Chapter 11

MANAGEMENT OF IMPORTANT INSECT-PESTS AND DISEASES OF VEGETABLE CROPS

OBJECTIVES

After studying this chapter, students will be able to:

- Understand about harmful effect(s) of insect-pests and disease infestation in vegetable crops
- Identify the major insect-pests and diseases of vegetable crops
- Recognize the symptoms of important insect-pests and disease infestation
- Management practices to control disease and insect-pest infestation including integrated pest management strategies in vegetable crops.

INTRODUCTION

As in human beings we have many diseases like typhoid, malaria *etc.* Likewise, plants also affected by many pests and diseases which affect normal growth and development. Infection by pests and diseases in vegetable crops causes huge loss in terms of yield and quality of produce. Hence, identification of various diseases and pests in early stages and their immediate management become very necessary. There are various categories of pests and diseases that infect vegetables crops. Pests include insects, mites, rodents, animals, birds *etc*. Insects are the major and important pests which causes damage in different ways *viz.*, sucking sap from plants; biting plant parts; boring into the fruits, twigs and leaves; damaging roots and flowers. Fungi, bacteria, viruses and mycoplasmas are the major organisms which cause various diseases in vegetable crops. Disease infested plants shows particular symptom on plants *e.g.* powdery mildew, downey mildew, rust *etc*.

Do you know?

* A horn worm can eat an entire tomato plant in one day!
* The potato disease "Late Blight" was the principal cause of the Irish Potato Famine, which killed a half million people.

Another group of microorganisms that causes significant loss to vegetable crops are nematodes. Nematodes are thread like microorganism. They are sub-terranean in habit and damage roots of various vegetable crops leading to the development of symptoms similar to that of nutrient deficiency symptoms. The most prominent symptom of nematode damage in vegetable crops is swelling of roots (gall formation).

In this chapter, we will learn about various insect-pests and diseases of vegetable crops and their management practices. Different types of insects and pathogens attack vegetable crops and cause reduction in yield and quality of produce. To overcome the harmful effect(s) of insects and pathogens, the of management practices are broadly caterorised as:-

1. Preventive measures
2. Protective measures.

Preventive measures are used before the attack of pest/pathogen and protective measures are used after the pest/pathogens attack. In general, pests and diseases can be managed by following methods:

1) Mechanical methods:

- Manual picking and destroying the pests, larvae or the diseased parts
- Removal of infested plants or plant parts and their complete destruction

2) Cultural methods:

- Crop rotation: Growing a series of different/dissimilar types of crops in the same area in sequential season. This method helps in non-establishment of pest and pathogen population.
- Deep ploughing of field: This method result in destruction of eggs, larvae, adult insects, and fruiting body of pathogens present in the soil.
- Clean cultivation *i.e.* weed / debris free cultivation
- Proper use of fertilizers and water
- Growing resistant varieties
- Timely or late sowing and proper harvesting

3) Chemical methods:

Chemicals are used to kill the insect-pests and pathogens. These chemicals which kills insect are called pesticides/insecticides, which kills fungus are called fungicide, which kills mites are called acaricide and which kills nematodes are called nematicide and so on. Chemical control method is used as curative method. This method should be used carefully because improper use is hazardous to environment and human health, and also may lead to development of resistance in insect- pests/pathogens against that particular chemical thereby causing heavy out-break.

4) Biological methods:

Use of bio-control agents to control pests and pathogens are called biological methods. Bio-control agents are generally predators, parasites or beneficial micro-organisms *e.g.Bacillus* (Bt)*, Trichogramma,* NPV, neem / castor formulations *etc.*

Check your progress

Match the following

	A		B
1.	Pest	a.	Used after the pest/pathogens attack
2.	Preventive measures	b.	Mite
3.	Protective measures	c.	Powdery mildew
4.	Disease	d.	Used before the attack of pest/pathogen

Integrated pest management (IPM)

Integrated pest management (IPM) means careful combination of all available pest and disease control techniques and subsequent integration of appropriate measures to manage and control pest and pathogen population. IPM is not a single pest control method but, rather, a series of pest management evaluations, decisions and controls. In practicing IPM, growers who are aware of the potential for pest infestation follow a four-tiered approach. These four steps include:

1. **Set action thresholds**

   Before taking any pest control action, IPM first sets an action threshold. A point at which pest populations or environmental conditions indicate that pest control action must be taken. Sighting a single pest does not always mean control is needed. The level at which pests will either become an economic threat is critical to guide future pest control decisions.

2. **Monitor and identify pests**

   Ii is not necessary to control all insects, weeds, and other living organisms require control. Many organisms are harmless, and some are even beneficial. IPM programs work to monitor pests and identify them accurately, so that appropriate control decisions can be made in conjunction with action thresholds. This monitoring and identification removes the possibility of using pesticides when they are not really needed or that the wrong kind of pesticide will be used.

3. **Prevention**

   As a first line of pest control, IPM programs work to manage the crop to prevent pests from becoming a threat. In an agricultural crop, this may include using cultural methods, such as rotating between different crops, selecting pest-resistant varieties, and growing pest-free plants/seeds of vegetable crops. These control methods can be very effective, cost-efficient and pose little to no risk to people or the environment.

4. Control

Once monitoring, identification, and action thresholds indicate that pest control is required, and preventive methods are no longer effective or available, IPM programs then evaluate the proper control method both for effectiveness and risk. Effective and less risky pest control measures are chosen first, including highly targeted chemicals, such as pheromones to disrupt pest mating, or mechanical control, such as trapping or weeding. If further, there are indications that less risky control measures are not working, then additional pest control methods would be employed, such as targeted spraying of pesticides/fungicides. Broadcast spraying of non-specific pesticides is a last resort.

Major insect-pests of important vegetable crops and their management

Usually the larvae or the nymph of the insects cause the damage. The insects can cause damage in two ways: Chewing and sucking.

The most common chewing insects are:

1. Beetles, grasshoppers and caterpillars on leaves
2. Bollworms, fruit fly larvae and codling moths on fruits
3. Termites and borers on stems and roots
4. Cutworms on seedlings and stems
5. Weevils on seeds.

The most common sucking insects are:

1. Aphids on leaves
2. Mites and stinkbugs on leaves and fruits
3. Thrips and red spider mites on leaves and fruits
4. Scale insects on fruits, shoots and branches
5. Fruit piercing moths on fruits.

It is very important to identify the insect and their life-cycle for better management practices. The major insects of important vegetable crops and their identification/symptoms of damage are summarized here under.

TOMATO

1. Fruit borer *(Helicoverpa armigera):* Eggs are creamy white in colour and laid singly on leaves. Larva color varies from greenish to brown. It has dark brown grey lines on

the body with lateral white lines and also has dark band. Pupa is brown in colour, occurs in soil, leaf, and crop debris.

Adult

Larvae

Infected fruit

Fruit borer of tomato

An adult female is light pale brownish yellow fleshy moth and the male is pale greenish moth with V shaped specks.

Symptom of damage

- Young larvae feed on tender leaves
- The larvae bore into the fruits and make them unfit for consumption and marketing.

Management

- Collect and destroy affected fruits and larvae.
- Install pheromone trap
- Spray biological pesticides like NPV, *Bt (Halt, Dipel)*
- Use Coragen @ 0.3 ml/ lit or Indoxacarb 14.5 % SC @ 0.3 ml/ lit as chemical control

2. Serpentine leaf miner (*Liriomyza trifolii):* Larva is minute yellowish orange coloured maggots. Pupa is yellowish brown and adult is pale yellow in colour.

Management

- Collect and destroy mined leaves
- Spray Neem seed kernal extract 5% @ 5.0 ml/lit

Serpentine leaf miner symptoms

3. Leaf eating caterpillar (*Spodoptera litura):* Eggs appear in golden brown masses. Larva is pale greenish with dark markings and gregarious in the early stages. Adult

have brown colour with wavy white marking on forewing and white colour with a brown patch along the margin on hind wing.

Symptoms of damage

- Young larva scrap leaves on ventral surface
- Defoliation (Shedding of leaves) occurs

Leaf eating caterpillar

Management

- Deep ploughing during summer season with mould board plough
- Install light trap and pheromone traps
- Spray biological pesticides like SI- NPV
- Spray chlorpyriphos 20 EC 2lit/ha or Dichlorovos 76 WSC 1 lit/ha

White fly (adult and nymph)

4. Whitefly (*Bemisia tabaci):* Egg-Pear shaped, light yellowish, stalked. Nymph is oval, scale-like, greenish white. Adults are white, tiny and scale-like.

Symptoms of damage

- Chlorotic spots
- Yellowing
- Downward curling and drying of leaves.
- Vector of tomato leaf curl virus.

Symptom of damage of Tomato leaf curl virus (transmitted by Whitefly)

Management

- Uproot and destroy the affected leaf curl plants with curled leaves.
- Balance and judicious use of nitrogen and irrigation.
- Use yellow sticky traps to attract and kill insects.
- Use Imidachlorprid 17.8 SL @ 0.3 ml/ lit or Acetamaprid 20% @ 0.3 g/ lit or Thiamethoxam 25 % WG @ 0.3 g/ lit as chemical control.

BRINJAL

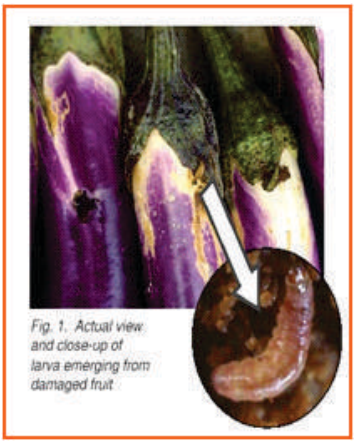
1. Shoot and fruit borer (*Leucinodes orbonalis):* Eggs creamy white; Larva pink in colour; Pupa greyish boat shaped cocoon; Adult is a medium sized moth. Forewings have black and brown patches and dots on white colour

Symptoms of damage

- Withering of terminal shoots
- Bore holes on shoots and fruits plugged with excreta
- Shedding of flower buds.

Management

- Damaged portions of the plants should be removed and destroyed.
- Avoid continuous cropping of brinjal crop
- Install pheromone trap
- Avoid using insecticides at the time of fruit maturation and harvest
- Spray Neem seed kernel extract (NSKE)5 % @ 5.0 ml/ lit starting from one month after planting at 15 days interval
- Use Coragen @ 0.3 ml/ lit or Indoxacarb 14.5 % SC @ 0.3 ml/ lit or Triazophos 40 % EC @ 2.5/ lit as chemical control



Brinjal shoot and fruit borer

2. Hadda/spotted beetle (*Henosepilachna vigintioctopunctata)*: Eggs are cigar shaped, yellow in colour; Grub is yellowish bearing six rows of longitudinal spines; Pupa is yellowish with spines on posterior part and anterior portion being devoid of spines.

Symptoms of damage

- Scrapping of chlorophyll
- Leaves shows skeletonization symptom and become dry.

Management

- Collect damaged leaves with grubs and egg masses and destroy them
- Use Coragen @ 0.3 ml/ lit or Indoxacarb 14.5 % SC @ 0.3 ml/lit or Triazophos 40 % EC @ 2.5/ lit as chemical control.

Hadda / spotted beetle

CHILLI

1. Chilli thrips (*Scirtothrips dorsalis):* Nymphs are tiny, slender, fragile and straw yellow in colour and adults have heavily fringed wings

Symptoms of damage

- The infested leaves develop crinkles and curl upwards
- In early stage, infestation leads to stunted growth and flower production. Fruit set is arrested

Management

- Do not raise chilli and as onion as mixed crop as both the crops are attacked by thrips.
- Treat seeds with imidacloprid 70% WS @ 12 g /kg of seed.
- Spray Imidacloprid 17.8 % SL @ 0.3ml/ lit or Fipronil 5 % SC @ 1.0 ml/ lit.

Chilli thrips

2. Aphid (*Myzus persicae):* Initially nymphs are greenish, but soon turn yellowish while adults are yellowish green in colour. They are polyphagous pests. It multiplies rapidly under cloudy weather conditions. Heavy rains cause reduction in their population. Adults are found in large numbers on the undersurface of leaves and growing shoots of plants.

Symptoms of damage

- The infested plants turn pale with sticky appearance.
- The leaves are curled and appear crinkled
- Honeydew excrete leads to development of sooty mould.
- Stunted growth of the plant

Management

- Treat seeds with Imidacloprid 70% WS @12 g /kg of seed
- Apply phorate 10 % G @ 10 kg/ha
- Foliar spray with Imidacloprid 17.8 % SL 0.3 ml/l or acephate 1.5 g/l is effective.

Aphid

3. Chilli Mites(*Polyphagotarsonemus latus):* Oval shaped eggs while are white in colour. Eggs glued firmly on the leaf surface. Nymphs are white in colour whereas adult is large, oval and broad and yellowish in colour.

Symptoms

- Downward curling and crinkling of leaves
- Leaves with elongated petiole
- Stunted growth

Management

- Foliar spraying of Dicofol 5ml/l, Ethion 50% EC @ 2.0ml/ lit, Milbemectin 1 % EC @ 0.6 ml/ lit or wettable sulphur 3g/l.

Chilli mites

OKRA

1. Shoot and fruit borer (*Earias spp):* Larva is brown with white median longitudinal streak. Pupa is brown and boat shape, uniformly silvery green fore-wings.

Symptoms of damage

- Drooping of tender shoots
- Holes on the infested fruit and the fruit is filled with excreta.
- Fruits distorted and unfit for human consumption.

Management

- Install pheromone trap
- Collect and destroy affected fruits.
- Foliar spray with Quinalphos 25 % EC 3 ml/l during vegetative and at fruiting stages.
- Spray Profenophos 2 ml/l twice at 10 day interval after harvest of fruits

Shoot and fruit borer

2. White fly (*Bemisia tabaci):* Nymph is greenish yellow, oval in outline and adults are minute insects with yellow body covered with a white waxy bloom.

Whitefly

Symptoms of damage

- Chlorotic spots on the leaves which later unite and form irregular yellowing of leaf tissue
- Severe infestation results in premature defoliation
- Development of sooty mould is there.
- Vector of yellow vein mosaic virus

Management

- Use silver mulch to control the insect population
- Spray any one of these insecticides : Phosalone 35 EC @ 2.5 l/ha or Quinalphos 25 EC at 2.0 l/ha or Triazophos 40 EC at 2.0 l/ha to control the insect vector.

3. Jassids (*Amrasca devastans):* Nymph is light green, translucent, wingless found between the veins of leaves on the under surface. Adult is green, wedge shaped leafhopper.

Jassids

Symptoms of damage

- Tender leaves become yellow.
- The margin of the leaves start curling downwards
- In the case of severe infestation, leaves get bronze which is typical “hopper burn” symptom.
- Growth of the crop is retarded.

Management

Spray any one of the following insecticides (Mix with 500 lit water/ha)

- Imidacloprid 200 SL at 100 ml/ha
- Dimethoate 30 EC @500 ml/ha
- NSKE 5%

4. Aphid (*Aphis gossypii***):** Nymphs are yellowish or greenish brown and found on the under surface of leaves. Adults are greenish brown, soft bodied small insects

Symptoms of damage:

- Infest tender shoots and are found on the under surface of the leaves.
- Curling and crinkling of leaves
- Stunted growth
- Development of black sooty mould due to the excretion of honey dew

Aphid

Management

- Spray Imidacloprid 17.8 % SL @ 0.3 ml/lit
- Monitor the activities by setting up yellow sticky traps

CUCURBITS

1. Fruit fly (*Bactrocera cucurbitae*): Egg laid singly or in clusters on fruits. Larvae are white maggot and pupate in soil. Adult has hyaline wings with brown and grey spots at the apex.

Symptoms of damage

- Maggots feed on the pulp of the fruits
- Oozing of resinous fluid from fruits
- Distorted and malformed fruits
- Premature dropping of fruits which are also unfit for consumption

Fruit Fly

Management

- Collect infested and fallen fruits and bum in deep pits
- Expose the pupae by ploughing and turning over soil after harvest.
- Use fruit trap
- Harvesting of fruits before ripening.
- Mix methyl eugenol + malathion 50 EC at 1:1 ratio and keep 10 ml of the bait in polythene bags @ 25/ha.

2. Red pumpkin beetles (*Aulacophora foveicollis):* Freshly hatched grubs are dirty white. Full grown grub is creamy yellow in colour. Adult is red in colour.

Symptoms of damage

- Grubs feeds on the roots, stem and fruits touching the soil
- Adult feeds on leaf and flowers.

Red pumpkin beetles

Management

- Plough the fields just after harvesting to destroy the hibernating adults
- Collect and destroy adult beetles
- Dusting the plants with ash which temporarily repel the beetles
- Foliar spray with dimethoate at 2 ml/lit and drenching the soil at root zone so as to kill the grubs.

3. Pumpkin Caterpillar (*Diaphania indica):* Eggs are laid singly or in groups on lower surface of leaves. Larva is bright green with a pair of white mid dorsal lines. Pupation takes place inside a cocoon among the leaves. Adult has whitish wings with broad and dark marginal patches.

Symptoms of damage

- Young larva graze the cholorophyll content
- Later on it folds and webs the leaves and feeds within.
- It also feeds on flowers and bores into developing fruits

Pumpkin Caterpillar

Management

- Collect and destroy early stage caterpillars
- Spray quinalphos @ 2 ml/lit

4. Leaf miner (*Liriomyza trifolii):* Larva is minute orange yellowish maggots and pupates within mines. Adult is pale yellow in colour

Symptoms of damage

- Leaves with serpentine mines.
- Drying and dropping of leaves due to severe infestation.

Management

- Collect and destroy mined leaves
- Removal of affected plants.
- Growing tomato as a trap crop.
- Foliar spray with neem oil 5ml/l can minimizes the incidence.

Symptom of damage by Leaf miner

COLE CROPS

1. Diamond back moth (*Plutella xylostella):* Eggs are minute yellow coloured, laid singly or in groups on upper surface of leaves. Larva is pale yellowish green caterpillar. Pupation takes place on the foliage in a transparent cocoon. Adult is a small greyish brown moth.

Damage by Diamond back moth

Symptoms of damage

- Young caterpillars cause small yellow mines on leaves.
- Scrapping of epidermal leaf tissues producing typical whitish patches on leaves.
- Holes are there on leaves and later on symptoms appear on the curd.

Management

- Remove and destroy all debris and stubbles after crop harvesting
- Use Pheromone traps. Use biological control agent as *Bt. or* Neem seed kernel extract
- Crop rotation with cucurbits, beans, peas, tomato and melon
- Spray Cartap hydrochloride 2.0 g/ lit at 10,20 and 30 DAS (nursery) and primordial stage
- Alternatively Spinosad 2.5 % SC @ 1.5 ml/ lit can also be sprayed over infested crop

2. Cabbage borer (*Hellula undalis):* Yellow shiny eggs are laid on the leaves. Full grown larva is greyish yellow with seven purplish brown longitudinal stripes. Adult is pale greyish brown moth with wavy grey markings.

Symptoms of damage

- Webbed leaves
- Holes in cabbage head with fecal matter.

Management

- Collect and destroy caterpillars mechanically in the early stages of attack
- Apply *Bacillus thuringiensis* @ 2g/lit at primordial stage
- Spray Cartap hydrochloride 2.0 g/ lit.

Leaf Webber

3. Leaf Webber (*Crocidolomia binotalis):* Eggs are laid in groups under surface of leaves. Larva is green coloured and pupation takes place within the webbed up leaves. Adult's forewings have distinct wavy lines and prominent wavy spots and hind wings have semi hyaline colour.

Symptoms of damage

- Young larva feeds gregariously on leaves
- Later webs together the leaves and feed within.

Management

- Remove and destroy the webbed leaves along with caterpillars.
- Set up one light trap in one heatre area.
- Encourage the activity of parasitoid: *Cotesia crocidolomiae*
- Spray malathion 50 EC @ 0.1% or carbaryl 0.2%.

4. Cabbage butterfly (*Pieris brassicae*): Larva is velvety bluish green in colour with black dot. Adult is white butterfly.

Symptoms of damage

- Defoliation occurs.
- It bores into the heads of cabbage

Management

- Collect and destroy caterpillars in the early stage of attack
- Spray insecticides like quinalphos 25EC @ 2 ml/ lit.

Cabbage butterfly

5. Cabbage aphid (*Brevicoryne brassicae):* Nymphs and adults yellowish green with wavy white filament over the body.

Symptoms of damage

- Yellowing of leaves.
- Crinkling and cupping of leaves
- Distorted primordia
- Presence of white cast skin at the base of the plant

Management

- Install yellow sticky trap @10 no./ha to monitor adults (winged adult).
- Spray of neem oil 3 % with 0.5 ml Teepol/lit or dimethoate at 2.0 ml/l is effective.

POTATO

1. Cut worm (*Agrotis ipsilon):* Creamy white and dome-shaped eggs which are laid singly on lower surface of the leaves. Newly emerged young larva is yellow in colour. Dark brown pupae are found in earthen cells lying underground in the potato fields. Adult moth is dark with some grayish patches on the back and dark streaks on the forewings.

Cut worm

Symptoms of damage

- Young larvae feed on the epidermis of the leaves.
- Older larvae come out at night and feed young plants by cutting their stems
- They also damage the tubers by eating away part of them.

Management

- Flood the infested fields.
- Hand pick and destroy the larvae in the morning and evening hours on cracks and crevices in the field
- Plough the soil during summer months to expose larvae and pupae to avian predators
- Set up one light trap in one hectare to monitor the insect population.
- Pheromone traps @ 10 No./ha to attract male moths
- Spray insecticides or chlorpyriphos 20EC @ 1 lit/ha or neem oil 3% @ 5.0ml/ lit

2. Potato tuber moth (*Phthorimaea operculella):* Eggs are laid singly on the ventral surface of foliage and exposed tubers. Larva is yellow coloured caterpillar with dark brown head. Pupation occurs within a cocoon among the trash, clods of the earth in the field. Adult is small narrow winged moth, greyish brown forewings and dirty white hind wings- .

Symptoms of damage

- It is a pest of field and storage.
- Larva tunnels into foliage, stem and tubers.
- Galleries are formed near tuber eyes.

Management

- Select healthy tubers
- Avoid shallow planting of tubers. Plant the tubers to a depth at 10 - 15 cm deep.
- Install pheromone traps @ 15 No./ha.
- Collect and destroy all infested tubers from the field
- Do not leave the harvested tubers in the field overnight
- Adopt intercropping with chillies, onion or peas
- Do earthing up at 60 days after planting to avoid female moths laying eggs on the exposed tubers.
- Spray NSKE @ 5% or quinalphos 25 EC @ 2ml/lit of water to manage foliar damage
- Spray *Bacillus thuringiensis* @ 1 kg /ha at 10 days interval.
- Storing the tubers under 3 cm thick layer of sand.

Activity 1

Visit different fields of your area and collect samples of vegetable crops infested by insects. Try to identify the insects.

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Check your progress

Match the following

A	B
1. Brinjal	a. Jassids
2. Potato	b. Red pumpkin beetle
3. Cabbage	c. Shoot and fruit borer
4. Bottle gourd	d. Diamond back moth
5. Chilli	e. Cut worm

Major diseases of important vegetables crops and their management

Diseases include four main groups: Fungal, Bacterial, Viral and Biological disorders. The diseases receive their name from the symptoms rather than from the agents which cause them.

The most common symptoms of fungal diseases are:

1. **Rot:** Different parts of the plant decay and rot. Soft plant tissue and bad smell characterize the process.
2. **Leaf spot:** Spots of different colors appear and may coalesce and appear as big spot on the leaves with yellow border.
3. **Rust:** Rust or metal like spots on the underside of the leaves.
4. **Blight:** Brown to black colored circular spots on the leaves. They can also appear on the fruit.
5. **Powdery mildew:** Light colored powder on the upper surface of the leaves.
6. **Downy mildew:** Soft, grey growth on the lower surface of the leaves cause dead spots on the upper surface.
7. **Damping off:** Affect Seedlings. The bottom of the stem dries out and the seedlings fall over.
8. **Anthracnose:** Brown to black colour spots appears on leaves and fruits.

The most common symptoms of bacterial diseases are:

1. **Canker:** Bumps and cankers appear on the branches, releasing gum onto the bark. It is usually accompanied with small brown spots on the leaves.
2. **Blight:** Brown areas and spots on the leaves grow from the edge of the leaf inwards.
3. **Spot:** Light colored areas on the leaves that turn to black. The spots on the fruit dry and crack.

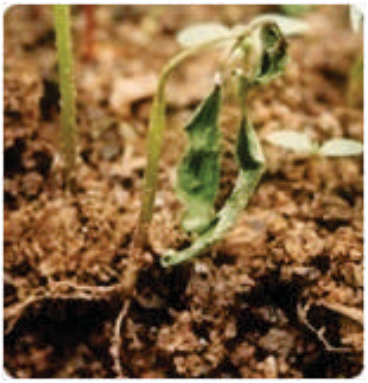
The most common symptoms of viral diseases are:

1. **Mosaic:** Leaves are covered in small, alternate yellow and green patches, accompanied by dwarf syndrome.
2. **Leaf curl:** Leaves curl upside, most common in solanaceous vegetable. Plants become unproductive.
3. **Ring spot:** Green and brown rings on the fruit. The plant stops growing.

The major diseases of important vegetable crops and their identification/symptom of damage are summarized here under.

TOMATO

1. **Damping off:** It is caused by *Pythium spp., Phytophthora spp., Rhizoctonia solani and Sclerotium rolfsii. It is a serious disease in nursery.* The symptom includes seed rot or death of young seedlings; toppling down of the infected seedlings; infected tissues appear to be water soaked and soft.



Damping off

Management:

- Spray Captan or Blitox (2.5 g/lt)
- Treat the seed with *Trichoderma* (biocontrol agent) or Bavistin or Capton.

2. **Leaf curl virus:** It is a viral disease transmitted by white fly. The symptoms are stunting plant growth with downward rolling and crinckling of the leaves. The newly formed leaves show chlorosis.

Management:

- Spray Confidor/Malathion or Rogor
- Destroy infested plants

Leaf curl virus

3. Early Blight (*Alternaria solani):* This is a common disease of tomato occurring on the foliage at any stage of the growth. In later stage, disease also affect fruits. Early blight is first observed on the plants as small, black lesions mostly on the older foliage. Concentric rings are also present on the fruit.

Management

- Use tolerant varieties.
- Remove and burn damaged plant parts.
- Remove weeds regularly and thoroughly.
- Use pathogen-free seeds.
- Adopt crop rotation.
- Make sure the plants have enough water. Spray the crop with Thiophenate methyl @ 3.0 g/lit for effective disease control.

Early Blight

4. Bacterial Leaf Spot*: (Xanthomonas campestris pv. vesicatoria):* Infected leaves show small, brown, water soaked, circular spots surrounded with yellowish halo.

Management

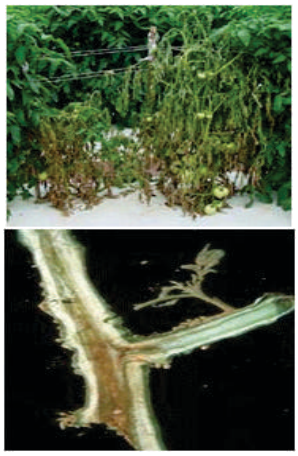
- Use disease-free seed and seedlings
- Adopt crop rotation
- Seed treatment with mercuric chloride (1:1000) is also recommended for control of disease.
- Spraying with a combination of copper and organic fungicides as a regular preventative spray or Agrimycin-100 (100 ppm) thrice at 10 days intervals effectively controls the disease.

Bacterial Leaf Spot:

5.Bacterial Wilt *(Pseudomonas solanacearum):* Deadly disease of tomato which results in wilting of plant, stunting plant growth, yellowing of entire plant, and brown vascular system.

Management

- Crop rotation with Cruciferous vegetables.
- Grow resistant varieties such as Arka Ananya, Arka Rakshak *etc.*
- Hot water seed treatment at 50^{0}C for 25 minutes.
- Spray with streptocycline @ 200ppm at 4-7 days interval.



Bacterial Wilt

BRINJAL

1. Phomophsis Blight (*Phomopsis vexans):* In seedlings, it causes damping off symptom. When leaves are infected, small circular spots which appears become grey to brown with irregular blackish margin, blighting of affected portion of plant.

Management:

- Dip the plant roots for 20 minutes in water solution of Bavistin and spray 3 weeks after transplanting or as per requirement.
- Collect and destroy infested fruits or plant parts

Phomophsis Blight

2. Bacterial Wilt (*Pseudomonas solanacearum):* Sudden wilting and death of infected plants is the characteristic symptom**.** Lower leaves may droop first before wilting occurs. Plant show wilting symptoms at noon time will recover at nights, but die soon.

Management

- Growing resistant varieties
- Crop rotation with cruciferous vegetables such as cauliflower
- Fields should be kept clean and affected parts are to be collected and burnt.
- Spray Copper fungicides to control the disease (2% Bordeaux mixture.)

Bacterial Wilt

3. Damping off: Causal organisms, symptoms and management of disease is same as that of tomato.

4. Little leaf: It is caused by mycoplasma. Infection is initially observed in one branch and later the entire plant shows symptoms followed by reduction in size of newly formed leaves.

Management:

- Seed treatment with 4 g of *Trichoderma viride* formulation per kg seed help in reducing the disease.
- Spraying with Mancozeb @ 2g/Litre of water.
- Collection and destruction of diseased parts and portions of the plant.

CHILLI:

1. Damping off (*Pythium aphanidermatum***):** The seedlings are attacked at the collar region and the infected seedlings topple down.

Management:

- Soil drenching with Copper oxychloride @0.25%
- Do soil solarization with clear film for 45 days during April to June months in Nursery.

2. Fruit Rot and Die Back (*Colletotrichum capsici):* Black colour spot developed over fruits.

Fruit Rot

Management:

- Use disease-free seeds.
- Seed treatment with Thiram or Captan @4g/kg is found to be-effective.
- Use chemicals like wettable sulphur @0.2% or Copper oxychloride 0.25%. The first spray should be given just before flowering and the second at the time of fruit formation and third spray may be given a fortnight after second spraying.

3. Cercospora leaf spot (*Cercospora capsici):* Leaf lesions are typically brown and circular with small to large light grey centers and dark brown margins. The lesions may enlarge to 1cm or more in diameter and sometimes unite. Severely infected leaves drop off prematurely resulting in reduced yield.

Cercospora leaf spot

Management: Spray twice at 10-15 days interval with Mancozeb (0.25%) or Chlorothalonil (Kavach) @0.1%.

4. Powdery mildew (*Leveillula taurica):* Shedding of foliage and white powdery growth on lower side of leaves

Management: Spray wettable sulphur 0.25% or Dinocap (Karathane) @ 0.05%.

Powdery mildew

5. Viral diseases

Leaf curl

- Leaves curl towards midrib and become deformed.
- Stunted plant growth due to shortened internodes and leaves get reduced in size.
- Flower drops
- The virus is generally transmitted by whitefly.

Leaf curl

Mosaic Viruses

- Light green and dark green patches appear on the leaves.
- Stunted plant growth during early stages.
- Yellowing, chlorotic ring spots appear on leaves and fruits.

Management of viral diseases

- The infected plants should be uprooted and burnt or buried to avoid further infection.
- Avoid monoculture of chilli crop.
- Selection of healthy and disease free seed.
- Suitable insecticidal sprays reduce the incidence of viral diseases, since majority of viral diseases are transmitted by insect vectors.
- Nursery beds should be covered with nylon net or straw to protect the seedlings from viral infection.
- Raise 2-3 rows of maize or sorghum as border crop to restrict the spread of aphid vectors.
- Apply Carbofuran 3G @ 4-5 kg/acre in the main field to control sucking complex and insect vectors selectively.
- Spray Dimethoate (2ml) or Acephate (1g) per litre of water.

COLE CROPS (CABBAGE AND CAULIFLOWER)

Black rot

1. Black rot (*Xanthomonas campestris):* The tissue at the leaf margin becomes yellow; chlorosis progresses towards leaf center creating a V-shaped area at the mid rib.

Management:

- Spray streptocycline (5 g) and Blitox (10 g) per 10 litre of water after transplantation

***2. Sclerotinia* rot:** Disease first appears as wet soft lesions on cauliflower head and leaf. Later lesion enlarges into a watery rotten mass of tissues that is covered by white silvery appearance.

Sclerotinia rot

Management:

- Spray Bavistin (1g/lt) or Dithane- M-45 (2g/lt) after appearance of disease at 15 days interval if required.

3. Black spot (*Alternaria spp.):* Light brown spots appear on leaves. The infected leaves become yellow and later on they fall down.

Management:

- Treat the seeds with thiram @2.5 g/kg of seeds or spray at 15 days interval as per need.

4. Black leg: (*Phoma lingam***):** It occurs in areas with heavy rainfall during the growing period. It is a seed borne disease and therefore may appear at an early stage of grwoth. Stem of affected plant when split vertically shows severe black discolouration of sap stream. Whole root system decays from bottom upwards. Often, the affected plants fall over in the field.

Management:

- Hot water treatment of seed before sowing
- Spray the seed crop with copper oxychloride or with an organomercuric compound.

- Variety Pusa Drum Head of cabbage is tolerant under field condition.

5. Downy mildew (*Pernospora parasitica):* It causes serious damage at all stages of plant growth. Discolouration occurs in the young seedlings and in severe cases whole plant perishes. In adult plants, purplish leaf spots or yellow brown spots on the upper surface of the leaf appear, while fluffy downy fungus growth is found on the lower surface. During bolting stage, the seed stalk shows blackish patches and in severe cases whole curd is spoiled.

Downy mildew

Management:

- Spray of Ridomil MZ 72 @ 2.0 g/lt of water at 10-15 days interval or with Dithane M 45 @ 2.5 g/l of water.
- Chinese cabbage and kale are resistant to downy mildew while others are susceptible.

6. Bacterial soft rot (*Erwinia carotovora):* A weak parasite which penetrates the plants through damaged tissue *e.g.* lesions caused by other pathogen. In the field, it occurs only following black rot or after mechanical injury of nearly mature cabbage head. Infection is favoured by high humidity. The affected plants show a soft, slimy, bad smelling rot that under favourable conditions rapidly spreads throughout the plant.

Bacterial soft rot

Management:

- Control other diseases and prevent any kind of damage to the crop.
- Spray 100-200 ppm streptocycline or plantomycin combined with copperoxychloride (0.3%) at 15 days interval.

ONION AND GARLIC

1. Purple blotch (*Alternaria porri):* Small white sunken spots develop on leaves. The lesions enlarge and become zonate and under moist condition, turn purple. The bulb tissue becomes papery.

Purple blotch

Management:

- Spray Indofil -M-45 or Blitox 50 (2 g/lt) at 10 days interval, if required.

2. Downy Mildew (*Peronospora destructor*):There is violet growth of fungus on the surface of leaves and flower stalks which later become pale-green yellow and finally collapse.


Downy Mildew

Management:

- Crop rotation with a 4 year break in onion cultivation.
- Good weed control and field hygiene.
- Removal of primary infected onion plants.
- Spray Zineb @0.2% .

3. Onion Smut (*Urocytis cepulae):* It is a soil borne disease and infects cotyledon and seedlings which result in heavy mortality.


Onion Smut

Management:

- Treat seed with 55-85 g of arsan per 4.5 kg of seed before sowing or with thiram or captan (3 g/kg of seed)
- Treat nursery soil with thiram or captan (0.2%) along with methocal sticker.

POTATO

1. Early blight (*Alternaria solani):* Symptoms develop on the lower most leaves. Infected leaves show brown spots which may be angular, oval or circular.


Early blight

Management:

- Grow resistant varieties
- Spray Indofil-M-45 (2g/lt) or Blitox 50 (2.5 g/lt) after 30 days of sowing and at 10 days interval, if necessary.

2. Late blight (*Phytophthora infestans):* Disease appears on the leaves as pale green, irregular spots. In moist weather, the spots enlarge rapidly with central tissue turning necrotic and dark brown or black.

Management:

- Spray Ridomil MZ- 72 (2g/lt) after appearance of disease and at 10 days interval, if necessary.
- Grow resistant varieties.

Late Blight

OKRA

1. **Powdery mildew** (*Erysiphe cichoracearum):* Greyish powdery growth occurs on the under as well as on the upper surface of the leaf. Diseased leaves turn yellow and drop off.

Powdery mildew

Management:

- Spray inorganic sulphur (0.25%) or Dinocap (0.1%) for 3 or 4 times at 15 days interval.
- Spray vertimac @ 1.0 ml/ lit.

2. Yellow Vein Mosaic: Yellowing of the veins on the leaf blade is the characteristic symptom. In severe infections the younger leaves turn yellow, become reduced in size and the plant is highly stunted. Infection restricts flowering and fruit formation. The virus is spread by whitefly.

Yellow Vein Mosaic

Management:

- Grow resistant varieties *e.g.* P-8, Parbhani Kranti, Arka Abbay, Arka Anamika *etc*.
- For summer season, the whitefly activity is high, so the cultivation of susceptible varieties should be avoided.
- Use 25 micron silver or yellow mulch.

CUCURBITS

1. Downy mildew (*Pseudoperonospora cubensis):* Symptoms resembling mosaic *viz.*, pale green areas separated by dark green areas appear on upper surface of leaf. During

wet season, corresponding lower surface is covered with faint purplish fungal growth. The entire leaf dries up quickly.

Management:

- Use bed system with wide spacing, good drainage and air movement and exposure to sun help to check the disease development.
- Spray Moncozeb (0.2 %) or Chlorothalonil (0.2%) or Difolaton (0.2%) or Ridomil MZ 72 (0.1%).

2. Powdery mildew: (*Erysiphe cichoracearum):*

Powdery mildew, is especially prevalent in hot dry conditions. White or brown mealy growth will be found on upper and lower surfaces and stems. Under severe infestations, the plant will be get weak and remain stunted.

Powdery mildew

Management: The disease can be controlled by spraying Wettable sulphur (0.1%).

3. Mosaic: Leaves curl downwards and become mottled, distorted, wrinkled and reduced in size. Veins appear bunchy because of shortening of internodes. Fruits are often misshapen, mottled, warty and get reduced in size

Mosaic

Management:

- The virus is readily transferred by aphids and survives on a wide variety of plants.
- Rogue out infected plants
- Eliminate perennial weed hosts
- Spray systemic insecticide to control insect vector.

Activity 2

Visit different fields of your area and collect samples of vegetable crops infested by various diseases. Try to identify the causal organism (Virus, bacteria, fungi etc) and record it.

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Management of nematodes in vegetable crops

Gall formation due to nematode infestation in tomato

Nematodes are microscopic organisms which live around the roots in the soil. Unlike insects, viruses, fungi or bacteria, nematode population increase rather slowly and the diseases caused by them are generally not of sudden epidemic type resulting in obvious destruction of crop and yield but cause a rather slow decline in yields. Symptoms of nematode diseases are often not clear cut and easy to pinpoint.

The damage due to nematodes is many a time a result of interaction between nematodes or bacteria, viruses or fungi. The most common nematode attacking the vegetable crops is Root knot nematode (*Meloidogyne* sp).

Root knot nematode is a parasite of root, juveniles enters into young roots and feed. The cells in the root-tissue enlarge and multiply repeatedly leading to the formation of knots or galls of various sizes on the roots. Sticky gelatinous egg masses can be seen on root surface. The symptom of nematode infestation in vegetable crops is characterized by yellowing of leaves, stunting growth of plants, reduction in flowering and fruiting. Nematodes can be managed by following methods:

- Crop rotation for 1-2 year with non host crops (mustard, marigold *etc.*)
- Summer fallowing and deep ploughing
- Soil solarization of nursery area using thin polythene mulch
- Soil application of Carbofuran or Phorate @1-2 kg ai/ha
- Use of resistant varieties of vegetable crops
- Application of organic products such as FYM or de-oiled neem cake to soil 2-3 weeks before transplanting.

Activity 3

Visit different fields of your area and collect samples of vegetable crops infested by nematodes. Observe the gall formation in nematode infested root and compare growth with healthy crop.

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Further readings and references

1. Handbook of Horticulture, ICAR, New Delhi
2. Handbook of Agriculture, ICAR, New Delhi
3. Technology options for enhanced productivity and profit, IARI, New Delhi
4. http://agritech.tnau.ac.in

CHECK YOUR PROGRESS

Fill in the blanks

1. To overcome the harmful effect of insects and pathogens, there are broadly two types of management practices ……..and ……
2. Growing a series of different / dissimilar types of crops in the same area in sequential season is called ……..
3. A point at which pest populations or environmental conditions indicate that pest control action must be taken is known as……
4. The most important nematode which attack vegetable crop is ……...
5. Causal organism of powdery mildew in cucurbits is ……..and can be controlled by…….(fungicide).

Short answers

1. Yellow vein mosaic virus of okra
2. Bacterial wilt of tomato and brinjal
3. Brinjal shoot and fruit borer
4. The most common symptoms of bacterial diseases in vegetable crops
5. Management of potato tuber moth

Long answers

1. List five pests and diseases of solanaceous, cole crops and cucurbitaceous vegetable crops
2. Discuss about nematode infestation in vegetable crops and their management practices.
3. Define and discuss integrated pest management strategies.
4. List five diseases caused by viruses in vegetable crops.
5. Discuss general management practices to control pests and diseases of vegetable crops.