosen due to the indiscriminate use of pesticides and other chemical inputs in agriculture.

Learning ouctomes

The learner :

- defines organic certification, enlists the production standards and explains the purpose of organic certification.
- narrates the process of organic certification and describes product labelling.
- describes organic certification in India and enlists the organic certification agencies.
- defines Good Agricultural Practices (GAP) and explains its objectives and principles.
- narrates the importance of Information communication technology (ICT) in agriculture.

4.3 Organic certification

4.3.1 Definition

Organic certification is a certification process for producers of organic food and other organic agricultural products. In general, any business directly involved in food production can be certified, including seed suppliers, farmers, food processors, retailers and restaurants.

Certification is a procedure by which a third party gives a written assurance that a product, causes or service is in conformity with certain standards.

4.3.2 Production standards for organic certification

Organic standards are defined as minimum production practices including storage, transportation, processing, handling, packing and labelling requirements which must be followed for certifying the products as organic.

1. avoidance of synthetic chemical inputs (e.g. fertilizer, pesticides, antibiotics, food additives), irradiation and the use of sewage sludge.
2. avoidance of genetically modified seeds.
3. use of farmland that has been free from prohibited chemical inputs for a number of years (often, three or more).
4. for livestock, adhering to specific requirements for feed, housing and breeding.
5. keeping detailed written production and sales records (audit trail).
6. maintaining strict physical separation of organic products from non-certified products.
7. undergoing periodic on-site inspections.

4.3.3 Purpose of certification

- Organic certification addresses a growing worldwide demand for organic food.
- It is intended to assure quality and prevent fraud.
- Organic certification improves the image of organic agriculture and provides transparency in certification. For gaining consumer's confidence, valid organic certification is an essential pre-requisite for marketing especially in the export market.
- Generally organic certification involves many standards, inspection and certification.

4.3.4 Process of organic certification

Certification process focuses on the methods and materials used in production. There are two main requirements.

1. The methods and materials used in production must meet organic standards.
2. There must be clear and ongoing documentation of these methods and materials.

To certify a farm, the farmer is typically required to engage in a number of new activities, in addition to normal farming operations:

- **Study** the organic standards, which cover in specific detail what is and is not allowed for every aspect of farming, including storage, transport and sale.
- **Compliance** — farm facilities and production methods must comply with the standards, which may involve modifying facilities, sourcing and changing suppliers, etc.

- **Documentation** — extensive paperwork is required, detailing farm history and current set-up, and usually including results of soil and water tests.
- **Planning** — a written annual production plan must be submitted, detailing everything from seed to sale: seed sources, field and crop locations, fertilization and pest control activities, harvest methods, storage locations, etc.
- **Inspection** — annual on-farm inspections are required, with a physical tour, examination of records, and an oral interview.
- **Fee** — an annual inspection/certification fee (currently starting at $400–$2,000/ year, in the US and Canada, depending on the agency and the size of the operation). There are financial assistance programs for qualifying certified operations.
- **Record-keeping** — written, day-to-day farming and marketing records, covering all activities, must be available for inspection at any time.

4.3.5 Product Labelling

Being able to put the word "organic" on a food product is a valuable marketing advantage in today's consumer market. Certification is intended to protect consumers from misuse of the term, and make buying organics easy. However, the organic labelling is made possible by certification.

In many countries organic legislation defines **three levels of organics**. Products made entirely with certified organic ingredients and methods can be labelled **"100% organic".** Products with 95% organic ingredients can use the word **"organic"**. Bothmay also display organic seal. A third category, containing a minimum of 70%organic ingredients, can be labelled **"made with organic ingredients".** In addition, products may also display the logo of the certification body that approved them.

4.3.6 Organic certification in India

To provide a focused and well directed development of organic agriculture and quality products, Ministry of Commerce and Industry, Government of India, launched a National Program on Organic Production (NPOP) in the year 2000, which was formally notified in October 2001 under the Foreign Trade & Development Act (FTDR Act). This document provides information on standards for organic production, systems criteria and procedures for accreditation of Inspection and

Certification bodies, the national organic logo and the regulations governing its use. The standards and procedures have been formulated in harmony with international standards such as those of Codex and IFOAM.

These make it mandatory that all certification bodies whether international or foreign operating in the 150 countries must be accredited by an Accreditation Agency.

ORGANIC LOGO A trademark – "India Organic" will be granted on the basis of compliance with the National Standards for Organic Production (NSOP). Communicating the genuineness as well as the origin of the product, this trademark is owned by the Government of India. Only such exporters, manufacturers and processors whose products are duly certified by the accredited inspection and certification agencies, will be granted the licence to use of the logo which would be governed by a set of regulations.

"India Organic"- Symbolizing the rhythm of cosmic and earth forces represented by the blue and brown waves of force and energy, 'India Organic' logo celebrates the essence of nature.

4.3.6.1 Six accreditation agencies in India

1. Agriculture Processed Food Products Exports Development Authority (APEDA).
2. Coffee Board.
3. Spices Board.
4. Coconut Development Board.
5. Tea Board.
6. Directorate of Cashew and Cocoa Development.

APEDA has recognized the following Inspection Certification bodies, all of these are able to certify based on the NPOP:

- BVQ1 (India) Pvt. Ltd (Mumbai).
- E cocert (Aurangabad).
- IMO control private limited (Bangalore).
- Indian organic certification agency (Indocert, Aluva).
- International Resources for farmer trade members.
- Lacon quality certification Pvt. Ltd (Theepany, Kerala).

- National organic certification Association Pvt. Ltd (Pune) .
- One Cert Asia Agri Certification Pvt. Ltd (Jaipur).
- SGS India Pvt. Ltd (Gurgaon).
- Skal International (Bangalore).

4.3.7 Good Agricultural Practices (GAP)

There are numerous systems that growers can adopt to ensure safe food production, w*hich* include Good Agricultural Practices (GAP), Good Manufacturing Practices (GMP), Hazard Analysis Critical Control Points (HACCP) and Good Hygiene.

Definition

Good Agricultural Practices is acollection of principles to apply for on-farm production and post-production processes which results in safe and healthy food and non-food agricultural products. GAP are specific methods which, when applied to agriculture, create food for consumers or further processing that is safe and wholesome.

4.3.7.1 Objectives

1. Ensuring safety and quality of produce in the food chain.
2. Improving natural resources use, workers health and working conditions.
3. Creating new market opportunities for farmers and exporters in developing countries.

4.3.7.2 Principles of Good Agricultural Practices for Selected Agricultural Components

i. Soil

Good practices related to soil include maintaining or improving soil organic matter through crop rotations, manure application, pasture management and other land use practices, conservation tillage practices.

ii. Crop Protection

Use resistant cultivars and varieties, adopt organic control practices, apply pest and disease forecasting techniques, promote integrated pest management (IPM).

iii. Water

Good practices related to water will include those that maximize water infiltration and practices that avoid contamination of water resources.

iv. Crop and Fodder Production

Good practices related to crop and fodder production will include selection of cultivars and varieties with high productivity, quality, market acceptability and nutritional value, disease and stress resistance etc.

v. Harvest and On-farm Processing and Storage

Good practices related to harvest and on-farm processing and storage will include.

- clean and safe handling for on-farm processing of products.
- use recommended detergents and clean water for washing.
- store food products under hygienic environmental conditions.
- pack food produce for transport in clean and appropriate containers.
- training of staff for giving awareness on personal health and hygiene .
- proper maintenance of equipment.

Practical activity

1. A progressive farmer practicing organic farming wants to apply for crganic certificate to ensure actual price for his organic produce as per organic standards. Help him by giving him a list of certifying agencies and explaining the procedure for getting organic certification.
2. To certify a farm and its products as organic several procedures have to be followed and inspected. Give a brief note.
3. Safe and wholesome food for consumption is the right of consumers. GAP is the term associated with this. Explain its significance.

Assessment activity

1. Group discussion on concepts and relevance of organic certification.
2. Seminar on Organic certification (purpose of organic certification, organic certification agencies, process of organic certification).
3. Visit to an organic produce outlet to collect details on product labelling.
4. Assignment on organic certification in India.
5. Assignment on Good Agricultural Practices (concepts, objectives, key elements, potential benefits).

TE questions

1. A progressive farmer practicing organic farming wants to apply for crganic certificate to ensure actual price for his organic produce as per organic standards. Help him by giving him a list of certifying agencies and explaining the procedure for getting organic certification.
2. To certify a farm and its products as organic several procedures have to be followed and inspected. Give a brief note.
3. Safe and wholesome food for consumption is the right of consumers .GAP is the term associated with this. Explain its significance.

4
ICT Enabled extension services in agriculture

In present scenario of Agriculture farmers need accumulation and integration of knowledge and information from diverse sources. Inorder to make credential, accurate and rational decisions farm managers need speedy access to advise on agricultural problems which should be timely, reliable and consistent. The unit gives an overview on ICT enabled extension services related to agriculture such as popular agri extension related softwares, decision support systems , pest, disease and nutrient deficiency diagnose softwares, ICT enabled crop health clinics and farmer support schemes

Learning outcomes

The learner :

- narrates the importance of Information communication technology (ICT) in Agriculture.
- practises the common holistic, specific and diagnostic information systems .
- practices various kiosk based and mobile phone based information systems
- narrates other areas of ICT in agriculture.
- identifies the various farmer support schemes in Kerala.

4.4 ICT enabled extension services in agriculture

4.4.1 Importance of ICT in Agriculture

The farmers need timely information on what to produce, when to produce, where to produce and how to produce. They also need timely and reliable solutions to the problems which they encounter during the various stages of crop production . Information and decision support system has been recognized as a powerful tool to store human knowledge in computers for the purpose of making expert's knowledge available to users.

ICT stands for " Information and Communication Technology". It refers to technologies that provide access to information through telecommunication.

4.4.2 Information and Decision Support System (DSS)

Information systems provide content mostly as you are reading a book. The decision support system (DSS) takes inputs from users and guides them to arrive at the right decision. The diagnosis of a pest problem based on structured questions and photos forms an example for DSS.

4.4.2.1 Holistic Information Systems

1. **Harithakeralam:** *www.celkau.in*

- developed by Kerala state IT Mission in 2004.
- covers over 50 major crops of Kerala and contains a number of animated videos.

2. **Kissan Kerala Information System :** *www.kissankerala.net.*

- covers basic details on over 100 major crops of Kerala.
- the online 'fertilizer advisor' and 'contact an expert' forms the uniqueness of the system.
- a collection of FAQs are also maintained.
- the project is run by Department of Agriculture and IIITM-K.

3. **Karshikajalakam :** *www.celkau.in*

- covers details of major crops, animals and fisheries aspects.
- a pest doctor and crop calendar makes the information system still relevant.
- small video clipping were used to depict real field situation.
- developed by KAU originally as a CD version.

4.F**arm Extension Manager**: *www.farmextension manager.com*

- covers the major five crops of Kerala in detail.
- it has an online fertilizer calculator, pest doctor, management guide, irrigation advisor, crop planner etc.
- agri-business and veterinary aspects are also covered.
- developed by KAU and DRISHTI.

5. **KAU Agri-infotech Portal** : *www. celkau.in.*

- detailed information on important crops of Kerala besides fisheries and veterinary aspects.
- the KAU Fertulator, KAU E-Crop Doctor and media gallery make the portal unique.
- developed by Center for E-Learning, KAU, Vellanikkara.

6. **TNAU Portal:***www.agritech.tnau.ac.in*

- information on all round production aspects of a number of agricultural crops.
- the voluminous nature and the correct description of managementl measures under plant protection make the information system unique.

9. TNAU Agritech Portal: *www.agritech.tnau.ac.in*

- provides detailed information on all round production aspects of a number of agricultural crops.

10. Farmer Portal : *www. farmer.gov.in*

- national portal on agriculture maintained by the Government of India.
- contains region specific information on seeds, fertilizers, pesticides, machineries

11. AGMARKNET Portal:*www.agmarknet.nic.in*

- provides information on price and arrival of important agricultural commodities on a daily basis across the country.

4.4.2.2 Specific Information Systems

1. Flowering plants of Kerala:

- done by Kerala Forest Research Institute, Peechi.
- it contains botanical information on over5000 plants of Kerala with good quality photos.
- CD version is available at KFRI, Peechi for sale.

2. Fruitipedia: *www.fruitipedia.com*

- encyclopedia of edible fruits of the world developed by DrChiranjitParmar.
- contains detailed information on over 452 fruit plants identified across the world.

3. Medicinal and aromatic plants:

- contains details about over 300 medicinal plants of Kerala

- the CD can be purchased from The Aromatic and Medicinal Plants Research Station, Odakkali.

4. Flowers of India : *www.flowersofindia.net*

- online website on flowers.
- contains the largest collection of garden plants with good quality photograph.

5. Farmer advisory and KM system for Hi-tech agriculture:*www.keralahitechagri.in*

- a new initiative from Department of Agriculture, Government of Kerala.
- users can login and get connected with all poly house growers in Kerala.
- users can contact experts to solve field problems.

6. **ATMA Kerala:***www.atmakerala.in*

- developed by the department of agriculture.
- an information system for displaying innovations and success stories of ATMA from various districts.
- the monthly technical advisory from various districts, the field trials conducted, the farmers' field school etc is uploaded in this website.

4.4.2.3 Diagnostic and Calculation Tools

1. Crop Health Decision Support System: *www.kissankerala.net*

- this software covers plant protection aspects of major crops of Kerala.
- good quality original photos with comprehensive management recommendation are the salient feature.
- the problem identification is done through photographs.This software is developed by a team of KAU scientists.

2. Pest doctor: *www.farm extensionmanager.com*

- this tool under follows a three step inverted tree diagnostic methodology.
- diagnosis starts from the basic plant part where symptoms are noticed. Based on elements of visual perception narrowing of choices is achieved.
- a detailed information sheet on each problem is included.

3. Online rubber clinic : *clinic.rubberboard.org.in*

- developed by rubber board

- the tool helps to arrive at the problems in rubber cultivation through a series of questions and photographs.

4. **KAU Fertulator**:

- the tool helps to have the fertilizer recommendation for all the crops covered in the package of practice.
- the specialty of the tool is that the recommendation will be available for all the commonly used fertilizers.
- the users have to download the software

5. Soil based plant nutrient management information system : *www.keralasoilfertility.net*

- an outcome of a major project that stores the database of soil fertility data of almost all panchayats of Kerala.
- Can be logined with user name and password only.

6. KAU E -Crop Doctor: *the www.celkau.in*

- helps to have a realisticestimation of thequantity of pesticidesrecommended for the crop plants of Kerala.
- the details of tradename and quantity for various units can be easily taken from the information system.
- the users have to download the software.

7. Credit C alculator: *www.farmextensionmanager.com*

- a realistic estimate of the eligible finance under crop loan component from nationalized banks.
- developed based on the concept of scale of finance, the software also takes care of the loan for intercrops as well.
- the final repayment amount with the interest portion is worked automatically based on the area of cultivation.

8. Fertilizer Calculator:

- The newly developed tool under farm extension manager has over 200 recommendations of almost all plants covered in the package of practice of KAU.
- The online tool facilitates you to modify the blanket recommendation according to soil test values.

- the final recommendations can be taken in the form of straight or complex fertilizers.

9. Pesticide calculation:

- available under farm extension manager
- helps to have the recommended pesticide crop wise and pest wise.
- facilitates sorting based on trade name, label colour, type of formulation chemical name.
- the dosages are given per liter, per acre basis with needed spray volume.

10. Oushadham: *www.ctcri.org*

- an online disease and pest diagnostic developed from CTCRI, Trivandrum.
- the online system with the help of photos and systematic reasoning procedure arrive at the problem.
- the control measures are also included.

4.4.2.4 Kiosk Based Information Systems

1. Agricultural Kiosk:

- developed by scientists of KAU, covers around 10 crops and cover all aspects of crop production.
- implemented in the Kiosks promoted Department Agriculture, by the of Government of Kerala.
- copy of the software can be obtained from Extension Department, College of Agriculture, Vellayani.

2. Nelkrishi.com:*www.farmextension manager.com*

- developed by a team of KAU scientists exclusively for touch screen kiosk.
- contains information on rice cultivation.

3. **Vegetable cultivation:** *www.celkau.in*

- developed by Green Touch Media, Trivandrum for the Department of Agriculture, Government of Kerala,
- the DVD contains information with video clippings on around 15 vegetables.
- the organic production aspects are also well taken care off.

4.4.3 Mobile phone based ICT services

4.4.3.1 Kissan Call Center

The Department of Agriculture & Cooperation (DAC), Ministry of Agriculture, Govt. of India launched Kisan Call Centers on January 21, 2004 across the country to deliver extension services to the farming community.

The main aim of the project is to answer farmers' queries on a telephone call in their own dialect. These call Centres are working in 14 different locations covering all the States and UTs. A countrywide common eleven digit Toll Free number 1800-180-1551 has been allotted for Kisan Call Centre. This number is accessible through mobile phones and landlines of all telecom networks including private service providers. Replies to the farmers' queries are given in 22 local languages.

Call center services are available from 6.00 am to 10.00 pm on all seven days of the week at each KCC location. Kisan Call Centre agents known as Farm Tele Advisor(FTAs), are graduates or above (i.e. PG or Doctorate) in Agriculture or allied (Horticulture, Animal Husbandry, Fisheries, Poultry, Bee-keeping, Sericulture, Aquaculture, Agricultural Engineering, Agricultural Marketing, Bio-technology, Home Science etc. and possess excellent communication skills in respective local language.

Queries which cannot be answered by Farm Tele Advisor (FTAs) are transferred to higher level experts in a call conferencing mode. These experts are subject matter specialists of State Agriculture Departments, ICAR and State Agricultural Universities.

4.4.3.2 Voice SMS based service

The voice SMS facility overcome the language barriers in the text based SMS. Here the message is normally given as voice for 60 seconds. There are many initiatives in this direction. The Department of Agriculture, Government of Kerala has initiated a programme of sending voice- SMS to farmers. The content information was developed by Kerala Agricultural University and the technical side was looked by IIITM-K, Trivandrum. The message was send on Monday and Thursday at 7 AM free of cost. The reach of message was up to 1 lakh farmers. One has to register at the Krishi Bhavan for getting the service.

IFFCO Kisan Sanchar Limited

IFFCO Kisan Sanchar Limited is a joint venture between the telecom network operator Airtel and the Indian Farmer's Fertilizer Co-Operative Limited (IFFCO). In addition to crop advice and the weather, IKSL provides advice on animal husbandry, rural health initiatives, and the availability of products such as fertilizers.

Members of the service receive five voice messages a day with agricultural information and advice; they also have free access to a dedicated agricultural help line. For details refer at *www.iksl.in.*

mKisan SMS Portal for farmers enables all Central and State government organizations in agriculture and allied sectors to give information/services/advisories to farmers by SMS in their language, preference of agricultural practices and location. Farmers can register themselves for receiving these messages on their mobiles as per their need.

4.4.4 Other Areas of ICT in Agriculture

A. E-learning platform

The development in e-learning platform helps to redefine the distance education programmes. The course materials that were earlier send through post now reach the students online. There can have better tutorials with animated video and text. The students can contact the expert or participate in various discussion forums online. Further, real time objective evaluation process can also be introduced.

The Centre for e-Learning of Kerala Agricultural University offers e-Krishi Patashala online courses. "Organic Agricultural Management", "Plant Propagation and Nursery Management", "Post Harvest Management and Marketing of Fruits and Vegetables" are the three online courses. The six months duration courses are offered in English.

B. Video and TV Programmes

Farm videos form another major area of ICT application in agriculture. Kissan Kerala project itself has uploaded over 450 videos on agriculture. These videos give a true representation of real life situation. All major news and entertainment channels are broadcasting farm programs. To know about the programme schedule and details, the media link under *www.celkau.in* is very much useful. And to contact any media person the Media Handbook 2014 available online and published by Information & Public Relations Department, Government of Kerala will be greatly useful.

C. Radio and Other Wireless Technologies

Wireless technologies have numerous applications in agriculture. A number of AM and FM stations are functioning in Kerala under private and public sector. These stations telecast a number of farm programmes at regular intervals.

Community radio is another innovation in this direction. Community radioprovides a mechanism for facilitating individuals, groups, and communities to tell their own diverse

stories and to share experiences. Radio Mattoli (90.4 FM) is the first Community Radio Service of Kerala operating at Wayanad District. It provides farmers, tribes, dalits, women and children an opportunity to speak out, and be heard. As of now, nine community radio stations got registration from ministry of broadcasting to run in Kerala.

D. Community Learning Centers

The opening of community learning centers and running various educative programmes by them is a move happened with the progress in ICT. In the Wayanad district of Kerala, six village resource centers are operating. These centers are connected through local cable networks and offering video conferencing facility.

Experts who are far away can handle a training section through video conferencing facility. The listeners can ask question and interact with various other groups through the facility. The topic covered never restrict with agriculture. A number of health and nutritional topics are also been covered.

E. Computer-controlled Devices

Farming is now moving from subsistence to precision. And in precision farming a number of automated systems and application find a place. Just like a sphygmomanometer measuring the blood pressure, automatic pH meters measuring soil pH are now available. Similarly, with computer connected sensors, the data from remote weather stations can be automatically recorded and transmitted under user defined periodicity. With only a SMS from your mobile the pump set will start working and irrigate the whole field and you can still be away from the field. There are remote connected coconut climbers which do all climbing operation under a hand press. The milking of dairy farms can be fully automated in the same way as automatic drinkers can be used to supply water. The scope of ICT in this area is very wide and we can see many more new applications in the coming days.

F. Remote Sensing Technologies

A number of remote sensing technologies find an increasing application in agriculture. Geographic information systems (GIS) are extensively used in precision farming. Land is mapped digitally, and pertinent geodetic data such as topography and contours are combined with other statistical data for easier analysis of the soil. GIS is used in decision making such as what to plant and where to plant using historical data and sampling.

The use of the Global Positioning System provides benefits in geo-fencing, map-making and surveying. With the use of GPS, extension personal can produce simple

yet highly accurate digitized map without the help of a professional cartographer. To site an example, the solution to prevent an elephant from wandering into farms and destroying precious crops was to tag the elephant with a device that sends a text message when it crosses a geo-fence. Using the technology of SMS and GPS, the elephant can roam freely and the authorities are alerted whenever it is near the farm.

G. Office Automation

Office Automation Systems are systems that try to improve the productivity of employees who need to process data and information. Perhaps the best example is the wide range of software systems that exist to improve the productivity of employees working in an office (e.g. Microsoft Office XP).

Other, more-specialized applications, such as software used for supply chain or financial management are also becoming more relevant in today's farming. Simple accounting software has allowed cooperatives to manage production, aggregation, and sales with increased accuracy. The departments can develop computer networks and online bill payment facilities that can result better resource utilization. One of the recent innovation in this direction is the automatic seed vending machine.

4.4.5 Farmer Support Schemes

The Department of Agriculture in Kerala undertakes formulation of various programmes in areas such as:

- Crop production.
- Infrastructure.
- Planting material production and distribution.
- Quality control of agricultural inputs.
- Farm mechanization.
- Transfer of technology.
- Agricultural marketing.
- Crop damage relief.
- Women development.

Krishibhavans in every panchayat is the grass - root level office headed by the Agricultural Officer. There are 1046 Krishibhavans in the State. 2 - 3 Agricultural Assistants assist the Agricultural Officer. The activities of the Department are spearheaded and coordinated by the Agricultural Officer in his jurisdiction.

Krishibhavans have a lead role in planning, formulation, and implementation of agriculture projects of local self - government.

4.4.5.1 AgriClinics

The Ministry of Agriculture and farmers welfare, Government of India, in association with NABARD has launched a unique programme to take better methods of farming to each and every farmer across the country called Agriclinics and Agri Business Centers (AC & ABC) scheme.

Agri-Clinics are envisaged to provide expert advice and services to farmers on various technologies including soil health, cropping practices, plant protection, crop insurance, post-harvest technology and clinical services for animals, feed and fodder management, prices of various crops in the market etc. which would enhance productivity of crops/animals and ensure increased income to farmers.

One of the major agri ventures under this scheme is Crop protection services, including pest surveillance, diagnostic and control services (with culture rooms, autoclaves, microscopes, ELISA kits etc .for detection of plant pathogens including viruses, fungi, bacteria, nematodes, and insect.

4.4.5.1.1 Functioning of Agri clinics

1. Baseline data on plant health in the panchayat is to be collected.
2. Plant health record should be maintained.
3. Feedback register should be kept.
4. Pest surveillance group should be formed.
5. Training and awareness programme should be given in regular intervals.
6. Computerised data base for all the pest and diseases reported in the panchayat should be developed and e -mail support should be used for consultation for diagnosis and advisories. Panchayat should be involved in all the activities of the clinic.

4.4.5.2 Schemes implemented by Department of Agriculture

1. RKVY /Rastriya Krishi Vikas Yojana

- A special central assistance scheme launched to rejuvenate agricultural sector during eleven five year plan.
- RKVY funds are provided to states as 100 % grant by the Govt. of India.

2. Karshaka Pension Scheme for Small and Marginal Farmers

- The state government is implementing monthly pension scheme for small and marginal farmers above 60 years of age.

3. National Agricultural Insurance Scheme (NAIS)

- implemented by the Agricultural Insurance Corporation.
- covers insurance for crops such as paddy, banana, tapioca, ginger, turmeric and pineapple.

4. Comprehensive Vegetable Development Programme

- objective of attaining self-sufficiency in vegetable production in the state.

5. Agroservice Centres

- functions as a single window system to ascertain the availability of farm labor, inputs, planting materials, plant protection agents etc.

6. Crop Insurance Scheme

- A crop insurance scheme has been in operation in the State, with contribution from the participating farmers, covering 25 major crops grown in the state since 1995.
- it aims at revamping the crop insurance programme to cater to risk coverage of small and marginal farmers.

7. Agricultural wholesale markets

- function as facilitators in conducting auction sale of agricultural products collected directly from farmers without the interference of intermediaries.

8. LEADS/Lead farmer centred Extension Advisory and Delivery Services

- utilize the s potential of lead farmers for transfer of technology and address the field level problems of selected farmers.

9. ATMA/Agricultural Technology Management Agency

- a registered society of key stakeholders involved in agricultural activities for sustainable agricultural development in the district.
- ATMA at the district level is responsible for all the technology dissemination activities. It maintains a link with all the allied departments, research organisations, NGOs and other agencies associated with agricultural development in the district. Thus research and extension units within the district such as Zonal Research Stations or sub stations, Krishi Vigyan Kendras and the allied departments of

Agriculture, Animal Husbandry, Fisheries, Sericulture, Agro industries etc would constitute members of ATMA.

10. SAMETI/State Agriculture Management and Extension Training Institute

- functions as the model training institute at state level in the area of agricultural management.
- It is located at Thiruvananthapuram.

11.Schemes for Integrated Pest Management System

- to keep pests and diseases of crops below Economic Threshold level by adopting an integrated pest management practice.
- constant pest surveillance and monitoring to ascertain pest population.
- create awareness among farmers on the prominent pests.

12. Projects for value addition

- Small Farmers Agri Business Consortium (SFAC) has been identified as the implementing agency of the scheme.
- Individual entrepreneurs, SHGs, Clusters, NGOs, partnership will be considered under this scheme.

13. Kuttanad Package

- assistance for improving the farming condition in Alappuzha and Idukki districts in Kerala.
- by Government of India.

14. Idukki Package

- The report on Dr.MS. Swaminathan commission on Idukki deals with the problem and possible solutions related to Idukki District.

15. Wyanad Package

- Various agricultural development Programmes are implemented in the District which is considered as the most distressed and Backward District.

16. Spices Development Programme

- Implemented for the Promotion of Spice cultivators.

17. Sustainable Rice Development Scheme

- for sustainable development of rice based farming system.

- concentrated in three major rice - growing tracts of the State for augmenting rice productivity.
- objective of the project is to increase average productivity of rice to around 3 tonnes per hectre.
- The project is proposed to be implemented through Kudumbasree, self help group of rural women, local self governments in association with research institutions and financial institutions.Group farming samithies/Padasekhara samithies will constitute the nucleus of the programme.

18. Biogas Scheme

19. Quality control Scheme

20. Soil, Fertilizer and Plant Protection chemical analysis

21. People's Plan

22. Area Development Scheme

23. SHM Schemes (State Horticulture Mission)

This scheme envisages an end to end development of the Horticulture sector covering production, post harvest management, processing and marketing. The main objectives of the Mission are:

- To provide holistic growth of the horticulture sector through an area based regionally differentiated strategies which include research, technology promotion, extension, post harvest management, processing and marketing.
- To enhance horticulture production, improve nutritional security and income support to farm households.
- To create opportunities for employment generation for skilled and unskilled persons, especially unemployed youth.

Various Projects implemented under SHM are: Poly House cultivation, Rain Shelter, Creation of water source, training etc.

24. Agricultural Technology Information Centre, Mannuthy (ATIC)

The Information and Sales Centre of Kerala Agricultural University was upgrade into the ATIC. Its objectives are:

- To provide a single window delivery system for agricultural information as well as products and technologies developed by the University with a view to deliver quality services to the clientele.

- To strengthen the farm advisory services by adopting a multi - disciplinary approach to problem solving.
- To provide mechanism for feedback from the end users to the research system.
- To function as a repository of agricultural information pertaining to farming skills and practices, farm inputs and agricultural education.
- To offer consultancy services to the different stakeholders in the state.
- To offer training to unemployed youth to equip them to become job providers, rather than jobseekers as part of the NABARD project.

4.4.5.3 Other agencies which implement schemes for farmers

- Rubber Board
- National Horticultural Board
- Directorate of Arecanut & Spices Development
- Tea Board
- Coconut Development Board
- Spices Board
- Directorate of Cashew nut & Cocoa Development
- National Seeds Corporation
- Save Grain Campaign
- Land Development Corporation
- MILMA
- Land Use Board
- Poultry Development Corporation
- The Kerala Livestock Development Board Ltd
- NABARD
- KERAFED
- Small Farmers Agri Business Consortium
- Kerala Agro Industries Corporation Ltd
- KAMCO
- VFPCK

- Serifed
- Raidco
- Coir Board
- Agricultural and Processed Foods Export Development Authority
- Marine Products Export Development Authority
- Cashew Export Promotion Council

List of extended activities

Unit 1- Protected cultivation

Giving propaganda on the relevance of protected cultivation and low cost protected cultivation structures.

Preparation and sales of botanicals to the local people .

Setting up of community vegetable seedling nursery in a hitech farm and distributing the seedlings to them.

unit 2- Pesticides and pesticide residue elimination

Conducting seminars on the illeffects of indiscriminate pesticide use .

Distribution of leaflets showing simple methods to remove pesticide residues from vegetables.

Unit 3- Organic certification

Undertaking organic vegetable farm in nearby houses.

Setting up organic garden in a nearby office.

Taking classes on organic certification highlighting the environmental benefits and high market price of organic certified products.

Unit 4- ICT enabled extension services in agriculture

Updating farmers about various farmer support schemes .

Conducting workshops on the use of ICT enabled agriculture related softwares.

List of practical activities

Unit 1- Protected cultivation

1. Familiarization with different types of protected cultivation structures based on shape, construction and covering material.
2. Preparation of growth media used in protected cultivation.

3. Familiarization with various equipments used for measuring climatic parameters inside green house.
4. Diagnosis and management of common pests and diseases seen in protected cultivation.
5. Familarization with irrigation system and fertigation requirements in protected cultivation.
5. Visit to commercial Hi-tech farm.
6. Familiarization and practicing of Hydroponics.

Unit 2- Pesticides and pesticide residue management

1. Familiarization with common pesticide formulations.
2. Calculation and preparation of insecticideformulations for field application.
3. Familiarization with different new generation pesticides and their formulations available in the market.
4. Calculation of common fungicide formulations for field application.
5. Practicing field application of pesticide sprays.
6. Familiarization and preparation of pesticide label.
7. Practicing simple methods of pesticide residue elimination from vegetables.

Unit 3- Organic certification

1. Familiarization with the procedure for organic certification in India.

Unit 4 - ICT enabled extension services in agriculture

1. Familiarization and practice of different ICT enabled agriculture related interactive softwares- crop decision support system – pest, disease and nutrient deficiency diagnosis softwares like e-crop doctor, Karshika jalakam, pest doctor, online rubber clinic.
2. Familiarisation with crop health diagnostic centres.
3. Familiarization with various important farmer support schemes**.**

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9. *www.ppqs.gov.in*

APPENDIX I

PEST OF CROPS

Rice stem borer - Adult

Rice stem borer- larva

Gall Midge

Rice BPH

Hopper Burn

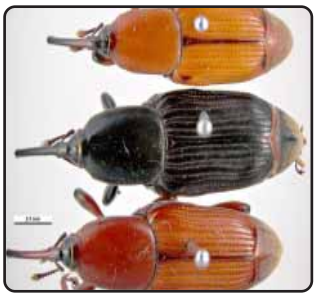
Rice case worm

Rhinoceros beetle

Red Palm Weevil

Leaf eating caterpillar

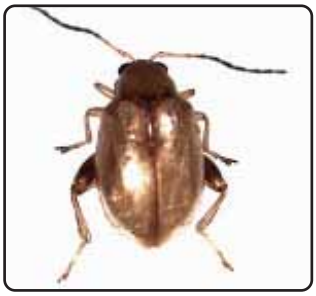
Coconut Mite



Pseudostem weevil

Banana rhizome weevil

Tea mosquito



Pollu beetle

Marginal thirps

Brinjal Fruit borer

epilachna beetle in Brinjal

Tomato fruit borer

Bhindi shoot & fruit borer

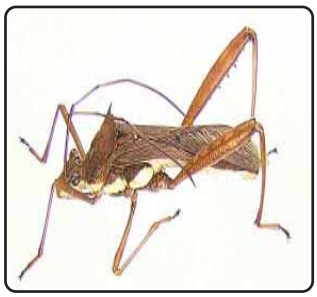
Amaranthus leaf webber and its attack

Fruit fly(Bitter gourd)

Pumpkin beetle

Snake gourd caterpillar

Cowpea aphid



Cowpea Bug

Cowpea fruit borer

American serpentine leaf miner

Mango fruit fly

Mango Hopper

APPENDIX II

DISEASES

Rice blast

Rice Sheath Blight

BLB of Rice

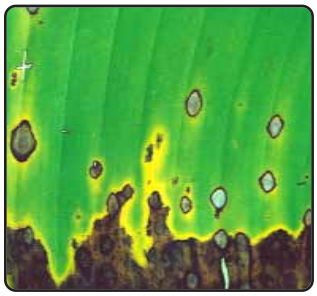
Coconut leaf rot

Coconut stem bleeding

Coconut Root wilt

Banana Bunchy Top

Kokkan Disease in Banana



Sigatoka leaf spot

Pepper Quick wilt

Damping off in vegetables

Little leaf of Brinjal

Phomopsis Blight in Brinjal

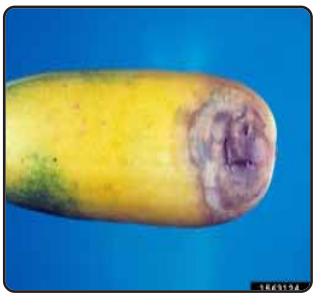
Bacterial wilt

Anthracnose in chillies

Leaf curl in chillies

Yellow vein mosaic in Bhindi

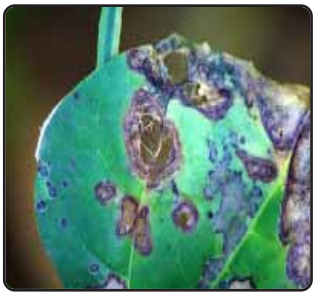
Leaf Blight



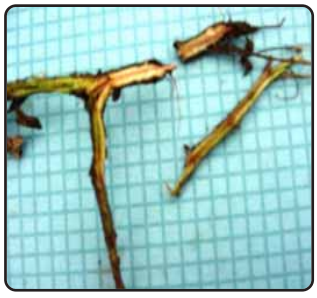
Fruit rot in cucurbits

Powdery mildew

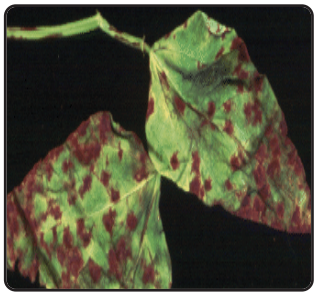
Mosaic(Cucurbits)



Web blight(cowpea)



Fusarial wilt (cowpea)



Anthracnose(cowpea)

Cowpea mosaic

Anthracnose (mango)

Powdery mildew

Abnormal leaf fall(rubber)

Powdery mildew(rubber)

Pink disease(rubber)