Unit 3

Integrated Pest and Disease Management in Vegetable Crops

Introduction

Solanaceous vegetables are more susceptible to different types of pests like insects, nematodes and mites. In India, upto 50–80% yield loss of vegetable crops incurs due to various diseases. The crop loss caused by diseases, such as early blight of brinjal is 78%, wilt is 10–60%, Begomovirus is 100%, phomopsis blight is 30–50% and chili anthracnose is 30-80%.

The use of fungicides and insecticides in vegetables to control diseases and insect-pests is increasing because of intensive farming practices and expanding cultivation into new areas and in seasons beyond the traditional range of crops. Pesticides are synthetic compounds and are hazardous for the environment and also for non-target insects. Indiscriminate use and improper application of pesticides create ecological imbalances due to the destruction of beneficial insects and the emergence of pesticide resistant species and strains.

The increasing use of pesticides is a major factor for the rising cases of pesticide residue in vegetables. In the past, a single approach to control pests and diseases was in practice, which was neither economical nor safe. Therefore, a systematic approach of integrated pest or disease management (IPM or IDM) was adopted.

IPM includes all types of control measures, such as physical, mechanical, biological and chemical as per the suitability of application, that control the pest population below the economic injury level.

It is a multidisciplinary approach, which includes different tactics, such as analysis of habitat, knowledge of crop husbandry, soil tillage, healthy seeds, balanced fertilisers, well-timed irrigation, sanitation, recommended spacing, tolerant and resistant varieties, use of natural enemies, release of parasitoids and predators and the use of need-based biological and chemical pesticides or fungicides. In this unit, you will learn about insect-pests and diseases that damage solanaceous crops. You will also learn about the control measures for various pests and diseases including the IPM and IDM approach.

SESSION 1: MAJOR INSECT-PESTS OF SOLANACEOUS CROPS

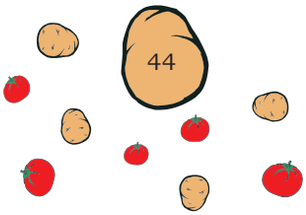
Insect-pests are a menace to vegetable production. They generally attack crop at all its stages. It is essential to adopt control measures for insect-pests at the right time to manage the pest population and minimise the yield loss. Knowledge about the insect-pests of the crop, the characteristics of the insects, their nature and the damage they cause helps to identify and manage the pest effectively.

Tomato Fruit Borer

Tomato fruit borer *(Helicoverpa armigera)* caterpillars are greenish in colour with dark brown and grey outline along the body. A caterpillar is the most active stage of tomato fruit borer. At a young stage, the larva feeds on tender foliage while at the advanced stage it bores circular holes in the fruit and feeds inside the pulp.

Control

- Use tolerant varieties like Punjab Kesari, Punjab Chhuhara, BT-1 and BT-32.



- Deep summer ploughing can expose the larvae and pupae to sunlight and predation of birds.
- Plant marigold (40 days old) as a trap crop with every 16 rows of tomato (25 days old) to attract the larvae. Collect the larvae from the marigold flowers and destroy them.
- Place 15-20 T-shaped bird perches per ha to invite insectivorous birds.
- Use HaNPV (*Helicoverpa armigera* nuclear polyhedrosis virus) @ 250 LE (larval equivalent)/ha during evening hours.
- Periodically release egg parasitoid, such as *Trichogramma chilonis or T. pretiosum* @ 1,00,000 egg /ha.
- In the early stages, spray 4% NSKE (neem seed kernel extract) to kill the larvae.
- Apply Novaluron 10 EC/1.5ml/l or Quinalphos 25 EC/2ml 40 SP/1g/l.

Aphids

Aphids or *Aphis gossypii* are soft bodied insects. They are also known as plant lice. The tiny insects may be green to black in colour and are found in a cluster on the tender parts of the plant. Tomato aphid adults are fragile, slender and minute with fringed wings. They harm the crop constantly by sucking sap from the lower leaves and the tender shoots of the plant. Aphids exude honey dew, which attracts ants and develops a sooty mold. The leaves curl up. They act as a vector for transmission of disease causing viruses.

Control

Spray the crop with dimethoate @ 0.03% or methyl demeton @ 0.025% or phosphomedon @ 0.04% for effective control of aphids.

Whitefly

Whitefly or *Bemisia tabaci* adults are white tiny scale-like insects covered with a white waxy bloom. Nymphs and adults both feed on the upper surface of

the leaves by sucking cell sap. The affected parts of the plant show yellowing and wrinkling of leaves. It also transmits leaf curl viral disease.

Control

- Remove weed hosts, which harbour the white flies to reduce the incidence of whiteflies and associated viral diseases.
- Treat seeds with imidacloprid 70 WS @ 2.5 g per kilogram to provide protection for 25–30 days.
- Use a nylon net (200 mesh) covering for 25–30 days to avoid insect infestation in the nursery.
- An alternate spray of neem seed kernel extract (NSKE) 4 per cent or neem soap @ 10g/litre and triazophos 40 EC, 10, 20, 30 and 45 days after transplanting, is effective for the control of white flies.

Leaf Miner

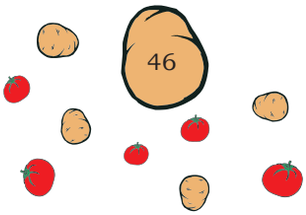
Leaf miner larvae are orange yellow and apodous. Maggots enter the leaf and eat the mesophyll of the leaves by making tunnels and zigzag structure on the leaves. Remove and destroy the severely infested leaves.

Control

- Spraying NSKE (neem seed kernel extract) @ 4.0 per cent along with sticker is effective. This pest can be controlled by spraying the crop with Cartap hydrochloride 50% SP @ 250–300 gram/acre.
- These natural enemies, particularly larval and pupal parasitoids, are active between the months of July-August.
- These parasitoids can be used to control leaf miner insect.

Leaf Hopper or Jassids

Leaf hopper or jassids (*Amrasca biguttula*) nymphs and adults are green and move diagonally when disturbed. They suck the sap from the leaves, leaving them yellow and curling upwards. In severe conditions, the leaves become brown, dry and fall down.



Control

- Treat the seeds with imidacloprid (3g/kg), which gives protection for up to 40-50 days after sowing. Also apply carbofuran @ 1.0kg/ha in the soil at the time of sowing.
- Dip the root of the seedling for one hour in imidacloprid17.8 SL @ 1ml/litre of water. This will protect the crop for 30 days after transplanting.
- Spraying NSKE @ 4% at an interval of 10 days is also effective.
- Applying imidacloprid 17.8 SL @ 0.35 ml per litre or thiamethoxam 25 WG @ 0.35 ml litre, after 25 days of transplanting, at an interval of 10-15 days is also effective.

Shoot and Fruit Borer

Leucinodes orbonalis have black and brown patches and dots show on the white forewings of the moth. The larvae are light pink in colour. Initially, the larvae bore into shoots and kill the growing point of the plant. The affected shoot wilts or droops. Adult caterpillars bore into the fruits. At the entrance hole, fecal pellets are visible.

Control

- Regularly clip and burn the affected and withered dead shoots and leaves.
- Spray Fenpropathrin 30 EC @ 0.75 ml/l or Emamectin benzoate 5 SC @ 0.35 G/litre, alternatively at 15-day intervals when the plant is in the vegetative and flowering stage. It is effective against shoot and fruit borer.
- Use sex pheromone lucilure @ 100 traps/ha at 20-25 days intervals.

Chili and Capsicum

Thrips

Scirtothrips dorsalis and Thrips palmi are minute insects with fringed wings. Both adults and nymphs damage the crop and lacerate leaf tissues and curl

the leaves inwards. This incidence is severe during dry periods.

Control

- Sow seed after treatment with imidacloprid 70WS @5-10 gram / kg seed.
- Cover the nursery with nylon net (200 mesh) to protect nursery plants from thrips till the plant is 25-30 days old.
- Foliar apply acetamiprid 20SP @ 0.2 ML / litre water or dimethoate 30 EC @1.5 ml / litre water or Emamectin benzoate 5SG @0.4 gram /litre water or imidacloprid 17.8SL @0.5 ml/litre water at an interval of 10-15 days.
- Avoid spraying same chemical repeatedly. Stop foliar spray of chemicals before 10 days of flowering.
- Trips can be controlled by blue polyethene coated with a sticky material like castor oil or grease (20-25polyethene/ hac) at equal distance.

Mites

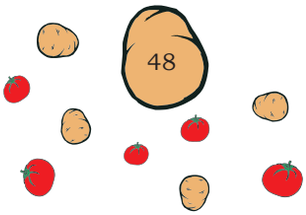
Polyphagotarsonemus latus, Tarsonemus translucens and Tetranychus cinnabarinus are very small and white in colour. They are difficult to see with naked eyes. They make the leaves curl downwards.

Control

Foliar Spray Buprofezin 25 SC @ 1.2 ml/litre water or Chlorfenapyr 10 SC @ 2ml/ litre water or Dimethoate 30 EC @ 2ml/ litre water or Fenpyroximate 5 EC @ 1.2 ml/litre water at 10-15 days interval is effective to control mites.

Green Peach Aphid

Green peach aphid or *Myzus persicae* are tiny, succulent, pear-shaped and vary in colour from yellow and green to black. They appear on newly emerging shoots and on the lower side of the leaves. They suck the sap from the tender parts and affect the plant's vigour. They secrete a sweet substance, which attracts ants and also form a sooty mould.



Control

Treat seeds with imidacloprid 70 WS @12 g/kg of seed. Foliar apply thiamethoxam 25WG @ 80 gm/acre or emamectin benzoate @0.5 ml/litre of water.

Insect Pests of Solanaceous Vegetables

Fig. 3.1: Whiteflies in tomato

Fig. 3.2: Aphids in tomato

Fig. 3.3: Leaf hopper in brinjal

Fig. 3.4: Aphids in brinjal

Practical Exercise

Activity 1

Identify the symptoms caused by mites and thrips in chili.

Material required

Infested specimen of chili

Procedure

1. Examine the sample carefully.
2. If the leaf shows upward curling (cupping) it has been infested by thrips.
3. If the leaf shows downward curling it is attacked by mites.
4. Suggest suitable control measures.

Activity 2

Identify the major insect pests in your nearby area.

Material required

Insect net, collection box and writing material.

Procedure

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

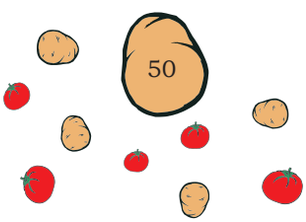
Check Your Progress

A. Fill in the blanks

1. Tomato's fruit borer can be kept away from the crop by growing _____ as trap crop.
2. Adults of _____ are fragile, slender and minute with fringed wings.
3. Maggots of _____mines into the leaf and feeds on the mesophyll of the leaves.
4. Leaf hopper or jassids' leaves become yellow and _____.
5. The leaves of the chili plant affected by _____show downward curling.
6. Larvae of _____bore into shoots and kill growing point of brinjal plant.

B. Multiple choice questions

1. The most active stage of insect of fruit borer of tomato is _____.
   (a) adult
   (b) caterpillar
   (c) Both (a) and (b)
   (d) None of the above
2. The number of pheromone traps used to control the moths of chili fruit borer are _____.
   (a) 5 trap/ha
   (b) 7 trap/ha
   (c) 9 trap/ha
   (d) 11 trap/ha
3. Which one of the following is an egg parasitoid?
   (a) *Tetranychus cinnabarinus*
   (b) *Epilachna*
   (c) *Trichogramma chilonis*
   (d) None of the above



4. In thrips infestation _____.
   (a) leaves curl upwards
   (b) leaves curl inwards
   (c) growing point kills
   (d) holes can be seen in the fruit
5. Aphids damage crop by _____
   (a) sucking cell sap
   (b) secreting sugary substance
   (c) vector of virus
   (d) All of the above

C. Subjective questions

1. Explain brinjal's fruit and shoot borer and its control measures.
2. What are the control measures of tomato's fruit borer?
3. Write about chili's fruit borer and its control measures.

D. Match the columns

A	B
1. Aphids	(a) Sex pheromone
2. LuciLure	(b) Yellowing and wrinkling of leaves
3. Whitefly	(c) Zig-zag pattern on leaves
4. Leaf miner	(d) Kills growing point of plant
5. Shoot and fruit borer	(e) Vectors

SESSION 2: MAJOR DISEASES OF SOLANACEOUS CROPS

What is a Disease?

A successful interaction between virulent pathogen and susceptible host in favourable conditions is called disease. Diseases are caused by fungi, bacteria and viruses. Disease causing organisms are called pathogens. Pathogens may be soil borne, carried through seeds or disperse through wind and water. Some viral diseases are transmitted by insect vectors. Some of the most common diseases of solanaceous crops are anthracnose, wilt, bacterial spot, bacterial blight, damping off, early blight, late blight, leaf curl, mosaic, powdery mildew, rots, and septorial leaf blight, little leaf, leaf curl, bacterial canker, buck eye rot, fruit rot, etc.

A few of the major diseases of solanaceous vegetables have been discussed below.

Damping off

This is a common disease among nursery plants, tomato seedlings, chili and brinjal that are generally attacked by the soil borne fungi. Fungi like *Phytophthora*, *Pythium* sp. are the causal organisms. Fungi infect seedlings in the collar region causing decay of tissues. Infected seedling cannot stand upright and collapse. It is commonly seen during the rainy season and under water stagnation conditions.

Control

- During the rainy season, the seedlings should be grown on a raised bed.
- Soil solarisation and sterilisation may reduce the soil borne inoculum of fungi.
- Soil drench with mancozeb or carbendazim (2-3g/ litre of water) also reduces infection.
- Treat the seed with trichoderma 5g/kg seed.

Early blight

It is a fungal disease commonly seen in tomato, brinjal and potato. The causal organism of this disease is *Alternaria alternata* f. sp. *lycopersici* and *Alternaria solani*. Irregular brown leaf spots appear on a marginal portion of leaves, which enlarge and become necrotic patches. Fungi is dispersed through air and favoured by high temperature.

Control

Two foliar sprays of mancozeb 2 gm/litre or zineb 75 WP @ 1.5-2 gm/litre of water are beneficial.

Phomopsis blight of brinjal

It is a fungal disease of brinjal caused by *Phomopsis vexans*. Clearly defined circular, light brown spots appear on the lower leaves. On fruits pale to light brown sunken spots develop, which later coalesce to form bigger patches.

Control

- Use disease-free seed material.
- Treat the seed with carbendazim 2.5 gm/kg of seed.
- Collect and burn the diseased twigs and plan material.
- Foliar spray with carbendazim 0.1% or 0.15% carbendazim + mancozeb (1.5 gm/litre of water) is found to be effective.

Anthracnose or die back of chili

It is a fungal disease caused by *Colletotrichum capsici*. Fungus is seed borne, which also disperse through wind. It starts from tender twigs from the top of the plant causing necrosis and withering. Drying starts from top to bottom, hence it is called die back. Small, irregular, sunken, light brown lesions with concentric rings can be seen on leaves, shoots and fruits.

Control

- Treat the seed with carbendazim @ 2.5 gram/kg seed.
- Remove and burn diseased parts of the plant.
- Foliar spray of Chlorothanonil 25 EC @1.5 gram/ litre water or propineb 3.5 gram/ litre water is found effective for control of the disease.

Bacterial wilt

It is a common disease of all solanaceous vegetable crops. Bacterium *Ralstonia solanocearum* is found associated with the disease. Sudden wilting of plant without yellowing and collapse of entire plant are primary symptoms. When an infected plant is cut and dipped in a glass of water, a thread like milky substance oozes out from the cut end of the stem.

Control

- Use disease resistance varieties.
- Adopt long-term crop rotation without solanaceous crops.
- pH of soil should not acidic.
- Before transplanting, treat the roots of the seedling with streptocycline 150 ppm (1 gram in 6 litre water) for 30 minutes.

Fusarium wilt

Leaves of the affected plants become yellow and droop. Later it may cause the death of the whole plant.

Control

- Avoid continuous solanaceous crop cultivation on the same piece of land.
- Treat the seed with carbendazim @ 2.5 gm/kg seed before sowing.
- Spraying tebuconazole @ 1 gram/ litre or carbendazim @ 0.2% at one week intervals is found to be effective.

Leaf curl disease

It is an important viral disease of the tomato and chili plant. The virus is transmitted by the whitefly. The leaves show downward rolling, curling, twisting and chlorosis. The plants show stunted growth with short internodes. It gives a bushy appearance to the plant. Such plants do not bear flower or fruit at a later stage.

Control

- To avoid whitefly attack, the nursery should be covered with a nylon net (40 mesh) or sprayed with insecticide @ 4-6 days interval to check the transmission of the disease.
- Uproot and destroy the infected plant as soon as it is seen, otherwise it could cause further infection and spread of disease.
- Use barrier crops like maize, bajra and sorghum.
- Place yellow sticky traps (20 traps/ha) to control the vectors.
- Spray the crop with imidacloprid (3 ml/ 10 litre water) to avoid infestation of whiteflies.
- At the time of transplanting, dip the roots of the seedlings in imidacloprid 17.8SL@0.5 ml/litre water for 2 hours to control the disease.

Little leaf of brinjal

The characteristic symptoms of this disease are excessive shortening of leaves. Numerous leaves aggregate in a bunch giving a bushy appearance. Due to shortening of internodes the plant becomes a dwarf. The infected

plants are totally unproductive and do not bear flower or fruit. Organisms like Mycoplasma are responsible for this. The pathogen is transmitted by vector leafhopper.

Control

- Uproot infected plants and burn them as soon as the first sign of initial symptoms appear.
- Avoid early transplanting to escape leafhopper population.
- Spray imidacloprid 3 ml/10 litre water to avoid the secondary infection of the disease.

Root knot nematode

Soil borne nematode *Meloidogyne incognita* infests almost all solanaceous vegetables through the roots. Nematode develops inside the root, causing swelling and knots. This affects the uptake of water and minerals from the soil, ultimately affecting the growth of the plant.

Judicious or need based application of nematicides is recommended. Application of Carbofuran 3G @ 1 kg ai/ha is found effective for vegetable crops under field condition.

Diseases of Solanaceous Vegetables

Fig.3.5: Early blight of tomato

Fig.3.6: Late blight of tomato

Fig.3.7: Leaf curl in tomato

Fig.3.8: Root knot in tomato

Fig.3.9: Phomopsis blight in brinjal

Fig.3.10: Little leaf in brinjal

Fig.3.11: Cercospora leaf spot in brinjal

Fig.3.12: Fusarium wilt in tomato

Practical Exercise

Activity 1

Identify the symptoms caused by bacterial wilt in brinjal and chili crops.

Material required

Infected chili or a brinjal plant, knife, glass and water, etc.

Procedure

1. Observe the infected plant.
2. Select the plants that show wilting in the field.
3. Fill a glass with water.
4. Cut the stem of the affected plant with the help of a knife.
5. Put the cut end into a glass of water.
6. Observe the milky secretion oozing out from the cut end of the stem.
7. Bacterial wilt affected plants will show symptoms of a thread like milky ooze.

Activity 2

Identify disease specimens of solanaceous crops.

Material required

Magnifying glass, disease specimens, pen, notebook, etc.

Procedure

1. Visit a nearby vegetable field and identify the crop.
2. Collect diseased samples from the field.
3. Observe the disease sample or specimen carefully.
4. Observe the symptoms with the help of magnifying lenses.
5. Write down the name of the disease.
6. Write down the name of the causal organism.
7. Write down the control measures.

Check Your Progress

A. Fill in the blanks

1. _____ is a disease at nursery stage.
2. _____ is a disease caused by coplasma like organisms.
3. In _____ disease, wilting is observed from top to bottom.
4. Knotting on roots is caused by _____.
5. Leaf curl in chili is caused by _____.

B. Multiple choice questions

1. In which disease is formation of a concentric ring found?
   (a) Anthracnose
   (b) Late blight
   (c) Wilt
   (d) None of the above

2. Irregular brown spots on the leaves during the early period of growth is observed in _____.
   (a) late blight
   (b) damping off
   (c) leaf curl
   (d) early blight
3. Damping off is a disease of _____
   (a) leaves
   (b) fruits
   (c) seedling
   (d) flowers
4. Milky white ooze from a cut stem is the sign of _____ infection.
   (a) nematode
   (b) bacterial
   (c) fungal
   (d) viral

C. Subjective questions

1. Write short notes on the following
   (a) Early blight of tomato
   (b) Late blight of potato
   (c) Leaf curl disease in chili
   (d) Little leaf of brinjal
   (e) Root knot nematode in solanaceous crops
2. What are the major differences between late blight and early blight?
3. Write the symptoms of damping off with its effective management practices.

D. Match the columns

A	B
1. Root knot	(a) Streptocycline
2. Leaf hopper	(b) Reduce nematode population in the soil
3. Soil drenching	(c) *Meloidogyne incognita*
4. Bacterial wilt	(d) Transmitted little leaf of brinjal
5. Marigold	(e) Carbendazim

SESSION 3: INTEGRATED PEST AND DISEASE MANAGEMENT OF SOLANACEOUS CROPS

Integrated Pest Management (IPM)

Integrated pest management is an efficient and economical approach to controlling pests in crops.

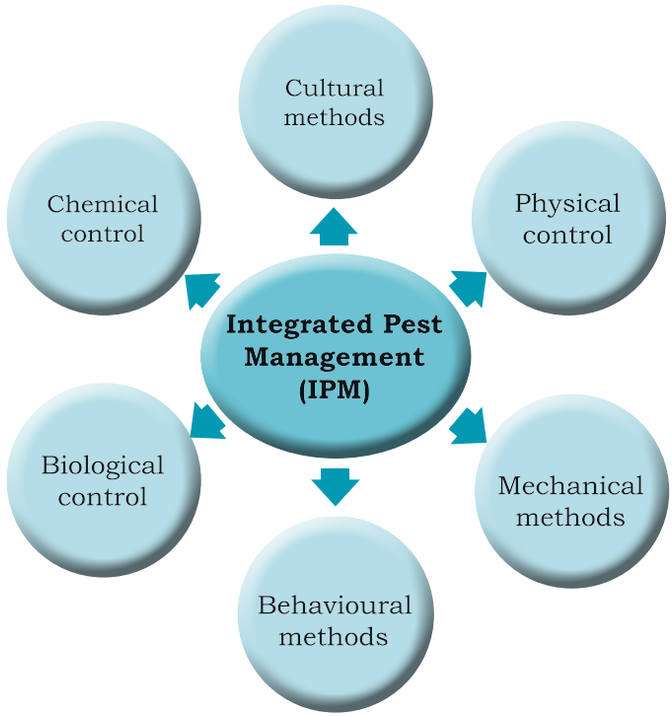


Fig.3.13: Integrated Pest Management (IPM)

It makes use of virtually all methods of pest control, including natural pesticides, beneficial insects, special cultivation practices, and even chemical pesticides in the right measure at the right time. Some practical techniques of IPM are described below. (Fig. 3.13)

Cultural methods

Routine agronomic practices can be utilised for minimising pest infestation by slight modification in timing or method of their application. These functions are preventive methods. The field operations right from field preparation to harvesting or post harvesting can reduce the population of one pest species or the other.

Resistant cultivars

Grow insect and disease resistant varieties recommended for specific regions. Chilli, Pusa, Sadabahar variety is resistant to mites and thrips, Kashi Gaurav variety is tolerant to thrips and resistant to fruit rot. Tomato, Kashi Aman variety is resistant to leaf curl and Kashi Abhay is a hybrid tolerant to leaf curl. Brinjal, the fruits of Pant Samrat variety is moderate against stem borer insect.

Clean cultivation

Destroy unwanted crop stubble after the crop is harvested. Destruction of cucurbit vines and stubbles of rapeseed mustard after the crop season kills the population of pumpkin beetle and painted bug, respectively.

Tillage

Deep ploughing and intercultural operations expose pests, such as army worm, cut worms, borers and white grubs, termites, and mole cricket to the vagaries

of nature. Thus, this helps to reduce pest infestation in crops.

Sowing time

The change in sowing or planting time is aimed to disturb the synchrony between the host and pest populations. Early sown cucurbits and rapeseed-mustard escape the attack of pumpkin beetle and aphids, respectively.

Intercropping

It helps in reducing the incidence of certain pests by making microclimate less favourable for them. It also hinders free movement of pests among plants of the same species. Intercropping of cabbage with tomato reduces the infestation of diamond black moth, while that of tomato with marigold is useful in checking fruit borer and nematodes.

Crop-rotation

It means altering the category of crop grown on a specific area of land from year to year. Crop rotations are mostly done in a span of 3 to 7 years. Avoid growing the same crop, or crops of the same family, over and over again in the same field. Ratooning should be avoided as it promotes the survival of brinjal shoot and fruit borer. Avoid sequential cultivation of vegetable cultivars as they are more prone to attack by insect pests and needs effective protection for profitability.

Trap crops

A 'trap crop' is grown as a companion to the main crop to attract pests away from the main crop. To reduce the incidence of diamond black moth, leaf webber, web worm and aphids, grow mustard as a trap crop with cabbage. Marigold planted with tomato as a trap crop is highly effective against fruit borer.

Nutrient and water management

Fertilisers should be applied in a balanced manner. Excessive use of nitrogenous fertiliser intensifies the incidence of sucking pests, such as jassids, whiteflies and aphids. Likewise, excess use of water should also be avoided as humidity increases pest population.

Physical control

It is the method of reducing pest population with the help of devices that influence them physically or adjust their physical environment. Manipulation of temperature, humidity and light is used for this purpose, for example, the use of light traps, pheromone lures, hot water treatment,etc.

Mechanical methods

This reduces pest control by manual devices. Mechanical methods along with physical and cultural methods are effective in reducing pest populations.

Behavioural methods

Use insect traps to monitor or directly reduce the population of insects. In this method visual lures, chemical attractants, sticky bands and pheromones are installed to attract insects.

Pheromone trap

- Pheromones may attract only the male insect.
- Use of Helilure for tomato fruit borer, Erivitlure for lady finger fruit borer, and *Leucine lure* for brinjal shoot and fruit borer is recommended as female sex pheromones are beneficial.
- Use methyl eugenol traps against fruit flies.
- Pheromone traps can be used either for monitoring (5 traps/hectare), mass trapping or mating disruption (25 or 100 traps/ha).

Biological control

Insects have some natural enemies. Predators, parasitoids, microbes, birds and other animals are useful in minimising insect pests.

- **Predators** are organisms that feed on other insects. The organism is called predator and the insect is known as the prey. For example, a lady bird beetle feeds on aphids. Birds like crow, egret, cuckoo, woodpecker, stork, warbler and babbler feed on insects. Owls, bats and peacocks help to control rat and mice population.

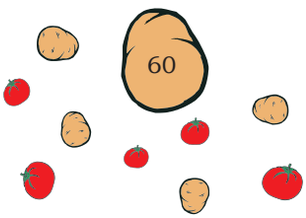


Fig.3.14: Biological pest control A spotted lady beetle(Adalia bipunctata) feeding on an aphid colony

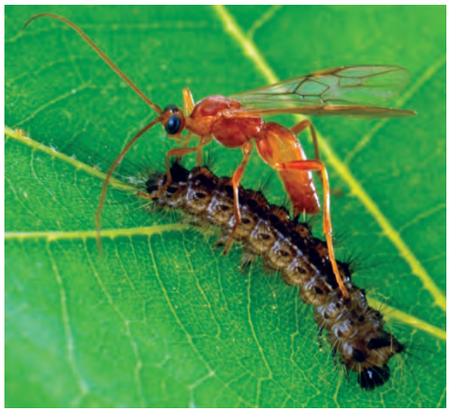


Fig.3.15: Biological pest control A parasitoid wasp (Aleiodes indiscretus) laying eggs on a caterpillar

- **Parasites** feed on other insects' body parts, internally or externally. For example, *Trichogramma chilonis* feeds on the eggs of *Helicoverpa armigera* (fruit borer of tomato).
- **Pathogens** are microorganisms developed to help in the killing of pests. This includes bacteria, viruses, fungi, etc.
- **Virus** Ha-NPV (*Helicoverpa armigera* Nuclear polyhedrosis virus) is used against tomato fruit borer.
- **Botanical insecticides** are naturally occurring chemical substances (insect toxins) extracted or derived from plants. They are also called natural insecticides.
  - **Neem** contains many active compounds like azadirachtin, which acts as feeding deterrents. It is effective on several types of insects, mites and nematodes. Neem oil (2-5 per cent)is found effective and neem cake (250 kg/ha)helps control fruit and shoot borer.
  - **Nicotine** is derived from tobacco and is used to control insects, such as aphids and mites in greenhouses.
- Use pesticides judiciously, that is, the right pesticides, in the right amount, at the right time, in the right place.
- Apply chemical pesticides only when other effective methods are not available.
- Choose less toxic and less persistent pesticides.

- Choose selective pesticides which control the pest species but leave beneficial species and neutral species unharmed.

Integrated Disease Management (IDM)

IDM involves timely use of various combined measures to reduce the pathogenic invasion. This involves site selection and preparation, altering the planting practices, use of resistant cultivars, modifying the environment, pruning, thinning shading, etc., and use of pesticides, if required. Along with this, following conventional techniques, monitoring environmental factors, disease forecasting and establishing economic thresholds are also important. The disease incidence can be minimised or eliminated by adopting the following tactics.

Cultural methods

- **Tillage**— soil-borne fungi, bacteria and nematodes that serve as sources of infection, perpetuate in the soil. When the soil is ploughed they get exposed to the sun's high temperature. This reduces their population or activity within the soil.
- **Field sanitation**— plant pathogen (fungi, bacteria, and virus) that survives on previous crop residues and weeds in the field can serve as a major source of inoculum. Clean cultivation means the removal of crop residues and keeping the bunds clean to minimise pest population in the field. Plant disease can be controlled by regularly destroying diseased plants or weeds. This disrupts the disease cycle and is an effective source of control.
- **Crop rotation**— availability of susceptible hosts every season or year after year increases the survival or persistence of diseases. Crop rotation with crops of other groups or different families breaks their persistence. Starving pests by making susceptible hosts unavailable for a long time makes it difficult for the pests to survive.
- **Resistant varieties**— such varieties of flower crops provide one of the most successful approaches to the control of plant pathogens in many crops,

especially those that cannot be controlled by other means. Some cultivars are resistant to a particular disease and are, therefore, 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 dodges the pathogens. Certain diseases, such as early blight and late blight are time-bound and require a particular stage of growth of the plant to infect. Unavailability of susceptible stage keeps the infection at bay.
- **Seed treatment**— most of the seed and soil borne diseases, such as damping off, wilt, rots, dieback, anthracnose, etc. attack the crop through seed or soil. Seed treatment reduces the chances of infection.
- **Crop density**— high density of crop means incidence of many diseases. Infections can move easily from diseased to healthy plants in a dense field. It is, therefore, desirable to plant the crop with proper spacing.

Mechanical methods

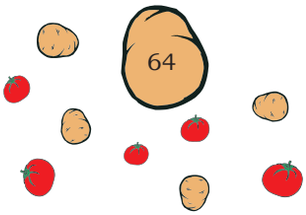
It includes uprooting or pruning of diseased plants or parts so that the infected plants or parts do not transmit pathogens to healthy ones. Training and staking the crop helps the plants so that their leaves do not come in contact with the soil and thereby controlling infection or infestation. Erecting nets, sticky bands and mechanical traps control insect-vectors that may transmit viruses.

Bio-control of plant diseases

Soil-borne diseases of tomato, brinjal, chilli and capsicum caused by *Pythium, Phytophthora, Rhizoctonia, Fusarium, Alternaria* and *Colletotrichum* species can be parasitised by *Trichoderma harzianum, Trichoderma viride and Gliocladium virens*. These bio-agents are effectively used either as soil application or seed treatments. The *Aspergillus niger* has been proved useful against *Fusarium* spp.

Chemical control

- **Use of fungicides**— chemical or a combination of chemicals lethal to the fungi that saves the host from infection is called fungicide. Fungicides, according to their movement in the plant system, are of two types. The first one is systemic,which when applied on plants dissolves on the cell sap and is effective for the whole plant irrespective of where it is applied. For example, benlate, carbendazim, metalaxyl, thiobendazol, propiconazole, etc. The second one is contact fungicide whose action is restricted to the area of the plant where it is applied. The examples are sulphur, mancozeb, zineb, etc
- **Fungicide application**— soil drenching should be undertaken when plants have a case of soil-borne infection of fungi (wilt, damping off, root rot) or nematodes (root-knot). Such fungicides are carbendazim, maneb, etc., and the Formaldehyde used for sterilization of seed bed.
- **Seed treatment**— this is a simple way to avoid infection in the soil and the seed. Generally, seeds are treated @ 2.0–2.5 g fungicide/kg of seed. A seed dressing drum or earthen pitcher can be used for treating the seeds. Fungicides used are carbendazim, carboxin, oxathin, etc.
- **Foliar application**— the aerial parts affected by foliar disease can be controlled by the foliar sprays of the fungicidal formulations. Specialised sprayers are available for the treatment. Generally, fungicides are sprayed along with compatible insecticides. This reduces the cost of application. These fungicides are sulphur, copper oxichloride, maneb, zineb, nabam, etc.
- **Dip method**— in this method, before planting, seedlings and cuttings are dipped in the fungicidal solution for a certain period to avoid infection. The solutions could be carbendazim, maneb, sulphur, zineb, etc.



Practical Exercise

Activity 1

Managing aphids and whiteflies by using yellow sticky cards.

Material required

Yellow and blue sheet of plastic, thermocol sheets, a wooden stick, cello tap, and adhesive (gum)

Procedure

1. Arrange the above items to prepare a sticky yellow or blue card or trap.
2. Cut the plastic sheet and thermocol 9×6 inch in size.
3. Fix the yellow or blue plastic sheet on both sides of the thermocol with the help of cello tap.
4. Attach the wooden stick on one side of the thermocol for support and make a board.
5. Paste gum on both the sides of the plastic sheet.
6. Place the board in the field of any crop just 6 inch above the crop height.
7. Next day, visit the field and observe the sticky trap cards.
8. You will find many insects on the board.
9. Identify the insects and count them.
10. Follow control measures according to the population of a particular insect.

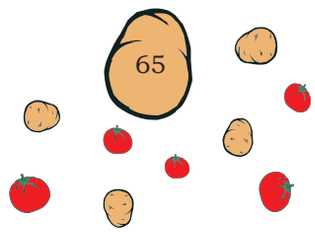
Check Your Progress

A. Fill in the blanks

1. Intercropping of cabbage with tomato reduces infestation of _____.
2. Ratooning encourages shoots and fruit borer in _____crop.
3. A crop grown as a companion that attracts pests away from the main crop is called _____.
4. Excess use of _____intensifies the incidence of sucking pests.
5. A pheromone trap attracts only_____ insects.
6. Methyl eugenol traps are useful against _____.
7. A lady bird beetle is a kind of _____.

B. Multiple choice questions

1. Organism that feeds on other insects is called _____
   (a) antagonist
   (b) predators
   (c) parasitoids
   (d) None of the above



2. Botanical pesticides are obtained from _____
   (a) animals
   (b) fungus
   (c) plants
   (d) bacteria
3. Which of the following is not a sucking pest?
   (a) Fruit and shoot borer
   (b) Aphid
   (c) Mites
   (d) White fly
4. Damping off disease by using Carbendazim is a_____
   (a) chemical control
   (b) biologicalcontrol
   (c) mechanical control
   (d) cultural control
5. Trichoderma sp. can be used to control _____ disease.
   (a) soil borne
   (b) water borne
   (c) air borne
   (d) viral

C. Subjective questions

1. Write a brief note about integrated disease management.
2. Describe the cultural methods of pest management.
3. Discuss the mechanical and behavioural methods of pest management.

D. Match the columns

A	B
1. Systemic fungicide	(a) Tobacco plant
2. HA-NPV	(b) Plant extract
3. Neem	(c) Benlate
4. Botanical insecticides	(d) Tomato fruit borer
5. Nicotine	(e) Azadirachtin compound