Unit 6

Insect Pests, Diseases and Weed Management

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Introduction

Insect pests, diseases and weeds are interlinked and complement each other. Individually, each one of these is responsible for a considerable loss by itself but if one remains neglected, it gives rise to the infestation of the other. Some insects secrete a sugary substance on which fungi develop. Weeds serve as the alternate host for rust and other fungi, and also harbour insect pests. Therefore, for efficient insect pests and disease management, it is necessary to also manage weeds. Regular removal of weeds is a type of preventive control as it minimises competition of nutrients, prevents hibernating pests, as well as, facilitates proper aeration and application of pesticides. The key behind the success of insect pests, diseases and weed management lies in early and perfect detection of maladies and their management. Eradicating and treating sources of inocula in the field are important preventive measures. Strengthen the crop by maintaining soil fertility, drainage and aeration check infection from soil, and develop resistance in the crop against pest attack. Infections in the crop may be soil-borne, aerial or seed-borne. Similarly, some insect pests suck the cell-sap of the crop, some chew the foliage and floral parts, some bore into the stems, buds and fruits, while there are insects where their larvae mine the leaves and sometimes even the stems. Each of these problems and infestations need specific approach towards prevention and control. For an

effective strategy on pest management, it is essential to gather technical know-how on identification of the pests. This will be useful for appropriate selection of pesticide with its specific dose, method and time of application.

Session 1: Insect Pest Management

Insect pests

A thorough knowledge of morphology, nature of damage, vulnerable stage of pest, damaging stage, pre-disposing factors, susceptible stages of host, natural enemies and predators help in preventing and controlling them effectively. All insects belong to the class *Insecta*. Their body is segmented and mostly comprises three main segments, i.e., head, thorax and abdomen. Insects have two pair of wings and three pairs of legs. According to structure of wing (*pteron*), they are classified into different orders, such as Coleoptera, Diptera, Hemiptera, Hymenoptera, Isoptera, Lepidoptera and Orthoptera, etc. All these insects belonging to different orders may have different life cycles with different damaging stages and nature of damage. With a view to accomplish a better pest management, all these factors are important, but the most important is how (nature of damage) and when (damaging stage) they attack the host.

Table 6.1: Types of insects

Order	Characteristics	Damaging stage
Diptera black flies, mosquitoes and flies (Fig. 6.1)	• A single pair of wings to fly, the hind wings being reduced to club-like balancing organs, hence, is known as halter and balancer. • The mouth parts of these insects are piercing and sucking type. • Life cycle comprises four distinct life stages — egg, larva (maggot), pupa and adult.	Adult and maggots
Coleoptera Beetles and weevils (Fig.6.2)	• These insects have 'sheathed wings'. Their forewings are hardened into a protective covering over the hind wings, which are membranous, and the soft dorsal abdominal wall. • Egg, larva (grub), pupa and adult are distinct stages of life cycle.	The larva known as 'grub' is the damaging stage.

Hemiptera true bugs, hoppers and aphids, scale insects, etc. (Fig. 6.3)	• Insects belonging to this order have half portion of the forewings hard near the base while the remaining half membranous. • These insects may have uniform wings (*homoptera*) or different wings (*heteroptera*). Their young ones are called 'nymphs', who resemble, more or less, their adults. • These have piercing and sucking type of mouth parts. • Life cycle comprises eggs, nymphs and adults.	Nymphs and adults
Hymenoptera bees, wasps, ants, saw flies, etc. (Fig. 6.4)	• The adults have four transparent membranous wings. • Their mouth parts are adapted for chewing. Mouth parts of some species are developed into a lengthy proboscis to suck liquids, such as nectar. • The females can be identified by the presence of typical sting. • Their life cycle comprises eggs, larvae, pupa and adults.	Larvae and adults
Isoptera termites (Fig. 6.5)	• These insects have a well-distributed class system that consists of queen, king soldiers and workers. Hence, these are also called 'social insects'. Nymph stage is the longest stage. Nymphs moult into workers, and later into soldiers. • Life cycle is completed in distinct phases of egg, nymph and adult stage.	Workers feed on cellulose
Lepidoptera butterflies and moths (Fig. 6.6)	• These insects have two pairs of large scale-covered beautiful wings. • Caterpillar is the damaging stage with chewing type of mouth parts, though its adults have sucking type of mouth parts which are known as 'haustellum'. • Haustellum consists of two tubes held together used for sucking nectar. • Life cycle has four stages, i.e., eggs, larvae (caterpillars), pupae and adults.	Caterpillar
Orthoptera grasshoppers, crickets and locusts (Fig. 6.7)	• Insects of this group have parallel-sided structure of the front wings. • Nymph stage is also called 'hoppers'. Grasshoppers, crickets and locusts belong to this group. Crickets have long antennae, while grasshoppers have short antennae. They have biting and chewing type of mouth parts. • Life cycle includes egg, nymph and adult stages.	Nymphs and adults

Thysanoptera thrips (Fig. 6.8)	• These are minute and slender insects hairy feather flat paper-like body with 'fringed wings'. • These have asymmetrical mouth parts. Flight capable thrips have two pairs of strap-like wings. • Their legs, usually, terminate in bladder-like structure. • Life cycle includes eggs, nymphs, pupae and adults.	Adult, nymphs

Fig. 6.1: Diptera

Fig. 6.2: Coleptera

Fig. 6.3: Hemiptera

Fig. 6.4: Hymenoptera

Fig. 6.5: Isoptera

Fig. 6.6: Lepidoptera

Fig. 6.7: Orthroptera

Fig. 6.8: Thysanoptera

Nature of insect damage

Chewing and cutting tissues of the host

These insects have biting and chewing type of mouth parts and may cut, chew and bite the tissues of the host. Infestation of such insect pests is confirmed through this type of damages found on various parts of the host. Mostly larvae and in some cases, adults are responsible for such damages.

Fig. 6.9: Chewing and cutting

Larvae of the Lepidoptera (caterpillars) and the Coleoptera (grubs) are well-known damaging stages that cause such type of damage. Maggots and immature stage of flies feed on flowers of chrysanthemum and many other plants. Sunflower maggots infest the stem and cause collapse of the plant. Larvae of painted lady butterfly, yellow woolly bear, checker spot butterfly, diamondback moth, etc., cause such damages to ornamental crops severely (Fig. 6.9).

Mining in the leaf

Larvae (maggots) of certain leaf minors by mining get inserted between upper and lower surface of the leaf. Irregular tunnel-like structure over the leaf surface is observed due to the feeding of inside tissues. Such infestation may be observed in ornamentals, such as chrysanthemum, dahlia, dianthus, salvia, verbena, etc. This can be identified by the creamy-yellow lines formed on the leaves due to tunneling (Fig. 6.10).

Fig. 6.10: Leaf minor

Boring in the host

Infestation of these pests can be identified by the presence of holes and bores that they make in several plant parts. Beetles, weevils, grubs, caterpillars and maggots are well known that bore into the host and feed on internal tissues. Caterpillars of armyworm bore into flower buds and feed inside. Flowering crops, such as China aster, chrysanthemum, dahlia, delphinium, iris, phlox and salvia, etc., are attacked by

most of the borers. Burdock borer (moth), iris borer, stalk borer and European corn borer are common borers found in ornamentals.

Yellowing and drying of foliage

A wide range of sucking insect pests is responsible for this type of damage. The pest sucks cell sap of the host plant parts (leaves, shoots, floral buds, sepals, petals) to the extent that these are unable to cope up with plant growth and express yellowing, and premature drying or falling off. In most cases, the growth of plant stunts and the plants become unproductive.

Nymphs and adults of aphids, jassids, whiteflies, thrips and bugs are found associated with such damages to almost all ornamentals. Sucking pests are supposed to be dangerous as most of them act as vectors and transmit viral and mycoplasma-like diseases, and aphids and whiteflies secrete honey dew-like substance on which sooty moulds are developed.

Thrips feed on sap and cause white patches on petals and leaves of most of the indoor and outdoor ornamentals. Tarnished plant bugs feed on many flowers. The insect sucks the cell sap and introduces toxic saliva into the plant. It is a serious pest of calendula, China aster, chrysanthemum, cosmos, dahlia, daisy, gladiolus, poppy, salvia, sunflower, verbena, zinnia, and many other ornamentals. Infestation can result in injury to flower buds and dropping of unopened flowers. Two-spotted spider mites infest many commercial ornamentals.

Galls

Sometimes, mites suck cell sap and produce abnormal growth of pimple-like structure on the leaves. Tiny wasps also sometimes produce galls on leaves, stems and twigs of roses and other plants.

Integrated Pest Management

Integrated Pest Management (IPM) is essential to deal with certain diseases, like wilts, and insect pests, such as green worms and spotted worms, by a number of approaches. The disease and insect pests,

if not handled in time can cause huge losses to the crop. Chemicals used against such pests not only have limitations but might have side effects on the plant. Frequent application of insufficient doses of such pesticide build resistance within the organism. Excessive use has residual effect in the crop, which also become a major cause of pollution. Pesticides also inhibit pollinators and predators in the field, which results in reduction of yield.

IPM includes involvement of measures, such as cultural, physical, mechanical, chemical and biological methods against pests.

Insect pest control

Anything that interferes with the life of insect pests and makes them difficult to survive in the field or on plants either by killing them or through repelling so that their population is reduced is known as insect pest control. Various methods for their control are employed.

Cultural methods

Tillage: Ploughing or flooding during summer season exposes hibernating stages of insect pests inside the soil. Stages, like eggs, larvae, pupae of some insects are found hidden deep inside the soil. These are exposed to their natural enemies and the hot Sun due to tillage operation.

Clean cultivation: Weeds and bunds of the field are important foci for hibernating insect pests. Through cleaning of bunds and regular removing of weeds, pest population is minimised. Crop residues of previous crop must be destroyed.

Crop isolation: Crop of the same group or same families, if grown close by, increases the availability of host and this may increase the pest population. If the crop is isolated at a sufficient distance, the movement of pests from one field to another can be avoided, so their control becomes easier.

Altering sowing or planting time: This is a dodging strategy by which the host or its suitable stage is made unavailable for the pest, required for infestation.

Crop rotation: Long crop rotation minimises the invasion of host-specific insect pests.

Eradication of alternate hosts: Weeds or other plants harbouring insect pests in the absence of the major host, if these are removed, break the chain of host availability and control the pest population.

Planting trap crops: Trap crop of less economic value is planted before planting the main crop to attract insect pests towards it and the crop along with pest is destroyed completely before the insect reaches the reproductive phase.

Exclusion of infested plant or part: Removal and destruction of infested plants and their parts reduce population and foci of pest in the field.

Physical methods

These methods are mostly useful in controlling pests in a closed environment, like storage or greenhouse or pot plant. This includes moderation in temperature, radiation and altering humidity of the structure. Drier conditions are unfavourable for pests. Similarly, low temperature of storage inhibits infestation. UV and γ-rays also prove lethal for pests.

Mechanical methods

Removal of infested parts and insect galleries also minimises their population.

Hand picking and destroying: The insects or their eggs can be handpicked and destroyed.

Trenching the field: This causes certain insects to be confined to a patch with no movement elsewhere as locusts.

Screening: Wire mesh protects crops from birds, moths and rodent attack.

Sticky bands: Ants, white ants and other tiny insects stick on the bands and die there without moving anywhere afterwards. Different colours attract insects differently, so coloured papers are pasted on a card board and sticky material is spread over it. Yellow colour attracts white flies.

Light traps: Phototropic insects such as borers (buds, pods and fruits) are attracted to light during night. Light source with a trap of kerosene or some pesticide solution will trap such insects and provide effective control.

Biological control of insect pest

Friendly insects, bacteria and fungi are used in biological control as bio-agents. *Trichograma*, *Crysopa*, Nabid bug, pentatomid bug, big-eyed bug, ladybird beetle (*Epilachna*), tiger beetle, robber fly, cirafid fly, orius bug, tachnid fly, fruit fly, spider and mantids predate over insect pests, and hence, they are known as friendly insects. *Bacillus thuringiensis (BT)* bacterium controls spotted bollworm, pink bollworm, green bollworm, etc.

Spore formulation of *Verticilliumlacani* at the rate of 2.5–5g/litre of water is used to control larvae and nymphs of sucking pests. Whitish growth of *Beauveria* at the rate of 5-10g/litre of water is found to be effective against beetles and their caterpillars. Similarly, *Metarrhizum* greenish growth of the fungus covers the caterpillars and controls beetles, flies and hoppers. Fungus *Hirsutela* is effective against mites. HaNPv *Virus* (Heliothisnucleo poly hydrosis virus) is found effective against bollworm. Various commercial products of above mentioned formulation are available in the market.

Chemical method

Use of chemicals to kill or repel insect pests comes under this method (Table 6.2).

Dust: Dry formulation with inert carrier. Available concentrations are from 1–10%, e.g., Quinolphos 4D, etc.

Wettable (WP), dispersible powder (DP): Dry formulation but can be applied with water, e.g., Carbaryl 75 wp.

Granules: Dry formulation, but particle size is more than found in powder. Applied in soil, e.g., Phorate 10G, Carbofuran 3G, etc.

Emulsifible concentrates (EC): Liquid formulation with emulsifiable agents, which form emulsion in water. Use for aerosol or foliar spray. Most of the insecticides

are available in this formulation, e.g., Cypermethrin 5EC, Malathion 50EC, etc.

Water soluble concentrates (WSC): Easily soluble in water, e.g., Monocrotophos 36WSC, etc.

Fumigants: They are found in liquid or solid form, e.g., methyl bromide, Aluminum phosphide, but these fumigants act in a gaseous state and are used in stored grain.

Table 6.2: Popular pesticides and their dilutions

Technical name	Active ingredient	Formulation	Dose	Use
Carbaryl	50	Powder	0.1%	Foliar spray, soil
Dicofol	18.5	Liquid	0.25%	Foliar spray
Diclorvos	76	Liquid	0.1%	Foliar
Dimethoate	30	Liquid	0.05%	Foliar
Dinocap	25	Liquid	0.05%	Foliar
Malathion	50	Liquid	0.1%	Foliar
Phorate	10	Granule	0.1%	Soil

Practical Exercises

Activity

Identify the major insect pests in your nearby area.

Material required: Insect net, collection box, notebook, pen, pencil, etc.

Procedure

1. Visit a nearby farmer's field and note down the following information:
   - crop grown in the field
   - stage and age of the crop
2. Collect insect pests from the crops.
3. Identify the insect pests.
4. Write control measures of the collected insect pests.

Check your Progress

Fill in the Blanks

1. Tapping of branch on white sheet of paper may detect _____ and _____ incidence.

2. Eradicating and treating sources of inocula in the field is also an important _____ measure.
3. All insects belong to the class _____.
4. Insect body comprises three main segments, i.e., _____, _____ and _____.
5. Greek word *pteron* means _____.
6. Termite belongs to order _____.
7. Larvae of caterpillar belong to order _____.

Multiple Choice Questions

1. The damaging stage of insects belonging to dipteral family is _____.
   (a) larva (b) adult and maggots
   (c) caterpillar (d) grub
2. Caterpillar has sucking-type of mouth parts, which are known as _____.
   (a) homoptera (b) halter
   (c) balancer (d) haustellum
3. The irregular tunnel-like structure over the leaf surface is observed due to the feeding of _____.
   (a) larva (b) maggots
   (c) caterpillar (d) grub
4. Abnormal growth or gall-like structure on the leaves are the damaging sign of _____.
   (a) larva (b) maggots
   (c) mites (d) grub

Subjective Questions

1. What is insect pest control?
2. How are insect pests controlled traditionally?
3. Describe Integrated Pest Management.
4. Write about the following nature of damages:
   - chewing and cutting tissues of the host
   - boring
   - mining leaves
   - galls or hypertrophied structure

Match the Columns

A	B
1. Grub	(a) Caterpillar
2. Lepidoptera	(b) Beetle
3. Nymph	(c) Wasp
4. Diptera	(d) Isoptera
5. Hymenoptera	(e) Maggot

SESSION 2: DISEASE MANAGEMENT

Disease

Any abnormality in the normal functioning of a plant caused by pathogen, which is harmful to the plant or its parts or reduces its economic value is called 'disease'. It is the interaction between susceptible host and virulent pathogen in a favourable environment.

Symptoms of plant diseases

Spot

The cells are killed in a limited area and the dead tissue, usually, becomes some shade of brown. In many cases, other colour changes, such as yellowing, precede the death of cells. The leaf spot diseases are numerous, the same host sometime being affected by many types.

Blight

The term means a burnt appearance. It expresses the sudden death of the plant or its conspicuous parts, i.e., leaves, blossoms. The dead organ of the plant, generally, turns into brown or black and may soon decay.

Damping-off

It is a common and serious disease in nurseries. Damping-off is a pre-emergence and seedling disease caused by various fungi, such as *Pythium*, *Phytopthora*, *Rhizoctonia* and *Fusarium*. These fungi, attack at the time of seed germination. In this disease, near base of the seedlings girdlings takes place and infected seedling collapse due to rotting in the collar region.

Wilt

In many diseases, the most striking effect is drying or wilting of the entire plant. The leaves and succulent parts lose their turgidity and droop. This effect is, generally, seen on young growing tips. Later on, the whole plant may start to dry up.

Dieback

It is a symptom of invasion by one or various pathogens, where first yellowing, then blackening

and then drying starts to take place in plants from top to bottom, pathogens entering through the wounds inflicted by pruning or otherwise. Its initial symptoms are visible as blackening of stem parts but afterwards the whole plant dies.

Necrosis

It means the death of the infected cell or disintegration of tissues. This includes diseases, like blast, blight, canker, damping-off, dieback, rots, bud rot, bulb rot, etc., blight of conifers, fleck of lily.

Powdery mildew

It is characterised by white and powdery fungal growth first on the upper surface of a leaf, then covering the lower surface, stems, thorns and floral buds during prevalence of dry conditions around the roots together with humid conditions in the atmosphere. Affected leaves may fall prematurely and the buds fail to open. The fungus overwinters as stem infections and in dormant buds spreads by air.

Rust

Black, brown, reddish or bright orange pustules appear on both the sides of leaves and expended into a larger spot. These also infect the stems, more serious being during favourable environmental conditions. Infected leaves fall off prematurely and stems are likely to wither.

Root-knot nematodes

They have been found feeding on roots by making galls in roots, which cause foliage yellowing. In severe cases, the plant even dies.

Flower bud rot

It appears as rot of the floral buds. Older leaves develop few deep brown necrotic spots. In humid weather, its infection becomes serious.

Leaf mosaic

Plants look mottled because of dark and light green area and also yellow patches, e.g., viral diseases.

Leaf curl

Leaves get deformed and twisted. They roll or curl towards midrib and become stunted in growth. Whole plant becomes dwarf and gives a sickly look.

Fig.6.11: Black spot of rosetera

Fig.6.12: Rust of Geranium

Fig.6.13: Root-knot nematode

Fig.6.14: Rose mosaic

Fig.6.15: Powdery mildew

Fig.6.16: Leaf curl

Fig.6.17: Gall

Integrated Disease Management (IDM)

It is the integration of the methods used for avoiding and controlling diseases. IDM is defined as a decision-based process, including all possible control measures for optimising the control of pathogen to keep the pathogenic population under control or below the level of economic loss.

Cultural method

Tillage

Soil-borne fungi, bacteria and nematodes, serving as sources of infection, perpetuate in the soil. When the soil is ploughed, they get exposed to high temperature of the Sun. This reduces their population or activity within the soil.

Field sanitation

Plant pathogen (fungi, bacteria, and virus) survives on previous crop residues and weeds in the field may serve as a major source of inoculums. Clean cultivation means removal of crop residues and keeping the bunds clean so that the pest population is minimised in the field. Plant disease can be controlled by regular destroying of the diseased plant or weeds, which disrupt the disease cycle, and thus, prove as an effective source of control.

Crop rotation

The availability of susceptible hosts in every season or consecutive years increases the survival and persistence of diseases. Crop rotation with different crops or families breaks their persistence. Starvation of pests due to unavailability of susceptible hosts for long time makes it difficult for pests to survive.

Resistant varieties

Resistant varieties of flower crops have provided one of the most successful approaches to control plant pathogens of many crops, especially those which cannot be controlled by any other means. Some cultivators are resistant to a particular disease and are inherently less damaged than other genetically related plants growing in the same area.

Alteration in sowing time

Manipulation of sowing time and selection of early or late varieties also dodge pathogens. Certain diseases, like early blight, late blight, etc., are time-bound and require particular stage of growth of the plant to infect. Unavailability of susceptible stage fails to infect.

Seed treatment

Most of the seed and soil-borne diseases, such as damping-off, wilt, rots, dieback, anthracnose, etc., attack the crop through seeds or soil. Seed treatment reduces the chances of infection.

Crop density

High density of crop favours incidence of many diseases. Infections can move easily from a diseased to a healthy plant in a dense field. It is, therefore, desirable to plant the crop at required spacing.

Mechanical methods

It includes uprooting or pruning off diseased plants or parts so that infected material may not be able to transmit pathogens to healthy ones. Training and staking the crop facilitates plants so that their leaves may not come in contact with the soil, and thus, infection or infestation is controlled. Erecting nets, sticky bands and mechanical traps control insect-vectors that may transmit viruses.

Bio-control of plant diseases

This is the most common method adopted nowadays as a biological control against many soil-borne diseases. Fungi *Trichoderma herzianum* and *T. viride*, and bacterium *Bacillus subtilis* have antagonistic properties against many fungi causing wilt and rot. Extracts of some plants are also well-known for their fungicidal properties. These are being used since a long time as pesticides. The extracts may be applied as soil or seed treatment or as sprays.

Chemical control

Use of fungicides

Chemical or combination of chemicals found lethal to fungi and escapes the host from infection is called 'fungicide'. Fungicides, according to their movement in the plant system, are of two types — systemic, which on application on plants gets dissolved in the cell sap and affectivity translocates to the whole system of plant irrespective of the place of application, such as Benlate, Calixin, Carbendazim (Bavistin), Demosan, Ridomil, Sten 50, Thiobendazol, Tilt, etc.; and contact fungicides, whose action on plants is restricted to the area of application, such as sulphur, mancozeb, Zineb, Rovral, etc. (Table 6.3).

Table 6.3: Fungicides and their chemical nature

Diseases	Chemical (fungicides)
Downy mildew, leaf spotting, anthracnose gummosis, collar rot, stem rot	Copper-based fungicide
Powdery mildew, leaf spotting	Sulphur-based fungicide, Dinocap
Seed-borne disease	Carbandazim, Carboxin, Oxathin
Soil-borne infection	Oxathin, formaldehyde

Fungicide application

Soil drenching: In case of soil-borne infection of fungi (wilt, damping off, root rot) or nematodes (root-knot), fungicide or nematicide should be applied to the soil. Such fungicides are carbendazim, formaldehyde, etc. (Table 6.3).

Seed treatment: To avoid infection from the soil, as well as, from the seed, the easy way is seed treatment. Generally, seeds are treated at the rate of 2.0–2.5 g fungicide/kg of seed. Seed dressing drum or earthen

pitcher can be used for treating the seeds. Fungicides used are *Carbandazim*, *Carboxin*, *Oxathin*, etc.

Pasting to affected parts: In case of scorching Sun or in gummosis, the affected parts, such as stem, are pasted with Bordeaux paste.

Foliar application: Aerial parts affected by foliar diseases can be controlled through foliar sprays of fungicidal formulations. Specialised sprayers are available for treatment. Generally, fungicides are sprayed with compatible insecticides, so it reduces the cost of application. These fungicides are sulphur, copper oxicloride, Maneb, Zineb, Nabam, etc.

Dip method: In this method, seedlings and cuttings are dipped before planting in the fungicidal solution for certain period to avoid infection, e.g., Benlate, Captafol, Carbendazim, Maneb, Sulphur, Zineb, etc.

Practical Exercises

Activity

Identify diseased samples of flowering crop

Material required: Diseased samples of different flower crops, etc.

Procedure

Observe the symptoms of diseased samples and write the following information:

1. Name of the crop
2. Name of the disease
3. Causal organism
4. Control measures

Check your Progress

Fill in the Blanks

1. An interaction between susceptible host and virulent pathogen in favourable environment is known as _____.
2. An integrated approach used for avoiding and controlling the diseases is termed as _____.

3. Chemical or combination of chemicals found lethal to fungi and escapes the host from infection is called _____.
4. Affectivity of fungicide when translocated to the whole system of plant irrespective of the place of application, is called _____.
5. Affectivity of the fungicide when restricted to the area of application is called _____.
6. The mechanism of controlling the growth of microorganism through another microorganism is called _____.

Multiple Choice Questions

1. Disease occurs only when there is _____.
   (a) virulent pathogen
   (b) susceptible host
   (c) favourable climate
   (d) All of the above
2. Fungi which have antagonistic properties against many fungi are _____.
   (a) *trichoderm aherzianum*
   (b) *trichoderma viride*
   (c) Both (a) and (b)
   (d) None of the above
3. Neem seed oil can be used effectively against _____.
   (a) *anthracnose*
   (b) charcoal rot
   (c) Both (a) and (b)
   (d) None of the above

Subjective Questions

1. Describe fungicides and their types.
2. Describe different methods of fungicidal application.
3. Describe different cultural methods of disease control.
4. Describe bio-control of disease and antagonism.

Match the columns

A	B
1. Powdery mildew	(a) Use of resistant varieties
2. Bio-control	(b) Sign of gall in roots
3. Cultural method	(c) bright orange pustules appear on leaves
4. Nematode	(d) *Trichoderma spp.*
5. Rust	(e) White fungal growth on leaves

SESSION 3: WEED MANAGEMENT

What is a weed?

An undesirable plant in the field that is responsible for economic losses to the human is called weed. Weeds appear suddenly in the field without any planting or sowing. Weed propagules remain viable for a long time and survive in the field even under odd conditions. Weeds may be categorised as annual, biennial or perennial, according to their life cycle. They can be reproduced by seeds or through vegetative means. Weeds are harmful as these compete with the main crop for nutrients, water, light and space, and badly affect the growth and production of the main crop. Weeds may also act as alternate hosts for many stages of insect pests and pathogens. They occupy land, spread fast, and hence, require regular eradication.

Common weeds of ornamental flowers

Weeds can be classified based on cotyledon and life span.

Based on cotyledon number

Based on the number of cotyledons, weeds can be classified as monocots and dicots.

Monocot weeds

The stem is hollow and round, internodes are short and hard, and the leaves are slender, long and have parallel veins. Most of the grasses belong to this group., e.g., yellow watercrown grass (*Panicum flavidum*), awnless barnyard grass (*Echinochloa colona*).

Dicot weeds

It has taproot system with broad leaves. Veins on leaves are netted and these produce flowers, e.g., blue rattlepod (*Crotalaria verucosa*), bathua (*Chenopodium album*).

Based on life span

Annual weeds

Kankawa (*Commelina benghalensis*), bathua (*Chenopodium album*), hazardana (*Phyllanthus niruri*), biskhapara (*Boerhavia diffusa*)

Biennial weeds

Wild onion (*Allium spp.*), joy weed (*Alternanthera spp.*)

Perennial weeds

Yellow nut sedge (*Cyperus spp.*), Doob grass (*Cyndon dactylon*), Johnson grass (*Sorghum halepense*), Congress grass (*Parhenium spp.*), etc.

Integrated Weed Management (IWM)

IWM involves the utilisation of both preventive and curative measures in a planned way. A combination of exclusion, physical, cultural, chemical and biological methods of weed control is adopted in sequence to bring down the number of weeds below a significant level.

Fig. 6.18: Chenopodium album (Bathua)

Fig. 6.19: Boerhavia diffusa (Biskhapara)

Fig. 6.20: Cyprus spp. (Motha)

Fig. 6.21: Commelina benghalensis (Kankawa)

Fig. 6.22: Phyllanthus niruri (Hazadaan)

Fig. 6.23: Sorghum halepense (Johnson grass)

Preventive method

To avoid introduction and spread of weeds in new locality is known as preventive method of weed control. Spreading of weeds can be avoided by taking the following measures:

- care in transplanting of seedlings
- removal of weeds along irrigation channels and bunds
- sowing of weed-free clean seeds
- use of clean implements
- use of well-decomposed manures
- use of pre-emergence herbicide

Curative method

Eradication of weeds

Complete destruction of weeds from the field is known as eradication. This may be possible only in a small area. This method is, generally, used in high value areas, such as greenhouses, ornamental plant beds and containers. In large areas, it is not possible because some seeds may have very long viability.

Control of weeds

Weed control refers to minimising the infestation of weeds so that the crop can be cultivated successfully. The various methods of controlling weeds are as follows:

Mechanical and physical methods

Mowing the weed

Mowing consists of superficial trimming of succulent and herbaceous weeds. This inhibits the formation of seeds on weeds. Mowing is practised to keep the growth of weeds under check, specially in lawns. It should be followed by other methods of weed control, otherwise it spreads branching of perennials, and so low-growing weeds become a problem.

Mulching the field

It is a practice of covering the open soil in between the rows and plants of the crop. The soil is covered by organic matter, crop residues, polythene or paper. Cover with mulch inhibits sunlight to the exposed areas between the crops. Due to darkness, the weeds are unable to germinate.

Hoeing

This practice is effective in controlling weeds in row crops. It has been a widely used weeding tool for centuries.

Hand weeding

It is effective against annual and biennial weeds. Hand weeding is done by pulling out weeds from the field with the help of a *khurpi*. This facilitates the loosening of soil and improves its drainage and aeration.

Cultural methods

Various agronomic practices, such as crop rotation, intercropping, soil solarisation, etc., have been found effective in weed management

Crop rotation

In mono culture farming, one type of weed grows with one particular type of crop. Crop rotation helps to break the life cycle of weed and prevent any weed species to dominate.

Intercropping

It suppresses the weeds better than the mono cropping system. It gives advantages to utilise crops themselves as tools for weed management.

Transplanting

Healthy and disease-free 4–6 week old seedlings should be transplanted. They have the ability to compete with weeds.

Soil solarisation

It is the method of increasing soil temperature through absorbtion of sunlight, so that it destroys the seeds and other propagules of weeds. Solarisation is done by covering the soil with black polythene during extreme summer for 4 to 6 weeks. The soil temperature may reach up to 40–55° C depending upon the intensity of sunlight. Many annual weeds can be controlled by this method.

Biological method

- Living organisms, such as fungi, bacteria and insects are used to control the weed population. Such herbicides are broadly known as 'bio-herbicides'. When fungal spores or fungi are used to control weeds this is known as myco-herbicide, i.e., *Phythopthora sp.*, *Colletotrichum sp.* and *Bipolari sp.* are in use as myco-herbicides.
- Cochinial insects (*Dactylopius indicus* and *D.tomentosus*) control the Prickly pear plant (*Opuntia sp.*). The larvae of the moth (*Crocidosema lantana*) control the *Lantana camara* plant, which bores into the flower, stems, eat flowers and fruits. *Cuscuta spp.* is controlled by *Melanagromyza cuscutae*, and *Cyperus rotundus* is controlled by moth borer (*Bactra verutana*).
- This method is uncommon as it needs technical knowledge and the success of control is limited. Very few host specific bio-agents are available at present.

Chemical control

As labour being uneconomical, one resorts to intensified use of chemicals in controlling weeds in ornamentals, which is economical. A wide range

of pre-emergence, post-emergence, selective and non-selective herbicides are commonly used to control weeds.

Herbicides

These are organic chemicals which are used in a crop field or elsewhere to control weeds. Herbicides are of two types.

Selective herbicides

These herbicides are used against specific group of weeds and do not prove harmful for other crops. Pendulum, Surflan, Treflan, etc., 2, 4, 5-T, 2, 4-D, etc. kill broad-leaved weeds but do not harm monocots, while Fusilade (fluazifop) controls monocot weeds and not broad-leaved plants.

Non-selective

These are the herbicides that prove lethal to almost all monocots and dicots that come in its contact, e.g., diquat, glyphosate.

Classification of herbicides

Herbicides are classified based on the time of application

Pre-plant herbicides

This is a group of herbicides that is applied before planting the main crop. These herbicides may be fumigants or non-selective chemicals that are lethal to all plants which come in their contact. These are useful in controlling emerged, as well as, emerging weeds. Most of these are applied in soil. Some may be applied on weeds as spray in case of perennial weeds. Pre-plant herbicides include Dazomet, Diquat, Glyphosate, K-pam, metam sodium, pelargonic acid, etc.

Pre-emergence herbicides

These are applied to the soil immediately after sowing the seeds before crop emergence. These herbicides are of selective type, i.e., safest for the crop. Flumioxazin,

Isoxaben, Napropamide, Oryzalin (Surflan), Oxadiazon, oxyfluorfen, Pendimethalin, Prodiamine and Trifluralin are included in this group.

Post-emergence herbicides

These herbicides are applied when weeds and crops have emerged, usually two to three weeks after emergence. These are selective herbicides and used for a narrow range of weeds.

Broad-leaved weeds can be controlled through herbicides containing phenoxy group, e.g., 2, 4-D. Non-selective herbicides are those containing Glufosinate, Diquat, Glyphosate and Pelargonic acid, and plant oils, such as euginol.

Application of herbicides

Success of weed control depends on the method and time of herbicide application. Application of herbicide is more important than herbicides launched at the targeted foci accurately and in measured quantity only. Method of application is as important as the selection of proper herbicide. Different equipment is used for the application of herbicides according to formulation and area to be covered. On small holdings or in greenhouses, it can be applied through back pack hand pump sprayer. In big fields or farms, tractor unit may be more desirable. Over-the-top type sprayer is appropriate for commercial nurseries. To get the most uniform distribution of pre-emergence liquid herbicidal formulations, flat fan nozzles evenly spaced on a boom can be used. Hollow or cone nozzles on a boom is used in case of spraying post-emergence herbicides on weeds. Granular herbicides can be applied through common types of spreaders. Herbicides can be spread by the side-throw-type or drop-type of spreader.

Practical Exercises

Activity

Identify weeds and classify them.

Material required: Weed samples, notebook, pen, etc.

Procedure

Identify the given samples and write following information:

1. Name of the weeds
2. Type: Monocot/dicot/sedge
3. Annual/biennial/perennial

Check your Progress

Fill in the Blanks

1. Undesirable plant in the field that is responsible for economic losses to the human is called a _____.
2. Weeds are harmful as these compete with the _____ for nutrients, water, light and space.
3. Blue grass and chick weed are commonly seen in _____ soils.
4. Spurge pusley and knot weed show the presence of _____ in soil.
5. Young shoots of _____ can be used against asthma and blood disorders.

Multiple Choice Questions

1. Leguminous weeds are commonly seen on _____.
   (a) soil rich in nitrogen content
   (b) soil poor in nitrogen content
   (c) soil rich in phosphorus
   (d) soil rich in calcium
2. Examples of weed that can be used as myco-herbicide _____.
   (a) *Phytopthora sp.*
   (b) *Colletotrichum sp.*
   (c) Both (a) and (b)
   (d) None of the above

3. Herbicides which are applied after weed emergence are called _____.
   (a) pre-emergence herbicides
   (b) post-emergence herbicides
   (c) pre- planting herbicides
   (d) None of the above

Subjective Questions

1. What are weeds and their various types?
2. Describe pre-emergence and post-emergence herbicides.
3. Describe selective and non-selective herbicides.
4. What are the different methods of weed control?

Match the Columns

A	B
1. Monocot weeds	(a) Perennial weeds
2. Dicot weed	(b) Biennial weeds
3. Sedges	(c) Feeding on the weeds
4. Wild onion	(d) Taproot system with broad leaves
5. Pallister beetles	(e) Stem is hollow and round, internodes are short