Jharkhand Rai university

Laboratory Manual

Course- Diseases of Horticultural Crop and their Management (DHCM)

B.Sc.(Hons.) Agriculture VIth Semester

Department of Agriculture,

Faculty of Science & Engineering

Jharkhand Rai University, Ranchi.

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Ex.1 :Diseases of Beans, Guava, Citrus and Sapota

Diseases of beans

1. **Anthracnose –*Colletotrichumlindemuthianum* and *Calletotrichumcapsici*.**

They affect the above ground parts, e.g.: leaf, stem and pod anthracnose.

Lesions on stems and pods more clearly defined than those on leaves, grey or brown, slightly sunken with raised dark brown or reddish edge. All vegetative parts are susceptible during early stages of development; invasion of the tap root of a young plant can lead to death. Elongated dark-brown or black sunken spots with reddish or yellowish margins appear on veins, petioles, stem and pods. Diseased seeds carry the fungus from season to season. Spots on the hypocotyl cause death of the plant. Seedlings show canker on cotyledons. These lesions produce pinkish spore masses during moist weather.

Management

Sowing disease-free seed, crop rotation and field sanitation. Treat seeds withCarbendazim (0.2%) or Thiram (0.3%). Additionally, spray Bordeaux mixture 5:5:50 or a copper oxychloride(0.3%) as soon as the symptoms appear.

2. **Powdery mildew:*Erysiphepolygoni* and *Leveillulataurica*.**

Symptoms

The fungus of powdery mildew grows as thin layers of mycelium (fungal tissue) on the surface of the affected leaves. Spores, which are the primary means of dispersal, make up the bulk of the visible white, powdery growth. Powdery mildew spores can be easily carried by wind to new hosts.

The spores can germinate and infect beans in the absence of free water. Powdery mildew growth generally does not require moist conditions however, increased humidity can increase the severity of the disease. Moderate temperatures and shady conditions generally are the most favorable environmental factors for the development of powdery mildew . Strong and direct sunlight with high temperatures can noticeably reduce the incidence of the disease.

1.Planting resistant cultivars in sunny locations whenever possible.
2. Pruning or staking plants to improve air circulation.
3. Disinfection ofpruning tools (one part bleach to 4 parts water) after each cut.
4. Removal of diseased foliage from the plant and cleaning of fallen debris on the ground.
5.Use ofa thick layer of mulch or organic compost to cover the soil after you have raked and cleaned it well. Mulch will prevent the disease spores from splashing back up onto the leaves.

6. Washing foliage occasionally to disrupt the daily spore-releasing cycle. Neem oil wash use of a 7 day schedule will prevent fungal attack on plants grown indoors.
7. Destruction of all plant debris after harvest.

8.Milk is a safe method that can be used to treat powdery mildew.Using milk full strength or mixing a 50:50 solution of milk and water (one part milk to one part water). Use it as a spray, applying milk treatment onto the leaves of the infected plant. Garlic is gaining in popularity as both a fungicide and insecticide.
9. Chemical control is possible with fungicides such as Sulfex (0.2%); Calixin (0.1%0;.Propiconazole (0.2%)

3. **Rust: (*Uromycesfabae, Uromyces appendiculatus* and *U. mucunae)*.**

Symptoms

Initial signs of bean rust on common bean (*Phaseolus vulgaris*) include fungal sori, seen as small white specks under the leaf epidermis, and rust coloured pustules. These pustules are found mainly on the underside of the leaf and can become surrounded by a circle of chlorosis. Dark lesions ranging from 0.3 to 3.0 mm in diameter may be visible on the leaves. Elongated pustules may appear on pods, stems and petioles. These can become black when teliospores form, usually on older leaves

Management

A medium planting density of and low rates of inorganic nitrogen has been found to be efficacious against rust.

Mixed intercropping reduced rust incidence levels on average by 51 and 25% compared with sole cropping and row intercropping, respectively.

Early sowing dates resulted in a lower disease index and higher yield.

Rust infection on *P. vulgaris* was reduced by between 39 and 52% compared with controls.

Spraying of mancozeb + sulfur (0.2%) spray followed by chlorothalonil(0.2%) has been recommended for control of rust on beans.

4. **Yellow mosaic**

Symptoms

Initially small yellow patches or spots appear on the young leaves. Slowly the area of yellow discoloration increases and the entire leaf may turn yellow.Infected leaves show alternating green and yellow patches. Yellow leaves turn slowly dry and wither. Infected plants mature late. Flower and pod production get reduced.Pods in the infected plants are small size, turn yellow and get distorted. Early infection causes death of the plant before seed set.Infection causes reduction in plant yield and quality of grains. Diseased plants have stunted growth. This disease is transmitted by whitefly.

Seeds are to be treated with insecticides like carbosulfon at 30gm or monocrotophos at 5ml per one kg seed before sowing.

Follow crop rotation and maintain soil health. Grow suitable region wise resistant varieties. Use seeds collected from disease-free plants.

Management

1. Infected plants should be removed.
2. Disease-affected leaves/plants from crop fields to avoid secondary spread.
3. Destruction of host weeds. Intercrop with non host crops like sorghum, pearl millet and maize.
4. Control of white fly by spraying insecticides viz., dimethoate 0.03 per cent or monocrotophos 1.6 per cent or metasystox (0.1 per cent) or triazophos 1.25 ml/l at the initial stage of disease proves effective.
5. If the disease is not controlled, apply second spray at an interval of 7-10 days.
6. Foliar sprays of methyl demeton 2ml/litre also controls the vector spread.

Diseases of Guava

Guava (*Psidium guajava* Linn.) is an important fruit of subtropical countries. It is hardy crop and is cultivated successfully even in neglected soils. There are number of pathogens, mainly fungal which affect guava crop besides few bacterial, algal and some physiological disorders or deficiencies.

Wilt of guava from India was first reported in 1935 from Allahabad. The disease is soil-borne and is difficult to control. Wilt is predominantly caused by the species of *Fusarium* , of which *F. oxysporum f.sp. psidii* is generally the main cause. The other species of Fusarium i.e., *Fusariumsolani* are also dominates in isolation. Since, the disease results in the complete mortality of the affected plants, the loss is total. Although, severe loss is there in the annual crops also, huge monitory losses occur especially in perennial fruit trees as it is a loss of labour of several years. Guava is a crop where this disease is very serious and it can be said that this is the only disease of guava which is threatening guava cultivation in India The Variety, L-49 is resistant to guava wilt.

Other important field diseases of guava are anthracnose (*Gloeosporiumpsidii = Glomerella cingulata),*

canker (*Pestalotia psidii*) and algal leaf and fruit spot (*Cephaleuros virescens*) etc. Some twig/stem diseases which are of minor importance are twig blight(*Phomopsis psidii*), stem canker and die back, drying and defoliation.

Bronzing of Guava leaves are due to Zn deficiency.

Diseases of Citrus

Citrus scab (*Elsinoe fawcettii*)

Symptoms:

Initially small, semi-translucent dots like lesion develops on leaves which become sharply defined pustular elevations. The opposite surface corresponding to the warty growth shows a circular depression with a pink to red centre.On the fruit, lesions consist of corky projections which often break into scab affecting larger areas on the fruits

Survival and spread:

Fungal survive in the infected leaves through overwintering lesions on the fruit or leaves and/or from any scab infections that have developed on the new spring flush.

Favourable conditions:

Scab can be particularly severe on summer growth flushes. Summer wet periods associated with rain showers and dew is highly conducive for spore germination and infection.

Citrus canker (*Xanthomonas axonopodis pv. Citri*)

Disease symptoms:

Initially, disease appears as minute water soaked round, yellow spots which enlarge slightly and turn brown, eruptive and corky. These pustules are surrounded by a characteristic yellow halo.Canker lesions on the fruit do not possess the yellow halo as on leaves. Several lesions on fruit may coalesce to form larger canker.Due to severe infections the there may be defoliation, and twig and stem may show die-back symptoms.

Survival and spread:

In lesions on Citrus, and can also survive for long periods in diseased plant tissues. Citrus leaf miners (*Phyllocnistiscitrella)* help in the dissemination of the pathogen.

Favourable conditions:

Spring seasion is favourable for the development of disease

Quick decline(Citrus tristeza virus)

Disease symptoms:

Disease affected tree leaves becomes chlorotic in the early stages. Gradually the leaves drop and the defoliated twigs show die-back.Diseased trees usually blossom heavily. Under the tree bark stem pitting can be observed.Trees with stem pitting are stunted and set less fruits.The fruits are of smaller size and of poor quality (insipid fruits).

Transmission and favourable conditions:

The disease is transmitted in semi persistent manner by aphid,*Aphis gossypi.* Aphids are more active in warm summer conditions and increase their population as well as spread of the disease.

Citrus tristeza virus belongs to Closterovirus. CTV virus particles are long & highly flexuous measuring 2000x 12 nm. CTV particles are the longest known virus patricle.

Gummosis (*Phytophthora citrophthora; Lasiodiplodia theobromae*)

Disease symptoms:

Disease starts as water soaked large patches on the basal portions of the stem near the ground level.Bark in such parts dries, shrinks and cracks and shreds in lengthwise vertical strips.Later profuse exudation of gum from the bark of the trunk occurs.Considerable amount of gum formation in sweet oranges may be observed, but relatively little in grapefruit.

Survival and spread:

The fungus survives in the form of dormant mycelium and under moist conditions. The fungi produces large numbers of motile zoospores, which are splashed onto the tree trunks.

Secondary infections often occur through lesions created by *Phytophthora*

Favourable conditions:

The *Phytophthora* species causing gummosis develop rapidly under moist and cool conditions.

Greening (caused by fastidious bacteria ,*Candidatus Liberobacter asiaticus*)

Disease symptoms:

Affected leaves show small circular green islands within the chloroticareas.Heavy leaf fall occurs with the onset of summer.Twig die-back may also occurs.Affected areas of the fruits remain green and gives bitter taste.Affected fruits show reduction in size, loopsided growth and oblique columella.Seeds are poorly developed, dark coloured and aborted.

Transmission and favourable conditions:

Thefastidious bacterium is transmitted by the psyllid vectors, ***Diphorina citri&Trioza erytreae***. The bacteria can be acquired by the insects in the nymphal stages and the bacteria may be transmitted throughout the life span of the psyllid.

Anthracnose (*Colletotrichum gloeosporioides= Glomerella cingulata*)

Disease symptoms:

Leaf - common symptoms are a more or less circular, flat area, light tan in color with a prominent purple margin that at a later phase of infection will show the fruiting bodies of the fungus (tiny dispersed black flecks).

Tissues injured by various environmental factors (such as mesophyll collapse or heavy infestations of spider mites) are more susceptible to anthracnose colonization.

Fruit - anthracnose usually only occurs on fruit that have been injured by other agents, such as sunburn, chemical burn, pest damage, bruising, or extended storage periods. The lesions are

brown to black spots of 1.5 mm or greater diameter. The decay is usually firm and dry but if deep enough can soften the fruit. If kept under humid conditions, the spore masses are pink to salmon, but if kept dry, the spores appear brown to black. On ethylene degreened fruit, lesions are flat and silver in color with a leathery texture. On degreened fruit, much of the rind is affected. The lesions will eventually become brown to grey black leading to soft rot.

Survival and spread

Once the spores germinate, they form a resting structure that allows them to remain dormant until an injury occurs

Favourable conditions:

Cool weather (temp 20°C) responsible for development of disease in plants. Long period of high relative humidity >80% with mists.

Sooty mould (*Capnodium* spp.)

Disease symptoms:

The dark, felty growth from sooty mold can be scraped off of plant surfaces, unlike fruit rots that extend into the rind and flesh.

Where sooty mold occurs, look for aphids, citricola scale, cottony cushion scale, mealy bugs, whiteflies, and other phloem-sucking insects that excrete honeydew on which sooty mold fungi grow.

Powdery mildew (*Oidium tingitaninum*)

Disease symptoms:

White ‘powdery’ spores develop mostly on the upper leaf surface.Young leaves turn a pale whitish-grey-green.The ends of mildewed leaves can twist and curl upward.Young shoots can whither and die back.Severe infections cause defoliation.White ‘powdery’ spores develop on the young fruits.Infected fruit fall prematurely.

Survival and spread

The fungi produce tiny, powdery spores that can survive on fallen leaves. It can be transported long distances by wind, on people (clothing, hands), equipment (e.g. pruning tools, mechanical harvesters or hedgers) or vehicles.

Favourable conditions

Cool and damp weather (temp 20°C) responsible for development of disease in plants

Long period of high relative humidity >80% with mists and fog are especially conducive for the development of disease.

Citrus Ecocortis- caused by Citrus exocortis viroid (CEV)

Symptoms-Scaling/cracking of bark.

Citrus stubborn- caused by citrus spiroplasma (*Spiroplasma citri*)- helical, motile by cork screw motion, produces fried egg colony on culture media.

Diseases of Sapota

The main diseases are leaf **spot (*Phaeophleospora indica),***and Sooty mold (***Capnodium spp***.).

Leaf spot (*Phaeophleospora indica*)- The disease is characterized by numerous small, pinkish to reddish brown spots with white centres on the leaves.
Management- Spraying of Mancozeb (0.2%); Dithane Z-78 (0.2%) or Copper oxychloride @ (0.3%) on appearance of the disease to be repeated if required.

Sooty mold (*Capnodium* spp.)- It is a fungal disease developed on honey dew-like excretion by aphids/ scale insects. The fungus covers the entire leaf and severely affects photosynthesis.
Management- Spray starch solution (5%) to remove fungal growth. Control insects through a systemic insecticide.

Ex. 2: Diseases of Papaya, Banana, Pomegranate and Ber

Papaya Diseases

Powdery Mildew *(Odium indicum, Odium caricae)* **:**The development of powdery mildew in papaya is promoted by high humidity (80-85%) and a temperature range of 24-26°C. The disease appears as on the foliage and pods. Infection is first apparent on the leaves as small slightly darkened areas, which later become white powdery spots. These spots enlarge and cover the entire leaf area. Severely infected leaves may become chlorotic and distorted before falling. Affected fruits are small in size and malformed.

Control: As soon as the disease symptoms are observed dusting Sulphur (30 g/10 litres of water) or spraying Calixin 75 EC (5 ml/10 litres of water) at 15 days interval helps to control the disease.

Leaf Blight *(Corynespora cassiicola)***:** The disease causes severe damage to leaves. The disease first appears as small, discoloured lesions, which are irregularly scattered on the leaves. These spots become irregular in shape, then increase in size, and appear brown to grey in colour. A light yellow zone surrounds the spots. Several lesions coalesce to cover large areas of the leaf and in severe infections the whole leaf dies. A considerable reduction in the yield is observed.

Control: Disease can be controlled by spraying of Dithane M-45 (0.2%) starting form the appearance of the disease symptoms.

Damping-Off (*Rhizoctonia solani*) **:**This is a disease of young seedlings. Lesions are seen on the stem at or just above soil level. The stem becomes watery and shrinks, followed by death of the plant.

Control: Well-drained soil should be used for planting and the crop should not be excessively irrigated. Before sowing the seeds should be treated with fungal culture of *Trichoderma viride*(3-4 g/kg of seed) or Captan (3 g/kg of seed) to protect the newly emerging seedlings.

Foot Rot of Papaya (*Pythium aphanidermatum*) **:**It is a severe disease of papaya. It is characterized by the appearance of water-soaked patches on the stem near the ground level. These patches enlarge rapidly and girdle the stem, causing rotting of the tissues, which then turn dark brown or black. Such affected plants withstand strong wind and topple over and die. If the disease attack is mild, only one side of the stem rots and the plants remain stunted. Fruit if formed are shriveled and malformed. Gradually the plant dies.

Control: Application of *Trichoderma viride*(15 g/plant) mixed in well-decomposed FYM should be applied around the root zone of the plants at the time of planting. The crop should be irrigated by adopting the ring method of irrigation so that the water does not come in direct contact with the stem. In the case of new plantings, preventing water logging of the soil may control the disease. The soil should be drenched with 2-3 litres of Copper Oxychloride (3 g per litre of water). The application should be carried out regularly at 15 days interval from the time of planting. During fruit formation, the plant should be sprayed with the same solution at the same time interval. Alternately, Mancozeb (2.5 g/ litre of water) may also be applied. In the case of disease attack in existing crops, the rotted portion of the plant should be scraped and Copper Oxychloride or Bordeaux paste should be applied. The paste can be prepared by dissolving one kg of Copper Sulphate and lime separately in ten litres of water each. The two solutions should be mixed and shaken to form a paste. The base of the plant should be drenched with three litres of Copper Oxychloride (3g/litre). The plant should be drenched during fruit formation with Copper Oxychloride or Mancozeb at the earlier mentioned concentrations twice at 15 days interval.

Anthracnose (*Colletotrichum gloeosporioides*): The disease prominently appears on green immature fruits. The disease symptoms are in the form of brown to black depressed spots on the fruits. The initial symptoms are water-soaked, sunken spots on the fruit. The centers of these spots later turn black and then pink when the fungus produces spores. The flesh beneath the spots becomes soft and watery, which spreads to the entire fruit. Small, irregular-shaped water-soaked spots on leaves may also be seen. These spots eventually turn brown. On the fruits, the symptoms appear only upon ripening and may not be apparent at the time of harvest. Brown sunken spots develop on the fruit surface, which later on enlarge to form water soaked lesions. The flesh beneath the affected portion becomes soft and begins to rot.

Control: The affected fruits should be remove and destroyed. The fruits should be harvested as soon as they mature. Spaying with Copper Oxychloride (3 g/litre of water) or Carbendazim (1 g/litre of water) or Thiophanate Methyl (1 g/litre of water) at 15 days interval effectively controls the disease. Fruits for exports should be subjected to hot water treatment or a fungicidal wax treatment.

Papaya Mosaic: The disease attacks the papaya plants of all age groups, but is most serious on young plants. The aphids are responsible for transmitting the disease. The disease symptoms appear on the top young leaves of the plants. The leaves are reduced in size and show blister like patches of dark-green tissue, alternating with yellowish-green lamina. The leaf petiole is reduced in length and the top leaves assume an upright position. The infected plants show a marked reduction in growth. The fruits borne on disease plants develop water soaked lesions with a central solid spot. Such fruits are elongated and reduced in size.

Control: Good field sanitation such as removal and destruction of affected plant reduce the spread of the disease. Also, losses can be minimised controlling the population of aphid. Application of Carbofuran (1 kg a.i./ha) at the time of sowing seeds followed by 2-3 foliar sprays of Phosphamidon (0.05%) at an interval of 10 days starting from 15-20 days after sowing effectively checks the population of aphids.

Leaf Curl of Papaya: The disease is transmitted by the vector white fly (*Bemisi tabaci*). Severe curling, crinkling and deformation of the leaves characterize the disease. Mostly the young leaves are affected. Apart from curling the leaves also exhibit vein clearing and thickening of the veins. Sometimes the petioles are twisted. In severe cases complete defoliation of the affected plant is observed. The affected plants show a stunted growth with reduce fruit yield.

Control: Removal and destruction of the affected plants is the only control measure to reduce the spread of the disease. Checking the population of white flies also can reduce the infection severity. Soilapplication of Carbofuran (1 kg a.i./ha) at the time of sowing and 4-5 foliar sprays of Dimethoate (0.05%) or Metasystox (0.02%) or Nuvacron (0.05%) at an interval of 10 days effectively controls the whitefly population.

Papaya Ring Spot Virus: The virus is spread from plant to plant by aphids. The earliest symptoms on papaya are a yellowing and vein-clearing of the young leaves. This is followed by a very conspicuous yellow mottling of the leaves and sometimes severe blistering and leaf distortion. Dark-green streaks and rings also appear in the leafstalks and stems. The disease derives its name from the striking symptoms that develop on fruit. These consist of concentric rings and spots or C-shaped markings, a darker green than the background-green fruit colour. Symptoms persist on the ripe fruit as darker orange-brown rings. Vigour of trees and fruit set is usually reduced depending on the age of the plant when infected. Fruit quality, particularly flavour, is also adversely affected.

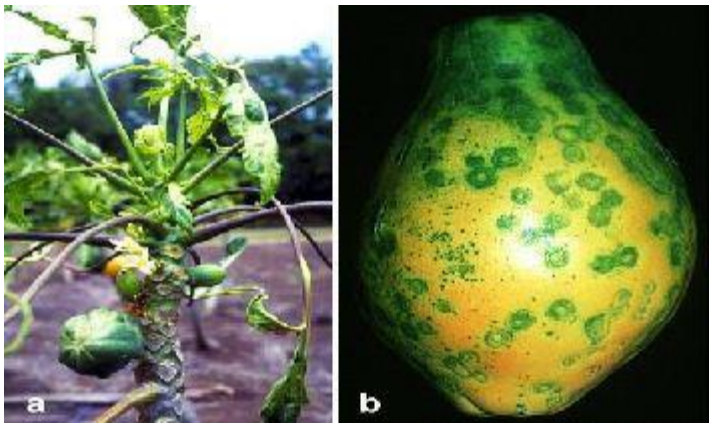
Control: Early detection of infected plants and prompt removal can check the spread of the disease. Aphids can be controlled by application of Carbofuran (1 kg a.i./ha) in the nursery bed at the time of sowing seeds followed by 2-3 foliar sprays of Phosphamidon (0.05%) at an interval of 10 days starting from 15-20 days after sowing.

Diseases of Papaya

Foot rot

Powdery mildew

Ring spot virus



Leaf curl

Anthracnose

Diseases of Banana

1.Banana Bunchy top

Symptoms

Dark green, dot-dash flecks along leaf veins adjacent to the midrib, these are most visible when viewed from the underside of leaves. Flecks in veins can form characteristic 'hooks' into the midrib from the leaf

blade. Vein-flecking can also be seen on the petioles and in the leaf sheaths of stems.Growth is reduced and emerging leaves develop a choked or '"bunched" appearance. Affected leaves are more upright with pale yellow margins and may have wavyier leaf margins than normal.If infected at an early stage, plants become very stunted and rarely produce bunches. If infected at a later stage, distorted bunches may be produced.

Transmission and natural spread

Banana bunchy top virus is spread in infected planting material, including suckers or bits, or by the banana aphid (*Pentalonia nigronervosa*), when it feeds on diseases plants and moves to healthy ones. Banana aphids can retain the virus for several weeks and may cover large distances especially when blown by the wind.

Management

Bunchy top cannot be cured and infected plants must be destroyed. Control depends on prompt detection and destruction of infected stools by a trained person. There are strict quarantine restrictions to prevent movement of contaminated planting material.

Recommended measures include use of tissue cultured, Banana bunchy top virus-free planting material when ever possible. Sensitive Banana bunchy top virus detection tests should be used.

2. *Fusarium* wilt of banana (*Fusarium oxysporum f. sp. cubense*)

Popularly known as **Panama disease**, is a lethal fungal disease caused by the soil-borne fungus *Fusariumoxysporum f. sp. cubense* (*Foc*). The fungus enters the plant through the roots and colonizes the xylem vessels thereby blocking the flow of water and nutrients. Disease progression results in the collapse of leaves at the petiole, the splitting of the pseudostem base and eventually plant death. Once established in a field, the fungus persists in soil for an indefinite period of time and cannot be managed using chemical pesticides. The solution best adapted to the continued production of bananas in infested soils is replacing susceptible cultivars by resistant ones. Fusarium wilt is the first disease of bananas to have spread globally.

3.**Sigatoka** leaf spot of banana (*Mycosphaerell musicola*)

(yellowsigatoka-*Mycosphaerella musicola*;blacksigatoka –*Mycosphaerella fijiensis*): Yellow sigatoka is one of the serious diseases affecting the banana crop. Initial symptoms appear in the form of light yellowish spots on the leaves. A small number of these enlarge, become oval; the colour also changes to dark brown. Still later, the centre of the spot dies, turning light grey surrounded by a brown ring. In severe cases, numerous spots coalesce, killing large parts of the leaf. Rainfall, dew and temperature determine the spread of the disease. Conditions favouring mass infection are most common during the rainy season with temperature above 21°C.

Control : Cultural practices such as improved drainage, control of weeds, removal of diseases suckers and adopting correct spacing is recommended. Dithane M-45 WP (in oil-water emulsion) and Dithane M-45 (in water only) controlled *Mycosphaerella fjijiensis var. difformis* in banana. Foliar spray of Copper Oxychloride (3 g/litre of water) or Thiophanate Methyl 1 g/ litres of water) controls the disease effectively.

Anthracnose (*Gloeosporium musae)*: The disease attacks banana plants at all stages of growth. Disease attacks the flowers, skin and distal ends of banana heads. The symptoms appear as large brown patches covered with a crimson growth of the fungus. The disease fruit turns black and the fruit is shrivelled.

Control: Spraying of Chlorothanlonil (0.2%) and Bavistin (1 %) four times at15 days interval is recommended. Minimizing bruising; proper sanitation of handling and prompt cooling to 14°C are essential in minimizing the disease in cold storage.

Cigar End Tip Rot *(Verticillium theobromae, Trachsphae fructi a*nd *Gloeosporium musarum)*: A black necrosis spread from the perianth into the tip of immature fingers**.** The rotted portion of the banana finger is dry and tends to adhere to fruits (appears similar to the ash of a cigar).

Control: Removal of pistil and perianth by hand 8-10 days after bunch formation and spraying the bunch with Dithane M -45 (0.1%) or Topsin M (0.1%) controls the disease effectively. Minimising bruising; prompt cooling to 14°C; proper sanitation of handling facilities reduce the incidence in the cold storage.

Banana diseases

Bunchy top of banana

Panama disease

Sigatoka of banana

Anthracnose

Moko disease


Panama

Cigar-end rot

Diseases of Pomegranate

Pomegranate (*Punica granatum* L.) is one of the important fruit crops in arid and semi-arid regions. The area under pomegranate is fast dwindling due to onslaught by a number of diseases such as bacterial blight, anthracnose, wilt and dieback or decline.

Bacterial blight

Bacterial blight of pomegranate caused by *Xanthomona axonopodis* pv. *punicae* has assumed epidemic proportions (40-85% severity) seriously threatening its cultivation. On leaves small, water soaked, brown to dark brown spots appear while on fruits oily, dark brown to black spots with L or Y shaped cracks are formed. The pathogen survives in fallen leaves and fruits during off-season and spreads through planting material, cutting secateurs and wind splashed rains. Temperatures around 31.8-35.6°C with enough rainfall during July-October were found to favor disease development. Pruning in September-October is beneficial to pomegranate plants and suppress the pathogen. Spraying streptocycline (500 ppm) + copper oxychloride (2000 ppm) has been found most effective.

Pomegranate Wilt

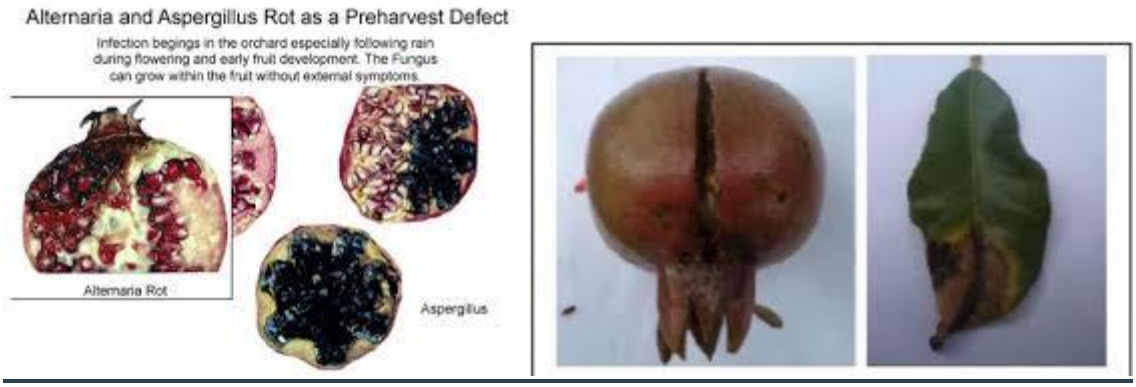
Pomegranate wilt (*Ceratocystis fimbriata*) is an important disease. Symptoms include yellowing of the leaves, epinasty and sudden wilting. The pathogen spreads through infected seedlings, sanitation measures such as removal and destruction of affected trees, soil sterilization with formalin (20 ml/L) check the disease. Pomegranate decline also referred to as wilt, involves poor soil and water management practices. Use of heavy and ill drained soils, close planting, excessive irrigation and fertilizers predispose the plant for disease complex.

Rhizoctonia bataticola, Fusarium solani and root knot nematode as well as shot hole borer management includes soil drenching with propiconazole (0.1%) + boric acid (0.5%) + phosphoric acid (0.5%).

Anthracnose

Anthracnose of pomegranate caused by *Colletotrichum gloeosporioides* is most serious during the period July-October. The disease appears as small, regular to irregular black spots on leaves, calyx region and fruits which turn later on as dark brown depressed spots. Rains, high humidity and temperatures of 20-27°C favor the disease, management through carbendazim/ difenconazole or thiophanate methyl at 0.1% or chlorothalonil 0.2% sprays at fort-nightly intervals have been found effective.

The minor diseases of pomegranate which appear occasionally in mild to less severe form include *Alternaria* blight, leaf spots due to *Cercospora, Sphaceloma, Fusarium, Phomopsis, Drechslera, Phytophthora nicotianae* and fruit spots and rots.



Heart rot" or black heart

Heart rot" or black heart, is a major pomegranate disease that impacts production worldwide. Heart rot is characterized by black rot of the fruit core that spreads from the calyx area, whereas the outer peel and the hard rind retain their healthy appearance. Several fungi have been isolated from pomegranate fruits, among which were species of *Penicillium*, *Aspergillus*, *Botrytis*, and *Rhizopus*, but the causative pathogen of the disease was identified as *Alternaria alternata*. It was found that *A. alternata* spores germinate on the stigmata of open flowers and develop into the style. At the beginning of disease development, the fungus causes brown soft rot of the arils, which becomes black and dry as the fungus grows. Eventually, the fungus grows from the lower loculus into the upper loculi, causing rot of the entire fruit.

***Aspergillus* fruit rot** (*Aspergillus niger*) and **gray mold** (*Botrytis cinerea*) also causes fruit rot

Alternaria fruit rot and *Aspergillus* fruit rot appear after rains as the flowers begin to open, and infect the internal portion of the pomegranate. Wounds must occur after flower initiation for these two infections to occur. The only exterior signs of disease would be a slight off-color in the peel, and a lighter weight due to internal decay Gray mold (*Botrytis cinerea*) causes problems after harvest. While the tree is flowering, airborne spores are spread to the open flowers and enter the fruit. The disease is activated with free water, commonly during the postharvest wash and spreads when stored at room temperature. However, if a postharvest fungicide is used

Gray mold

Diseases of Ber

Ber, a drought tolerant, poor man's fruit crop known for its nutritive value. However, it is affected by many serious diseases like powdery mildew, sooty mold, leaf spots (*Alternaria, Cercospora, Septoria, Cladosporium, Pestalotiopsi*etc.) and rust among the fungal infections and witches broom caused by MLOs.

Powdery mildew (*Oidiumerysiphoides*var. *zizyphi*) is economically important disease, which results in 50-60% loss in fruit yield and reduces market value of the produce. The disease is known to be severe in early pruned crop (April first fortnight) and generally favoured by rainfall, warm humid conditions proceeding to its appearance on fruits during September to December. The disease can be effectively managed by alternate sprays of triadimefon at 0.1% followed by wettablesulphur at 0.3% at an interval of 12-15 days. Among many genotypes, Jogia and Mundia were found resistant while, popular cultivar Umran was highly susceptible and another cultivar, Kadaka was moderately resistant to powdery mildew.

Among other diseases, **Sooty mold** caused by *Isariopsis indica*var. *Zizyphi* that causes sooty/black spots on leaf surface covering large area of leaves, often resulting in defoliation and reduced yields.

The **leaf spots** caused by *Cercospora zizyphi* and *C. jujube* cause circular oval spots on leaves s *Alternaria chartarum* forms small irregular brown spots resulting in defoliation. These diseases can be managed by carbendazim at 0.2% spray.

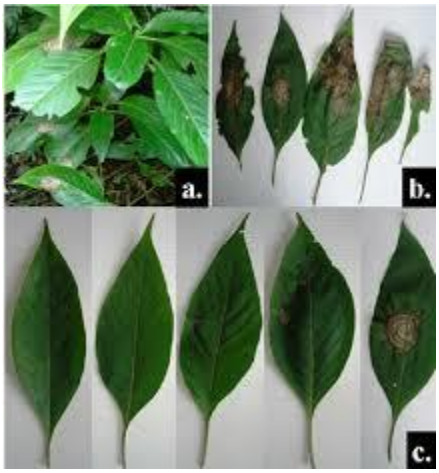
The **rust** (*Phakopsora zizyphi-vulgaris* Diet.) causes small irregular reddish brown pustules covering entire leaves resulting in drying and defoliation. The disease can be managed by spraying mancozeb at 0.2% or zineb at 0.2% or wettablesulphur at 0.2%.

Witche's broom, a MLO disease causes phyllody of plants producing auxillary bud proliferation giving bushy appearance and transmitted through grafting.

Diseases of ber

Powdery mildew

Leaf spot



Ex. 3: Diseases of Mango, Grapes, and Apple

Diseases of Mango

1) Anthracnose - *Colletotrichum gloeosporioides*

2) Powdery mildew- *Oidiummangiferae*

3) Mango malformation- *Fusariummoniliforme* var. *subglutinans*

4) Stem end rot- *Botrydiplodia theobromae*

5) Red rust- *Cephaleuros mycoides*

6) Grey Blight- *Pestalotia mangiferae*

7) Sooty mould:-*Capnodium mangiferae*

8) Black tip of mango

Anthracnose- *C. gloeosporioides*

Symptoms- Produces leaf spots, blossom blight, wither tip, twigs produces leaf spots, blossom blight, wither tip, twigs blight and fruit rot.Small blister like spots develop on the leaves and twigs. Young leaves wither and dry. Tender twigs wither and die back .ν Affected branches ultimately dry up. Black spots appear on fruits.The fruit pulp becomes hard, crack and decay.The fruit pulp becomes hard, crack and decay at ripening. Infected fruits drop.

Management- Spray *P. fluorescens* (FP 7) at 3 weeks commencing from October at 5g/liter on flower branches. 5-7 sprays one to be given on flowers and bunches.5-7 sprays one to be given on flowers and bunches. Before storage, treat with hot water, (50-55°C) for 15 minutes or dip in Benomylsolutionfor 15 minutes (500ppm) or Thiobendazole(1000ppm) for 5minutes

Powdery mildew–*Oidium mangiferae*

Symptoms - It attacks the leaves, flowers, stalks of panicle and fruits. Shedding of infected leaves occurs when the disease is severe. The affected fruits do not grow in size and may drop before attaining pea size. Survives as dormant mycelium in affected leaves. Secondary spread is by air borne conidia.

Management-Dusting the plants with fine sulphur (250-300 mesh) at the rate of 0.5 kg/tree, The first application may be soon after flowering, second 15 days later (or) spray with Wettablesulphur (0.2%), (or) Tridemorph (0.1%),(or) Karathane(0.1%).

Mango malformation–*Fusarium moliliforme var. subglutinans.*

Symptoms-Three types of symptoms: **bunchy top phase, floral malformation and vegetative malformation** are produced. In bunchy top phase in nursery, bunching of thickened small shoots, bearing small rudimentary leaves. Shoots bearing small rudimentary leaves. remain short and are stunted giving a bunchy top appearance. In vegetative malformation, excessive vegetative branches of limited growth in seedlings. They are swollen with short internodes forming bunches of various size shows bunchy top appearance..In floral malformation variation in the panicle occurs. Malformed head dries up in black mass and persist for long..Secondary branches are transformed in to number of small leavesgiving a witches broom appearance.

Management -1. Diseased plants should be destroyed. 2. Use of disease free planting material. 3. Incidence reduced by spraying 100-200ppm NAA during October.4. Pruning of diseased parts along the basal 15-20 cm apparently healthy portions 6. This is followed by the spraying of Carbendazim (0.1%) or Captafol (0.2%).(0.1%) or Captafol (0.2%).

Stem end rot*(Diplodia natalensis)*

Symptoms-

.In the initial stage the affected area enlarges to form a circular, black patch.Under humid atmosphere extends rapidly andturns the whole fruit completely black within two or three days.The pulp becomes brown and somewhat softer.

Management- Prune and destroy infected twigs and spray Carbendazim or Thiophanate Methyl(0.1%) or Chlorathalonil (0.2%) atfortnightly intervals during rainy season.

Red-rust (*Cephaleuros virescens*)

Symptoms--Algae attacks foliage and young twigs. Rusty spots appear on leaves, initially as circular, slightly elevated, coalesce to form irregular spots. The spores mature fall off and leave cream to white valvet texture on the surface of the leaves.

Management- Bordeaux mixture (0.6%) or Copper oxychloride 0.25%Bordeaux mixture (0.6%) or Copper oxychloride 0.25%

Grey Blight (*Pestalotia mangiferae*)

Symptoms

Brown spots develop on the margin and at the tip of the leaf lamina. They increase in size and become dark brown. Black dots appear on the spots which aredark brown. Black dots appear on the spots which are acervuli of the fungus. The pathogen survive on mango leaves for over a

year. Spreads through wind borne conidia.Heavy infection is noticed during the monsoon when the temperature is 20-25oC.and humidity is high.

Management- Remove and destroy infected plant parts. Spraying copper oxychloride 0.25 Mancozeb 1.0%.0.25% or Bordeaux mixture 1.0% is recommended.

Sooty mould : (*Capnodium mangiferae*)

Symptoms-

The fungi produces mycelium which is superficial and dark. They grow on sugary secretions of the plant hopper. Black encrustation is formed which affect the photosynthetic activity. The fungus grows on the leaf surface on the sugary substances secreted by jassids, aphids and scale insects.

Management-

Management should be done for insects and sooty moulds simultaneously. Controlling of insect by spraying systemic insecticides like Monocrotophos or methyl demeton. After that spray starch solution (1kg Starch/Maida in 5 litres of water. Boiled and diluted to 20 liters). Starch dries and forms flake which are removed along with the fungus.

Black Tip of mango

Black tip is a serious disorder, particularly in the some mango cultivar (Dasheri, Alfonso etc.). The affected fruits become unmarketable and reduce the yield to a considerable extent. The damage to the fruit gets initiated right at marble stage with a characteristic yellowing of tissues at distal end. Gradually, the colour intensifies into brown and finally black. At this stage, further growth and development of the fruit is retarded and black ring at the tip extends towards the upper part of the fruit. Black tip disorder has generally been detected in orchards located in the vicinity of brick kilns. It has been reported that the gases like carbon monoxide, sulphur dioxide and ethylene constituting the fumes of brick kiln are known to damage growing tip of fruits and give rise to the symptoms of black tip. Apart from these factors, irrigation, condition of the tree and management practices also play important role in deciding the severity of the disorder.

Management

Planting of mango orchards in North-South direction and 5-6 km away from the brick kilnsmay reduce incidence of black tip to a greater extent. The incidence of black tip can also be minimized by spraying Borax (1%) or other alkaline solutions like caustic soda (0.8%) or washing soda (0.5%). The first spray of Borax should be done positively at pea stage followed by two more sprays at 15 days interval.

Diseases of Grapes

1. Downy Mildew-*Plasmopara viticola*.

2. Powdery Mildew-*Erysiphe necator*; *Uncinula necator*..

3. Anthracnose-*Elsinoe ampelina*.

4.Grey Mold-*Botrytis cinerea*. (*Botryotinia fuckeliana*) ...

5. Black Rot- *Guignardia bidwelli*.

6. Crown gall- *Agrobacterium vitis*

Downy mildew(*Plasmopara viticola*)

Symptoms

The fungus is an obligate pathogen which can attack all green parts of the vine.Symptoms of this disease are frequently confused with those of powdery mildew. Infected leaves develop pale yellow-green lesions which gradually turn brown. Severely infected leaves often drop prematurely.Infected petioles, tendrils, and shoots often curl and eventually turn brown and die.Young berries are highly susceptible to infection and are often covered with white fruiting structures of the fungus. Infected older berries of white cultivars may turn dull gray-green, whereas those of black cultivars turn pinkish red.

Survival and spread

The fungus overwinters mainly in the fallen leaves which are the source of primary infection. Secondary infection occurs by motile zoospores by splashing rain.

Favourable conditions

The most serious outbreaks have been found to occur when a wet winter is followed by a wet spring and a warm summer with intermittent rains.

Management

Sprays of Metalaxyl + Mancozeb (0.2%) or Difolatan (0.25%) 0r Chlorothalonil (0.25%)

Powdery mildew (*Erysiphe necator*, *Uncinula necator*)

Disease symptoms

Powdery mildew, caused by the fungus *Uncinula necator*, can infect all green tissues of the grapevine.

Tissues are generally susceptible to infection throughout the growing season.

Diseased leaves appear whitish gray, dusty, or have a powdery white appearance. Petioles, cluster stems, and green shoots often look distorted or stunted. Berries can be infected until their sugar content reaches about 8%.

If infected when young, the epidermis of the berry can split and the berries dry up or rot. When older berries are infected, a netlike pattern often develops on the surface of the berry.

Survival and spread

The powdery mildew fungus overwinters in dormant buds or as specialized structures on the surface of the vines. When conditions are favorable for growth of the fungus in spring, spores are produced, released, and cause new infections. Secondary spread of the disease can occur if spores are produced in these new infections.

Favourable conditions

High humidity and moist weather favours the development of disease.

Management

The vines should be properly pruned.

Fungicidal sprays of Sulfex- 0.25%; or Carbendazim -0.1%

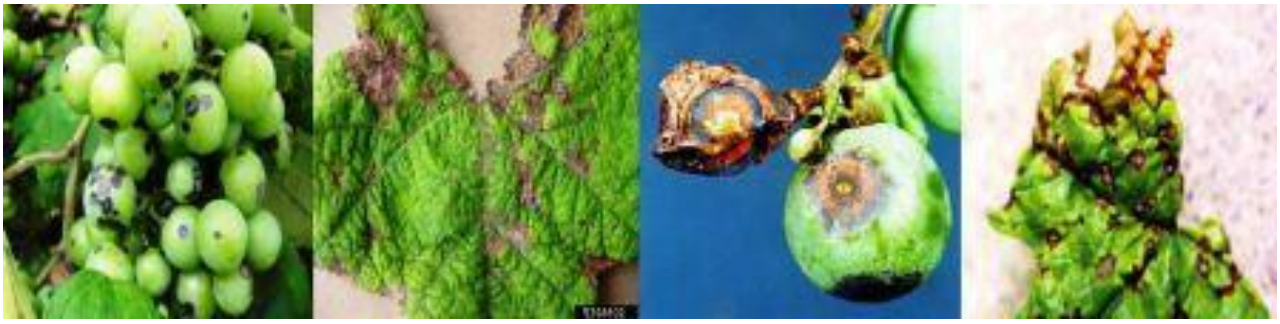
Resistant varieties- Red sultan, Saint George.

Anthracnose(*Elcinoe ampelina*)

Symptoms

Anthracnose, caused by the fungus *Elsinoe ampelina*, is also known as bird's-eye rot from its appearance on the fruit.The disease appears first as dark red spots on the berry. Later, these spots are circular, sunken, ashy-gray and in late stages these spots are surrounded by a dark margin which gives it the "bird's-eye rot" appearance. The spots vary in size from 1/4 inch in diameter to about half the fruit

The fungus also attacks shoots, tendrils, petioles, leaf veins, and fruit stems. Numerous spots sometimes occur on the young shoots. These spots may unite and girdle the stem, causing death of the tips. Spots on petioles and leaves cause them to curl or become distorted.



Survival and spread

The primary infection by diseased vines and secondary infection by wind-borne conidia.

Favourable conditions

Continuous/intermittent rains and high humidity are responsible for the development of disease.

Management

Removal of infected twigs.

Spraying of Copper oxychloride (0.3%) or Mancozeb (0.2%).

Greenaria bitter rot

Disease symptoms

This fungus can infect all green parts of the vine including leaves, tendrils, new shoots, as well as berries. However, mature leaves and ripe fruit are not susceptible. Infections of leaves first appear as red spots on the upper leaf surface in late spring.These circular spots enlarge and become tan to light brown with distinct, dark borders. Small, pinpoint black fruiting structures of

the fungus often develop in the centers of these spots.Most serious damage usually occurs on the berries. On the fruit, infections first appear as whitish spots which enlarge to sunken areas with dark borders. Significant infections usually occur when the grape is pea-size or larger. As infection progresses, the fruit becomes black, wrinkled, mummified, and look like raisins. Infected grapes often shatter leaving only the stem.

Survival and spread

The fungus overwinters on mummified berries on the soil or in old clusters still hanging in the vines. Secondary infections can occur when additional spores are produced on the newly infected tissues.

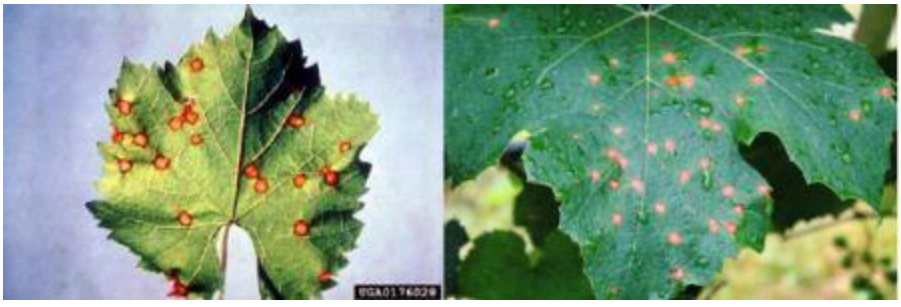
Favourable conditions

Moisture and temperature above 20-25 °C favours the development of disease

Bacterial leaf spot

Disease symptoms

The young growing shoots are affected first. Disease infects leaves, shoots and berries. The symptoms appear as minute water soaked spots on the lower surface of the leaves along the main and lateral veins.Later on these spots coalesce and form larger patches. Brownish black lesions are formed onthe berries, which later become small and shriveled.



Survival and spread

The pathogen survives in infected plant residue in soil and seed borne.

Favourable conditions

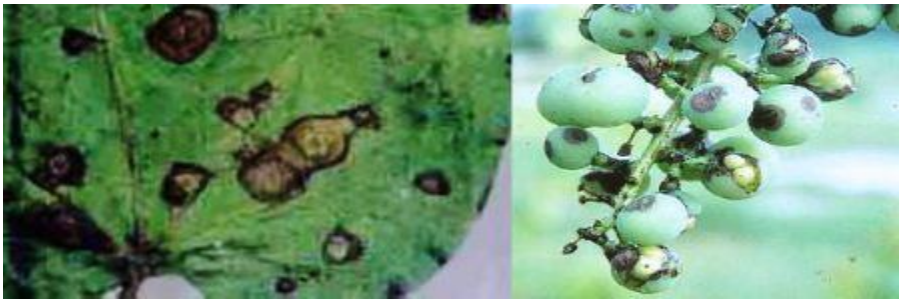
The disease is more prevalent during June-August and again in February-March.

Temperature range of 25-30 ºC and relative humidity of 80-90% is favourable for the development of the disease.

Alternaria blight(*Alternaria alternata*)

Symptoms

The disease attacks both leaves and fruits. Small yellowish spots first appear along the leaf margins, which gradually enlarge and turn into brownish patches with concentric rings. Severe infection leads to drying and defoliation of leaves.Symptoms in the form of dark brown-purplish patches appear on the infected berries, rachis and bunch stalk just below its attachment with the shoots.



Survival and spread

The disease is externally and internally seed borne. The pathogen survives through spores (conidia) or mycelium in diseased plant debris or weed.

Favourable conditions

Moist (More than 70% relative humidity) and warm weather (12-25 ºC) and intermittent rains favours disease development.

Black rot(*Guignardia bidweli*)

Symptoms

The disease attacks the leaves, stem, flowers and berries. All the new growth on the vineis prone to attack during the growing season.The symptoms are in the form of irregularly shaped reddish brown spots on the leaves and a black scab on berries.

Occasionally, small elliptical dark coloured canker lesions occur on the young stems and tendrils. Leaf, cane and tendril infection can occur only when the tissue is young, but berries can be infected until almost fully-grown if an active fungicide residue is not present.

The affected berries shrivel and become hard black mummies.

Survival and spread

Pathogen survives in soil and plant debris.

Gray mold (*Botrytis cinerea*. (*Botryotinia fuckeliana*) ...

Symptoms

One or more berries of a cluster show signs of decay just before harvest. The decay may progress to include most of the berries in a cluster. The infected fruit may become covered with a grayish-tan powder containing the spores of the fungus.Berry stems and cluster stems may be invaded, causing them to shrivel.When the fungus decays berries low in sugar, the rotting berry has a sour odor and taste.If the berries are nearly mature and have a high sugar content, the decaying berry is quite firm, dry, and somewhat sweetish to the taste. Berries that have split or have been punctured often are attacked by other organisms, resulting in a sour or moldy decay.

Survival and spread

Fungus survives in all decaying vegetation. Its spores are present in the vine yard throughout the year.

Favorable conditions

Brown mold is most common when temperatures are higher than 30°C in the field or 24°C in storage.Free moisture for six hours or longer on the surface is necessary for infection to occur.

Diseases of Apple

Marssonina leaf blotch of apple

Marssonina Blotch disease (*Marssonina coronaria*) It is one of the most serious disease of apple in India. All the commercial varieties of apple are susceptible to this disease. The main damage caused by Marssonina Blotch is premature defoliation of apple trees with fruit still hanging on the tree. The pathogen causes dark spots on both the leaves and fruit, which may weaken the trees.

SYMPTOMS

The disease usually starts in rainy summers with grey-black spots on the upper side of the leaves. These spots develop into larger spotted areas surrounded by red edges. The numerous spots turn the leaf yellow and prematurely fall off the tree. Defoliation starts approximately after two weeks of the first symptom. Severe defoliation reduces the quantity and quality of apples, and sometimes affects flower initiation in autumn, leading to reductions in fruit set in the following season. As such no symptoms are seen on the fruit but can be seen rarely in heavily infected orchards.

Survival and spread

The pathogen survives in infected leaf litter on orchard floor in the form of conidia and the sexual stage of pathogen

Diplocarpon mali is also intercepted in nature.

Favourable conditions

This disease favoured by high rainfall and moderate temperature ranging from 20-22°C during the fruit development stages of apple.

NON-CHEMICAL CONTROL

Proper sanitation is required to keep away disease. The spores of the Marssonina Blotch can be destroyed by destroying the fallen leaves in autumn.

CHEMICAL CONTROL

Protective sprays of fungicides provide significant reduction in disease incidence of Marssonina Blotch. Fungicides that are highly effective and exhibit maximum disease control are—

- Mancozeb(0.2%)
- Dodine
- Thiophanate-Methyl
- Metiram
- Trifloxystrobin
- Copper Oxychloride (0.3%) (post harvest application only)

Collar rot (*Phytophthora cactorum*)

Disease symptoms

Phytophthora collar rot attacks the lower 30 inches (76 cm) of apple trunks. Most infections start at the junction of a lateral root with the trunk. Infected bark becomes brown and is often soft and mushy or slimy when wet.Dark streaks often occur near the cambium and extend beyond the canker margin. If a canker enlarges for several years, only the marginal areas show the typical color and texture of newly killed tissue.

The development of the canker is rapid, horizontally and vertically. The ultimate effect of collar rot is to girdle the affected limb, roots, or trunk, resulting in the death of that organ or of the entire tree.

Survival and spread

Fungus overwinters as dormant resting spores or as mycelium within infected tissues. New infections occur when the pathogen releases motile spores that are carried via water to susceptible hosts.

Favourable conditions

Soils that are saturated from rain or over-watering provide the moist conditions necessary for *Phytophthora* spp. to thrive and spread.

The lack of oxygen in saturated soils may also increase the rootstock's susceptibility to this disease

Powdery mildew (*Erysiphe cichoracearum***)**

Disease symptoms

Disease appearswhen the buds develop into new leaves and shoots.Small patches of white or grey powdery masses on under surface of leaves occur. Leaves grow longer and narrower than normal leaves and the margin is curled.Twigs covered with powdery mass. Affected fruits remain small and deformed and tend to develop roughened surface.

Survival and spread

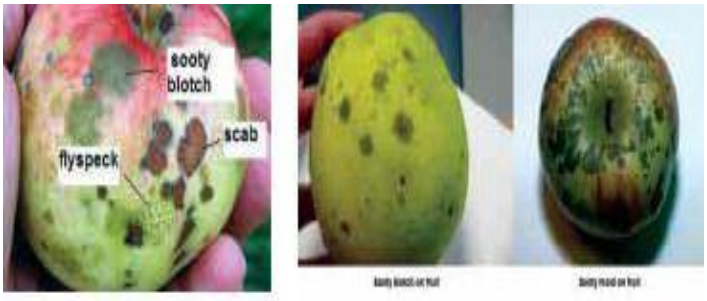
The fungus survives in the form of a resting mycelium or encapsulated haustoria in the buds and the secondary spread occur through wind borne conidia.

Favourable conditions

Powdery mildew infections occur when the relative humidity (RH) is greater than 70%. Infections can occur when the temperature lies between 10 to 25°C.

Sooty blotch and fly speck

Disease symptoms



Sooty Blotch and fly speck (Saprophytic fungi)

Sooty blotch appears as sooty or cloudy blotches on the surface of the fruit. The blotches are olive green with an indefinite outline. The blotches are usually one fourth of an inch in diameter or larger, and may coalesce to cover much of the fruit. The “smudge” appearance results from the presence of hundreds of minute, dark pycnidia that are interconnected by a mass of loose, interwoven dark hyphae.The sooty blotch fungus is generally restricted to the outer surface of the cuticle. In rare cases, the hyphae penetrate between the epidermal cell walls and the cuticle.

Flyspeck: Groups of a few to 50 or more slightly raised, black and shiny round dots that resemble fly excreta, appear on the apple fruit. The individual “fly specks” are more widely scattered and much larger than the pycnidia of the sooty blotch fungus. The flyspecks are sexual fruiting bodies (pseudothecia) of the fungus, and are interconnected by very fine hyphae. The blemishes can be removed by vigorous rubbing or bleaching.

Survival and spread

Sooty blotch: The pycnidia on host plants produce large numbers of spores (conidia) that ooze out of infections and collect in a gelatinous mass.

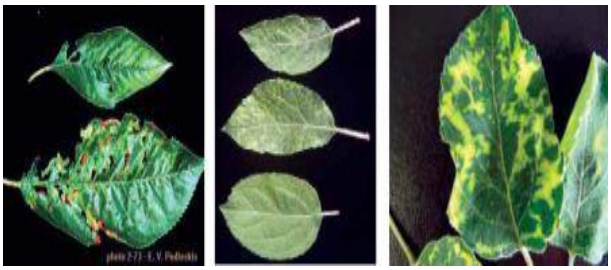
Flyspeck: In late spring, this fungus produces both ascospores and conidia that are wind-borne and survive into orchards from other plants.

Favourable conditions

Moist condition and 18 to27°C temperature are essential for infection and disease development

Apple mosaic and other virus diseases

Disease symptoms



Apple trees infected with apple mosaic virus develop pale to bright cream spots on spring leaves as they expand. These spots may become necrotic after exposure to summer sun and heat.

Other viral diseases are symptomless in most commercial cultivars, but may cause symptoms in certain cultivars, scionl / rootstock combinations, and ornamental varieties. Symptoms of apple chlorotic leaf spot virus may include chlorotic leaf spots, leaf distortion, chlorotic rings and line patterns, reduced leaf size, and stunting.

Apple stem grooving virus produces symptoms on 'Virginia Crab' such as chlorotic leaf spots, stern grooving and pitting, union necrosis, and swelling of the stem above the graft union.

Apple mosaic virus (ApMV) (Family-Bromoviridae) positive sense RNA virus.

Transmission

Root grafting, vegetative propagation, transmission of ApMV to *C. quinoa* and *C. sativus* was obtained under greenhouse conditions. *C. quinoa* reacted with mottling, whereas *C. sativus* showed chlorotic local lesions followed by systemic yellowing and stunting

Alternaria leaf spot/blight(*Alternaria mali*)

Disease symptoms

Leaf spots appear on the leaves in late spring and early summer. Initially, they are 1/8 to 1/4 inch in diameter, round, brown, and occasionally have a purple border.

As spots age, they often turn tan to ash gray. Some spots undergo secondary enlargement, becoming irregularly shaped.

Heavily infected leaves often abscise, resulting in defoliation. (Defoliation is greater when mites are present.) Fruit infections result in small, dark, raised pimple-like lesions associated with the lenticels.

Twig lesions, which are somewhat sunken, round, blackish spots bordered by cracks, occur on susceptible cultivars such as Indo but have not been observed on Delicious.

Survival and spread

Primary infection occurs about one month after petal fall the following year

Favourable conditions

The disease is favoured by temperatures between 77 and 86 °F (25–30 °C), and by wet conditions. Infection occurs at optimum temperatures with 5.5 hours of wetting and an outbreak can become serious within two days of infection.

Core rot (*Alternaria mali*)

Disease symptoms

Common injuries that can lead to *Alternaria* rot include mechanical or chemical injury, sunscald, or chilling injury.

Browning occurred most frequently with the occurrence rates of core rot. Infection can occur before or after harvest, although it is more commonly a post-harvest problem.

Survival and spread

The fungus is soil borne and Primary infection occurs by spores survives in the soil.

Favourable conditions

Warm weather and high humidity favour development of the disease.

Ex. 4: Diseases of Chillies, Brinjal and Bhindi

Diseases of Chillies

Damping off of chillies

This disease occurs and greatly damages many plants such as chilli, tomato and brinjal belonging to family Solanaceae in India.

Symptoms- Symptoms of this disease generally manifest at two stages: Pre-emergence stage and post emergence stage. Pre-emergence stage symptoms occur when the seeds sown are still to grow in soil or the developing seedlings are still to come over the soil surface. Seed generally fail to germinate, become soft and mushy then term brown, shrink and finally degenerate. Post-emergence stage symptoms occur when the seedlings are out on the surface of the soil. The pathogen attacks the young tissues at or below the ground level. The infected tissues become discoloured, water soaked and soon collapses.The infected part of the seedlings looks much thinner and softer than healthy part. The pathogen continues to invade the seedling tissues after it has fallen on the ground and seedling quickly withers and dies.

The disease is caused by *Pythium spp. (Pythium ultimum, P. debaryanum, P. aphanidermatum*).The mycelium is colourless, slender, coenocytic, profusely branching and rapidly growing. Mycelium produces terminal or intercalary sporangia, which and globose to oval. The zoospores are produced within a vesicle. Zoospores are – rainform and biflagellate.The size of resting zoospores is up to 8 µm in diameter. Sexual spores are oospores, the oospore develops into a smooth and thick walled oospore

Anthracnose, Die-back and Ripe fruit rot of chilies

This disease is one of the most serious disease of chillies. It occurs throughout India wherever the crop is grown but it prevailing causes severe damage in southern part of our country.□ Symptoms:□ The pathogen cause two different type of symptoms on two different parts of the host.

Die back-The disease cause necrosis of the tender twigs from the tip backwards. The entire branch or the entire top of the plant may wither away. The twigs are water soaked to brown, become grayish white or straw coloured in advance stage of the disease. Large number of black dots called acervvli are formed on the affected twigs.

Ripe fruit rot- The disease usually occurs on mature fruits as circular to elliptical sunken spots with black margins and marked with concentric rings.

Badly diseased fruits turn straw coloured from normal red. On this discoloured area, numerous black dots (acervuli) are present. The diseased fruit may drop off prematurely. Disease caused by *Colletotrichum capsici.* Mycelium septate, colourless and inter and intracellular. Hyphae develop the fruiting body called acervuli. Acervuli consists of setae, conidiophore and conidia. The setae are septate and dark brown with light brown tip.Conidiophores are mostly club-shaped, unbranched, small and unicellular. The conidia are hyaline, unicellular, sickle shaped and are produced singly at the tip of the conidiophore.

Bacterial leaf spots of chillies

This is a major disease of chillies in tropical and subtropical climates. This appears on leaves and fruits. In Rajasthan the disease cause 8-16% loss in yield of fruits

Symptoms- On leaves, the first indication of the disease is appear of small, circular to irregular, water soaked area which appear as definite spots on the lower surface of the leaf. As the colour change from dark green to purplish grey with a black center. A narrow yellow halo may surrounded the spot. In the wet weather, the leaves may look scalded. When the spots are too many, the intervening tissues become dry and brown and the whole leaf dies.

Disease caused by *Xanthomonas campestris pv. vesicatoria*. The bacterial cells are single, straight rods, 0.2-0.8 x 0.6-2.0 µm in size. They are gram negative and motile by a single polar flagellum. These bacteria are strict aerobes and optimum temperature for growth is 250-27 ^{0}C. In culture media production of copious amount of extracellular yellow slime is a characteristic of the genus, this yellow pigment produced by the bacterium is water soluble.

Xanthomonas vesicatoria is seed borne bacteria. 10 to 15% seeds carry the bacteria which is enough to initiate the disease through seedling. The bacterium also subsists on infected plant debris, weeds and volunteer tomato plants. Spattering rains are the chief means of local dissemination of bacterial cells from the ooze developed on the affected parts. The bacteria are also readily spread throughout the chilli. Fields during routine farming such as pruning of potato side shoots, manual tying of plant to stakes and movement of equipments and workers having come in contact with diseased plants.

Leaf curl of chillies

The leaf curl of chilies is very common wherever the crop is grown. It is a major imitation in successful cultivation of both hot and bell paper.

Symptom- The most characteristic symptoms are the curling of leaves, their small size, shortened internodes and general dwarfing of the plant which assumes a bushy appearance. Leaves are of pale (light yellow) colour and roll downwards. Fruiting is stopped, if fruits are formed, they are small and deformed.

Tobacco leaf curl (TLCV) virus- The genome consist of a simple circular ssDNA. Whereas the genome of the other known white fly transmitted Gemini viruses consists of two ssDNA. Gemini particles are paired and polyhedral. The member of this group are found predominantly in tropical area. Transmission: The disease is transmitted by white fly, Bemisia tabaci. This vector spread the maximum disease during the month of August to October. The vector acquires the virus after feeding on an infected plant for at least 15 to 30 minutes. There is a latent period of several hours (more than 20 hours) after which the virus can be inoculated into a healthy plant.

Integrated disease management of chilli

Integrated of following practices manage the diseases effectively economically and in a most environment friendly manner. Cultural practices- Field sanitation-Collect and burn the infected plant debris of chilli and other malformed plant parts lying in the field post- harvest to reduce the primary source of inoculum. Destroy self-grown solanaceous plant, other volunteer plants from the field and surrounding areas.

Deep ploughing, Post-harvest, plough the left-over inoculum deep into the soil.

Practice summer ploughing to expose the pathogenic material lying beneath the soil surface to hot sun. Solarize soil wherever possible.

Follow crop rotation- Avoid growing of two solanaceous crop in a single year in or around the same field.

Seed- Use certified seed of varieties for different areas.

Seeds obtained from a disease free crop.

Seed treatment with Carbendazim @ 2g/kg of seeds for damping off of chillies.

Treat the seed with 2g of Thiram per kg of seeds before sowing for Anthracnose of chillies.

Sowing- light sandy soil for nurseries or use of pure time sand sawdust mixture for raising seedlings. Under well drained conditions seedling can be transplanted into loam soil also.

Nutrition- Get the soil tested for its nutritional status. Apply fully decomposed FYM or compost to balance the nutrient supply. Add NPK fertilizer where necessary to make up for a 90:60:60 kg/ha. Thinning and weeding- Weeds serve carriers of plant pathogens and high plant density favour development. Remove the weeds once before and then after the irrigation. Rouge out the mixture and stray diseased plant as their serve as foci of infection.

Irrigation: Provide only need-based light irrigations, high humidity and frequent irrigations favour disease development.

Varietal- Use high yielding varieties recently released for different regions with tolerance to specific regional disease as no resistant/tolerant varieties have been released for the entire country. Resistant/tolerant genotypes . Resistant/tolerant genotypes against major diseases: G-4, G-5, Pusa Jwala, Pant C-1, NP-46 and JCA 196.

Chemical-Chemical treatment with fungicides provides good control of pre-emergence of damping off. The common seed protectants are use for seed treatment such as Thiram or Captan @ 3g/kg of seeds for the better control of Damping off. Soil drenching with Captan or Thiram @ 0.2-0.5%. For the management of Anthracnose chilli-Spray of captafol @ 0.2% followed by copper oxichloride @ 0.25% and Carbendazim @ 0.1%, two spray at 10-15 days interval, 35-45 days after transplanting Protect the crop in nursery bed from insect vectors (white fly) by spraying Metasystox or Rogor @ 1 ml/litre of water at 10 days intervals.

Diseases of Brinjal

Damping Off (*Pythium spp.*, *Phytophthora spp.*, *Rhizoctonia spp.)* : The disease causes severe damage in the nursery. High soil, moisture and moderate temperature along with high humidity

especially in the rainy season leads to the development of the disease. Two types of symptoms are observed-

Pre-emergence damping-off: The pre-emergence damping off results in seed and seedling rot before these emerge out of the soil.

Post-emergence damping-off: The post-emergence damping off phase is characterized by infection of the young, juvenile tissues of the collar at the ground level. The infected tissues become soft and become water soaked. The collar portion rots and ultimately the seedlings collapse and die.

Control: Healthy seed should be selected for sowing. The seed should be treated with Thiram @ 2g/kg of seed before sowing. Continuous raising of nursery in the same plot should be avoided. The top soil of nursery should be treated with Thiram @ 5g/m2 area of the soil and nursery should be drenched with the same chemical @ 2g/litre of water at fortnightly interval. Soil solarization by spreading 250 gauge polythene sheet over the bed for 30 days before sowing and application of bio-control agent *Trichoderma viride* in soil @ 1.2kg/ha is also found effective to control damping-off to considerable extent.

Phomopsis Blight (*Phomopsis vexans*) : It is a serious disease of brinjal infecting the foliage and the fruits. The fungus infects the seedlings in the nursery causing damping off symptoms. In seedling infection, it causes damping off symptoms. When the leaves are infected small circular spots appear which become grey to brown with irregular blackish margins Lesions may also develop on petiole and stem, causing blighting of affected portion of the plant. Symptoms on the infected fruits appear as minute, sunken dull and dusky spots which later merge to form rotten areas. The flesh of severely infected fruits rots.

Control: Adopting good field sanitation, destruction of infected plant material and crop rotation help to reduce the spread of the disease. Seeds obtained from disease plants should be used for planting. Seed treatment with Thiram (2 g/kg seed) protects the seedling in the nursery stage. Spraying with Dithane Z-78 (0.2%) or Bordeaux mixture (1%) effectively controls the disease in the field.

Leaf spot *(Cercospora melongenae)* : The disease symptoms are characterized by chlorotic lesion, angular to irregular in shape, later turning greyish-brown. Severely infected leaves drop off prematurely, resulting in reduced fruit yield.

Control: Removal and destruction of affected plant parts and spraying the affected plants with Bavistin (0.1%) or Chlorothalonil (2 g/litre of water) is useful for disease control.

Alternaria Leaf Spots (*Altrenaria melongenae*) : The disease causes characteristic leaf spots with concentric rings. The spots are mostly irregular and coalesce to cover large areas of the leaf blade. Severely affected leaves drop off. The symptoms on the affected fruits are in the form of large deep-seated spots. The infected fruits turn yellow and drop off prematurely.

Control: Removal and destruction of affected plant parts and spraying the affected plants with Bavistin (0.1%) is useful for disease control.

Fruit Rot *(Phytophthora nicotianae)* : High humidity favours the development of the disease. The symptoms first appear as small watersoaked lesions on the fruit, which later enlarges in size considerably. Skin of infected fruit turns brown and develops white cottony growth.

Control: Removal and destruction of the affected fruits and spraying the crop with Difolatan (0.3%) thrice at an interval of 10 days effectively controls the disease.

Verticillium Wilt (*Verticilium dahliae*) : The disease attacks the young plants as well as mature plants. The infected young plants show dwarfing and stunting due to the shortening of the internodes. Such plants do not flower and fruit. Infection after the flowering stage results in development of distorted floral buds and fruits. The affected fruits finally drop off. The infected leaves show the presence of irregularly scattered necrotic pale yellow spots over the leaf lamina. Later on, these spots coalesce resulting in complete wilting of the leaves. The roots of the affected plants are split open longitudinally, a characteristic dark brown discoloration if the xylem vessels is observed.

Control: Crop rotation with bhendi, tomato, potato should be avoided. Soil application and foliar application with Benlate (0.1%) is effective in reducing the wilt disease.

Bacterial Wilt *(Psedomonas solancearum*) : Bacterial wilt disease causes severe problem in brinjal cultivation. The characteristic symptoms of the disease are wilting of the foliage followed by collapse of the entire plant. The wilting is characterized by gradual, sometimes sudden, yellowing, withering and drying of the entire plant or some of its branches.

Control: Removal and destruction of the affected plant parts and using disease resistant varieties help to reduce the disease incidence. Crop rotation with bhendi, tomato, potato should be avoided. Before sowing the seeds should be dipped in a solution of Streptocycline (1 g/ 40 litres of water) for 30 minutes.

Little Leaf of Brinjal

This is a serious viral disease of brinjal. The disease is transmitted by leaf hopper (*Cestius* (*Hishimonus*) *phycitis* and *Amrasca biguttula biguttula*). The leaves of the infected plants in the early stages are light yellow in colour. The leaves show a reduction in size and are malformed. Disease affected plant are generally shorter in stature bearing a large number of branches, roots and leaves than healthy plants. The petioles get shorter considerably, many buds appear in the axil of leaves and internodes get shortened thus giving the plants a bushy appearance. Flower parts are deformed leading the plants to be sterile. Infected plants do not bear any fruit. However, if any fruit is formed it becomes hard and tough and fails to mature.

Control: Adopting sanitary measures including the eradication of susceptible volunteer crop plants from a previous planting can reduce the damage. Use of barriers of trap crops and early removal and destruction of infected plants is also recommended. The sowing time can be adjusted to avoid the main flights of the beet leafhopper. Spraying Malathion (2ml/litre of water) starting with the appearance of the leaf hoppers controls their population.

Mosaic: This is a viral disease caused by Potato Virus Y and transmitted by aphids (*Aphis gossypi* and *Myzus persicae*). The important symptoms of the disease are mosaic mottling of the leaves and stunting of plants. The leaves of infected plants are deformed, small and leathery. Plants show a stunted growth when infected in the early stages.

Control: The disease incidence can be minimized by reducing the population of aphids, removal and destruction of infected plants and eradication of susceptible weed hosts. In the nursery, aphids can be controlled by application of Carbofuran (1 kg a.i./ha) in the nursery bed at the time

of sowing seeds followed by 2-3 foliar sprays of Phosphamidon (0.05%) at an interval of 10 days. Spraying Phosphamidon (0.05%) at 10 days interval starting from 15-20 days after transplanting effectively controls the aphids in the field.

Diseases of Bhindi

Yellow Vein Mosaic

Caused by Bhendi yellow vein mosaic virus

It is the **most severe disease of bhendi all over India, limiting cultivation of the crop.**

Symptoms

Yellowing of the entire network of veins in 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. In a field, most of the plants may be diseased and the infection may start at any stage of plant growth. Infection restricts flowering and fruits, if formed, may be smaller and harder.

Control

The virus is transmitted by the whitely (*Bemisia tabaci),* So control of this pest will gives better results.

Parbhani Kranti, Janardhan, Haritha, Arka Anamika and Arka Abhay can tolerate yellow vein mosaic.

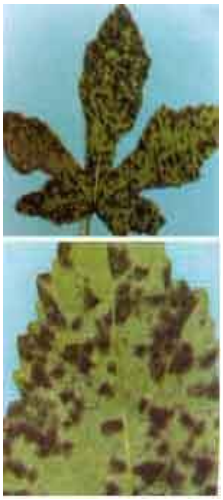
Spraying monocrotophos 1.5 ml/litre of water can restrict the disease spread.

Top

Management of yellow mosaic disease and its vector whitefly

It is a serious disease of bhendi. The veins of the leaves will be cleared by the virus and intervenal area becomes completely yellow or white. The affected plants produce fruits with yellow or white colour and they are not fit for marketing. The virus is spread by whitefly. It can be controlled by application of Chlorpyriphos 2.5 ml + neem oil 2 ml lit of water. On no account synthetic pyrethroids should be used because it will aggravate the situation. For sowing during the summer season, when the whitefly activity is high, the susceptible varieties should be avoided. By selecting varieties resistant to yellow vein mosaic like Parbhani Kranti, Arka Abhay, Arka Anamika, Co3, and Varsha Uphar, the incidence of the disease can be minimized. Even in these varieties, when a plant starts exhibiting symptom of the disease, it should be pulled out immediately and burnt by which the spread of the diseases can be prevented.

Cercospora Leaf Spots (*Cercospora malayensisC. abelmoschi)*



Symptoms

In India, two species of *Cercospora* produce leaf spots in bhendi. C. *Malayensis* causes brown, irregular spots and C. *abelmoschi* causes sooty black, angular spots. Both the leaf spots cause severe defoliation and are common during humid seasons. The fungi survive through conidia and stomata on crop residue in soil.

Control

Spraying Mancozeb or Zineb 2 g or Carbendazim 1 g/l can control the disease.

▲Top

Fusarium Wilt of bhindi*(Fusarium vasinfectum*)

Fursarium wilt, a serious disease, found wherever okra is grown intensively.

The okra *Fusarium* also infects cotton and certain other plants in the sp. Malvaceae family.

Symptoms

The conspicuous symptom is a typical wilt, beginning with a yellowing and stunting of the plant, followed by wilting and rolling of the leaves as if the roots were unable to supply sufficient water. Finally, the plant dies. If a diseased stem is split lengthwise, the vascular bundles appear as dark streaks. When severely infected, nearly the whole stem is blackend. The fungus has mostly three-septate spores. It is soil organism that enters the host through the roots and is disseminated in any way in which soil is transported from one field to another. Once the inoculum enters a field, it slowly increases until Okra crops become unprofitable.

Environmental effects

Soil moisture has little effect on the pathogen, except as it modifies temperature. Once the disease becomes destructive, it is advisable to find clean fields even if such a plan involves renting additional land. A better plan is to use a 6-year rotation before the fungus is destructive; this permits many years of okra growing without too much loss. Drench the field with Copper oxy chloride @3g/litre of water. Treat the seeds with Carbandazim or Mancozeb @ 3g/kg seed.

▲Top

Powdery Mildew *(Erysiphe cichoracearum)*

Symptoms

Powdery mildew is very severe on bhendi.

Greyish powdery growth occurs on the under as well as on the upper surface of the leaf causing severe reduction in fruit yield.

Control

The disease is effectively controlled by dusting finely ground sulphur at 30 kg/ha or spraying wettable sulphur 3 g/litre of water or Dinocarp 1 ml/litre of water three to four times at 15 days intervals.

Ex. 5: Diseases of Potato, Tomato and Crucifers

Diseases of Potato

Early blight

Disease symptoms:

- This is a common disease of potato occurring on the foliage at any stage of the growth and causes characteristic leaf spots and blight.
- Normally the disease symptoms become apparent during tuber bulking stage and develop leading to the harvest.
- The early blight is first observed on the plants as small, black lesions mostly on the older foliage.
- Spots enlarge, and by the time they are one-fourth inch in diameter or larger, concentric rings in a bull's eye pattern can be seen in the center of the diseased area.
- Tissue surrounding the spots may turn yellow. If high temperature and humidity occur at this time, much of the foliage is killed.
- Lesions on the stems are similar to those on leaves, sometimes girdling the plant if they occur near the soil line.

Leaves showing disease symptoms

Tuber showing disease symptoms

Survival and spread:

- **Primary:** The pathogen overwinters in infected plant debris in or on the soil where it can survive at least one and perhaps several years. It can also be seed borne.
- **Secondary:** The spores are transported by water, wind, insects, other animals including man, and machinery.

Favourable conditions:

- Warm, rainy and wet weather

Late blight

Disease symptoms:

- This disease damages leaves, stems and tubers. Affected leaves appear blistered as if scalded by hot water and eventually rot and dry out.
- When drying out, leaves turn brown or black in color. When infections are still active, spots appear on the underside of leaves blanketed in what looks like flour.
- Affected stems begin to blacken from their tips, and eventually dry out.
- Severe infections cause all foliage to rot, dry out and fall to the ground, stems to dry out and plants to die.
- Affected tubers display dry brown-colored spots on their skins and flesh. This disease acts very quickly. If it is not controlled, infected plants will die within two or three days.

Leaves showing disease symptoms

Tubers showing disease symptoms

Survival and spread:

- The pathogen survives in plant debris in the soil.
- It spreads through soil and infected seed tubers.

Favourable condition:

- High humidity
- Low temperature and leaf wetness

Bacterial wilt

Disease symptoms:


Plant showing wilting symptoms


Tuber showing wilting symptoms

- In addition to the potato, the pathogen also damages plants such as chili, tomato, tobacco and egg plant, as well as several species of weeds.
- The symptoms of bacterial wilt infection can be seen on all parts of infected plants.
- Infected plant begins to wilt, starting from the tips of the leaves or where the stems branch out, and then spreading to all parts of the plant.
- Leaves become yellow at their bases, then the whole plant wilts and dies. When stems are cut a brown colored ring will be visible.
- When a tuber is cut in half, black or brown rings will, however, be visible. If left for a while or squeezed, these rings will exude a thick white fluid.
- A further symptom is fluid coming out of tuber eyes. This can be signified by soil sticking to tuber eyes when crops are harvested. Serious infection causes tubers to rot.

Survival and spread:

- Bacterial wilt pathogen can survive in soil (without a host for several seasons), water, seed tubers, potato plant remnants.
- The disease can spread from field to field or from plant to plant within field via infected seed, air, water, soil, farming tools, livestock and people.

Favourable conditions:

- High temperature, soil moisture, low pH.
- The disease spread rapidly in the warmer temperatures in storage areas. Infected seed can also be a source of the disease in the field.

Septoria leaf spot

Disease symptoms:

Leaves showing disease symptoms

- Less vigorous plants are usually affected
- Small, round to irregular spots with a grey center and dark margin on leaves
- Spots usually start on lower leaves and gradually advance upwards
- At later stage spots coalesce and leaves are blighted
- Complete defoliation of affected leaves may take place.
- Stems and flowers are sometimes attacked
- Fruits are rarely attacked

Survival and spread:

- **Primary:** Mycelium or conidia found in pycnidia in infected plant debris or on solanaceous weeds
- **Secondary:** Conidia spread through rain splash or wind and also by slimy conidia sticking on to hands and clothing of potato pickers.

Favourable conditions:

- Poor vigour of plants due to nutrient deficiency in late season
- High humidity or persistent dew at 25 ºC
- Moist weather with intermittent showers.

Common scab

Disease symptoms:

- Pathogen infects young developing tubers through the lenticels and occasionally through wounds.
- Symptoms of common potato scab are quite variable and are manifested on the surface of the potato tuber. The disease forms several types of cork-like lesions including surface.
- Damaged tubers have rough, cracked skin, with scab-like spots. Severe infections leave potato skins covered with rough black welts.
- Initial infections result in superficial reddish-brown spots on the surface of tubers. As the tubers grow, lesions expand, becoming corky and necrotic.

Tubers showing disease symptoms

Survival and spread:

- Pathogen can survive in soil, uncomposted manure or seed
- It spreads through contaminated soil, seed and water.

Favourable conditions:

- Disease is common in fields with low soil pH favoured by high soil moisture. Disease problems may be aggravated by excessive irrigation.

Black scurf/ canker

Disease symptoms:

- Rhizoctonia canker occurs when stolons contact soil borne fungal bodies.
- Pathogen infects plant tissue and causes stolon blinding thus reducing tuber production and yield.
- It also infects tubers causing black scurf but this is purely cosmetic, reduces tuber appearance and does not reduce yield.

Tubers showing disease symptoms

Survival and spread:

- Pathogen is soil and seed borne, remain in soil and plant debris including infected tubers

Favourable conditions:

- High temperature and moisture is the favourable for disease development

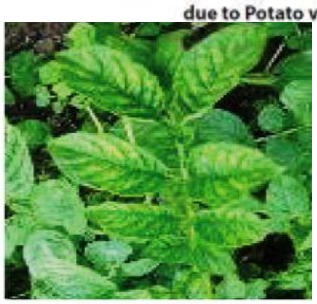
Viral disease (potato virus X, S, & Y)

Disease symptoms:

- Potato virus Y (PVY) is a Potyvirus, causes stipple streak. The necrotic strain generally causes mild foliage symptoms, but necrosis in the leaves of susceptible potato varieties.
- Potato virus S (PVS) is a Carlavirus, if plant infected early in the season, show a slight deepening of the veins, rough leaves, more open growth, mild mottling, bronzing, or tiny necrotic spots on the leaves. PVS is transmitted by aphids non-persistently.
- Potato virus X (PVX) is the type member of the Potyvirus family of plant viruses. Plants often do not exhibit symptoms, but the virus can cause symptoms of chlorosis, mosaic, decreased leaf size, and necrotic lesions in tubers.
- PVX can interact with PVY and PVS to cause more severe symptoms and yield loss than either virus alone. The source of this virus is infected tubers.

Tuber showing disease symptoms due to Potato virus Y

Leaves showing disease symptoms due to Potato virus Y



Leaves showing disease symptoms due to Potato virus X

Survival and spread:

- PVY is mechanical and aphid transmitted
- PVS is transmitted by aphids, including Myzus persicae, the green peach aphid. It is also mechanically transmissible, and transmissible through tubers.
- PVX is transmitted mechanically, not by an insect vector. Tobacco, pepper, and tomato can also serve as hosts of PVX.

Potato Spindle Tuber Viroid (PSTVd)

Disease symptoms:

- It causes mild foliar symptoms including smaller leaves that curl downward, giving the plant a more upright growth habit. Plants can also be stunted, and leaves can be grey and distorted.
- The stems are often more branched, with the branches having sharp angles on the stem.
- Tubers become narrow and spindle or oblong in shape, or more rounded than expected for a particular variety, and have prominent eyebrows.

- Tubers can also become cracked or develop knobs and swellings.

Leaves and tubers showing disease symptoms

Survival and spread:

- The PSTVd often transmitted mechanically, as well as through pollen and true seed.
- PSTVd can also infect tomato and nightshade.

Black leg and soft rot

Disease symptoms:

Seedlings and tubers showing disease symptoms

- Black leg is a rot of the lower stem region. This is encouraged by cool, damp conditions.
- Soft rot occurs when the bacteria gains access to the tuber through wounds & other entry points.
- Symptom can range from cultivator damage to fungal lesions.
- The bacteria dissolve the cell walls and liquefy the tuber invards. No distinct smell is present in true soft rot.

Survival and spread:

- The introduction of bacteria is always through a wound in the plant tissue. It can reside in plant residue for short periods. The pathogen may spread through the soil water and infected seed.

Favourable conditions:

- Disease is encouraged by cool, humid conditions.

Pink rot

Disease symptoms:

- Foliar symptoms of underground infections include wilting and chlorosis.
- Tubers become infected through diseased stolons and show darkened diseased area on the skin.
- The rotted tissues remain firm and become slightly spongy.
- If the tuber is cut the tissue oxidizes to a pinkish tinge, an easy diagnostic characteristic.

Tubers showing disease symptoms

Survival and spread:

- Soil and seed borne.

Favourable conditions:

- High soil moisture and cool condition increase disease incidence.

Black heart- disorder

Disease symptoms:

- Black heart occurs primarily in storage when the tubers do not receive enough oxygen.
- Blackening of the tuber center follows acute oxygen deficiency associated with either low temperature in confined storage or high field soil temperatures
- The tissue dies from the inside out and turns jet black. Smell is absent.
- Affected tubers rot later.

Tubers showing disease symptoms

Diseases of Tomato

Damping Off (*Pythium aphanidermatum, P. debaryanum, P. ultimum)*

Damage symptoms

- Damping off of tomato occurs in two stages, i.e. the pre-emergence and the post-emergence phase.
- In the pre-emergence the phase the seedlings are killed just before they reach the soil surface.
- The young radical and the plumule are killed and there is complete rotting of the seedlings.
- The post-emergence phase is characterized by the infection of the young, juvenile tissues of the collar at the ground level.
- The infected tissues become soft and water soaked. The seedlings topple over or collapse.

Favourable conditions

- High humidity, high soil moisture, cloudiness and low temperatures below 24° C for few days are ideal for infection and development of disease.
- Crowded seedlings, dampness due to high rainfall, poor drainage and excess of soil solutes hamper plant growth and increase the pathogenic damping-off.

Survival and spread

- **Primary:** Soil, Seed, Water
- **Secondary:** Conidia through rain splash or wind.

Septoria leaf spot (*Septoria lycopersicae*)

Damage symptoms

- Less vigorous plant are usually affected
- Small, round to irregular spots with a grey center and dark margin on leaves
- Spots usually start on lower leaves and gradually advance upwards
- Spots coalesce and leaves are blighted
- Complete defoliation of affected leaves
- Stems and flowers are sometimes attacked
- Fruits are rarely attacked

Survival and spread

- **Primary:** Mycelium or conidia in pycnidia in infected plant debris or on solanaceous weeds
- **Secondary:** Conidia through rain splash or wind and also by slimy conidia sticking on to hands and clothing of tomato pickers

Favourable conditions

- Poor vigour of plants due to nutrient inadequacy or in late season
- High humidity or persistent dew at 25 °C
- Moist weather with intermittent shower.

Bacterial stem and fruit canker (*Clavibacter michiganense sub sp. michiganense*)

Damage symptoms

-  Disease appears as spots on leaves, stems and fruits and as wilting of leaves and shoots
- White blister like spots in the margins of leaves
- Spots become brown with age and coalesce, but leaves do not fall off
- Leaflets on one side of rachis show withering initially
- Light coloured streaks on stems and petioles at the joints

- Cracks develop in streaks and form cankers
- Slimy bacterial ooze through the cracks in humid weather
- Small, shallow, water soaked, spots with white halo develop on fruits
- The centers of spots become slightly raised, tan coloured and rough
- Vascular discolouration is seen in split open stems

Survival and spread

- **Primary:** Bacterial cells survive on infected plant debris and seed (both internally and externally) and also on solanaceous weeds such as Solanum nigrum
- **Secondary:** Bacterial cells transmitted through rain splash

Favourable conditions

- Soil temperature of around 28 °C
- High humidity or persistent dew
- Moist weather with intermittent showers.

Early blight (*Alternaria solani*)

Damage symptoms

- This is a common disease of tomato occurring on the foliage at any stage of the growth.
- The fungus attacks the foliage causing characteristic leaf spots and blight. Early blight is first observed on the plants as small, black lesions mostly on the older foliage.
- Spots enlarge, and by the time they are one-fourth inch in diameter or larger, concentric rings in a bull's eye pattern can be seen in the center of the diseased area.
- Tissue surrounding the spots may turn yellow. If high temperature and humidity occur at this time, much of the foliage is killed.
- Lesions on the stems are similar to those on leaves, sometimes girdling the plant if they occur near the soil line.
- Transplants showing infection by the late blight fungus often die when set in the field. The fungus also infects the fruit, generally through the calyx or stem attachment.
- Lesions attain considerable size, usually involving nearly the entire fruit; concentric rings are also present on the fruit.

Survival and spread

- **Primary:** The fungus spends the winter in infected plant debris in or on the soil where it can survive at least one and perhaps several years. It can also be seed borne.
- **Secondary:** The spores are transported by water, wind, insects, other animals including man, and machinery. Once the initial infections have occurred, they become the most important source of new spore production and are responsible for rapid disease spread.

Favourable conditions

- Warm, rainy and wet weather

Bacterial leaf spot (*Xanthomonas campestris pv. vesicatoria*)

Damage symptoms

- Moist weather and splattering rains are conducive to disease development. Most outbreaks of the disease can be traced back to heavy rainstorms that occur in the area.
- Infected leaves show small, brown, water soaked, circular spots surrounded with yellowish halo.
- On older plants the leaflet infection is mostly on older leaves and may cause serious defoliation.
- The most striking symptoms are on the green fruit. Small, water-soaked spots first appear which later become raised and enlarge until they are one-eighth to one-fourth inch in diameter.
- Centers of these lesions become irregular, light brown and slightly sunken with a rough, scabby surface.
- Ripe fruits are not susceptible to the disease. Surface of the seed becomes contaminated with the bacteria, remaining on the seed surface for some time.
- The organism survives in alternate hosts, on volunteer tomato plants and on infected plant debris.

Survival and spread

- **Primary:** Bacterial cells survive on infected plant debris and seed (both internally and externally) and also on solanaceous weeds such as Solanum nigrum
- **Secondary:** Bacterial cells transmitted through rain splash

Favourable conditions

- Moist weather and splattering rains
- High humidity or persistent dew.

Bacterial wilt (*Ralstonia solanacearum*)

Damage symptoms

- Characteristic symptoms of bacterial wilt are the rapid and complete wilting of normal grown up plants.
- Lower leaves may drop before wilting. Pathogen is mostly confined to vascular region; in advantage cases, it may invade the cortex and pith and cause yellow brown discolouration of tissues.
- Infected plant parts when cut and immersed in clear water, a white streak of bacterial ooze are seen coming out from cut ends.


Survival and spread

- The spreads through wounds, soil and implements.

Favourable conditions

- Relatively high soil moisture and to be checked.

Yellow Leaf curl

Damage symptoms

- Leaf curl disease is characterized by severe stunting of the plants with downward rolling and crinkling of the leaves. The newly emerging leaves exhibit slight yellow coloration and later they also show curling symptoms.
- Older leaves become leathery and brittle. The nodes and internodes are significantly reduced in size.
- The infected plants look pale and produce more lateral branches giving a bushy appearance. The infected plants remain stunted.

Favourable conditions

- Whitefly is the vector for transmitting of leaf curl virus.

Mosaic (Tomato mosaic virus)

Damage symptoms

- The disease is characterized by light and dark green mottling on the leaves often accompanied by wilting of young leaves in sunny days when plants first become infected.
- The leaflets of affected leaves are usually distorted, puckered and smaller than normal. Sometimes the leaflets become indented resulting in "fern leaf" symptoms.
- The affected plant appears stunted, pale green and spindly.

Survival and spread

- The virus is spread by contact with clothes, hand of working labour, touching of infected plants with healthy ones, plant debris and implements.

Tomato spotted wilt disease (Tospovirus/ Orthotospovirus)

Damage symptoms

- Symptoms vary among hosts and in a single host species
- Stunting is a common symptom of TSWV infection
- Chlorotic or necrotic rings form on the leaves of many infected hosts
- Thickening of veins and bronzing of young leaves
- Growing tips may die-back and terminal branches may be streaked

- Affected plants may have a one sided growth habit or may be entirely stunted and have drooping leaves, suggesting a wilt
- Pale red or yellow areas with concentric circular marking in the normal red skin of ripe tomato are formed
- Discoloration of seed.

Survival and spread

- **Primary:** Virus particles in infected plants of many hosts like *Acanthospermum hispidum, Aster sp., Boerhaavia diffusa, Chrysanthemum sp., Cleome gynandra, cowpea, Dahlia variabili*s, egg plant, French bean, *Gerbera sp*., groundnut, Lagasca mollis, lettuce, marigold, pea, chilli, pineapple, potato, *Trianthema portulacastrum*, water melon and *Zinnia elegans*
- **Secondary:** Virus particles transmitted by thrips, *Frankliniella schultzii, Scirtothrips dorsalis.*

Fusarium wilt (*Fusarium oxysporum f.sp. lycopersicae*)

Damage symptoms

- The first symptom of the disease is clearing of the veinlets and chlorosis of the leaves.
- The younger leaves may die in succession and the entire may wilt and die in a course of few days. Soon the petiole and the leaves droop and wilt.
- In young plants, symptom consists of clearing of veinlet and dropping of petioles. In field, yellowing of the lower leaves first and affected leaflets wilt and die.
- The symptoms continue in subsequent leaves. At later stage, browning of vascular system occurs. Plants become stunted and die.

Survival and spread

- Soil and implements

Favourable conditions

- Relatively high soil moisture and soil temperature

Diseases of Crucifers

Black rot*(Xanthomonas campestris* pv. *campestris)*

This is a very serious disease on cole crops, especially cabbage, cauliflower, broccoli, turnipetc. Other hosts include kohlrabi, collard, rutabaga, and radish.

Symptoms. Plants may be affected at any stage of growth. The bacterium usually enters through the water pores around the leaf margins. Once the bacterium has entered the leaf, the tissue turns yellow. Infection progresses toward the center of the leaf, forming a V-shaped pattern. The veins within the yellow-colored tissue turn black. The bacterium moves down the leaf and is distributed throughout the entire plant. The infected leaves turn yellow and eventually drop off; some plants may be almost completely defoliated. The affected stem, when cut crosswise, reveals a black ring where infection has followed the water-conducting tissue . The bacterium is carried on and in seed. When infected seed is planted, the bacteria pass from seed parts into the leaves of the small seedling and symptoms develop as previously described.

Disease cycle. The pathogen overwinters in and on the seed and in the plant debris left in the field. The bacterium may become established in a field by planting infected seed, planting infected transplants, or planting in fields where the disease was a problem the previous year. The bacteria are spread by splashing or running water and insects.

Control. Control practices include (1) planting western-grown, disease-free seed, (2) using a hot water seed treatment, (3) applying a fungicide treatment, (4) maintaining good sanitation of planting beds, (5) inspecting plants and handling plants carefully, (6) using crop rotation, and (7) planting resistant cultivars when available.

Hot water seed treatment. The grower should use**hot** water-treated seed.

Fungicide treatment. Copper products may help slow the progress of the disease.

Plant bed sanitation. Take care to avoid planting beds that have been used for cole crop production. Wait at least three years. Drainage water from old compost heaps and old cabbage fields can contaminate the soil. If disease-free soil is not available, soil fumigation may be an option.

Plant inspection and handling of plants. Inspect the plants thoroughly and look for disease symptoms described earlier. Handle plants carefully to avoid injury.

Crop rotation. A three-year crop rotation with unrelated crops is required since the bacterium can overwinter in the soil for two years.

Seed rot and damping off

The pre-emergence rotting of seeds or the post-emergence damping-off (collapse) of seedlings are diseases caused by soil-borne fungal organisms. As noted under black rot control, using a good sanitation program, crop rotation, and treated seed when available are important precautions against all seed and seedling diseases. Fungicide treatments may also be used to protect seedlings. A fungicide such as PCNB is effective against wirestem, Rhizoctonia sp. root rot. Incorporate this fungicide into the top 3- 6 inches of soil. A fungicide such as mefenoxam is effective against *Pythium* sp. damping-off. Always follow label directions.

Black leg(*Phoma lingam)*

It is a major concern in areas involved with cole crop production because the pathogen can infect a variety of cole crops.

Symptoms. Plants may become infected in the seedbed or in the field at anytime during the growing season. Usually the first symptom is a circular depressed canker that develops at the base of the stem, enlarges, and eventually surrounds the entire stem. Yellow spots with gray centers appear on the foliage. The infected tissue on both the stem and leaves is marked with small dots. These black dots are fungal structures and indicate the presence of the pathogen. Severely infected plants usually topple over as the pathogen destroys the supportive stem tissue.

Disease cycle. The fungus overwinters in the soil on old, infected plant debris for at least three seasons. When infected seed is planted, the fungus infects the seedling and produces spores which, in turn, are disseminated to other plants. Rain and surface drainage water spread the pathogen. The disease can spread very rapidly even though only a few plants may be infected initially.

Control. The methods needed to control black leg (fungus) are the same as those described for black rot (bacteria) control. These control measures include (1) planting western-grown, disease-free seed, (2) using a hot water seed treatment, (3) applying a fungicide treatment, (4) maintaining good sanitation of planting beds, (5) inspecting plants and handling plants carefully, (6) using crop rotation and (7) planting resistant cultivars.

Club root *(Plasmodiophora brassicae*)

Symptoms. Infected roots enlarge, become distorted, and resemble clubs, hence the name. Often disease development on the roots of affected plants can be extensive before above-ground portions show any symptoms. Leaves on infected plants turn yellow, wilt, and die.

Disease cycle. The fungus gains entrance into the plant by attaching to the root hairs. As the fungus begins to develop in the roots, it produces spores. These spores are released and can be

disseminated by water and infested soil. Acid soils and cool wet weather favor pathogen development. The disease is not seed-borne.

Control. Location of the seedbed is very important in club root control. To avoid local and wide-spread distribution of the pathogen, plant in disease-free soil. Hydrated lime incorporated into the soil to raise the pH to 7.2 reduces club root; however, on muck soils the application of lime is of little value because of the high soil buffering capacity. Club root can be reduced by using PCNB fungicides per label recommendations. These control programs should be coupled with a long crop rotation.

Alternaria leaf spot (*Alternaria brassicae*.;*A. brasicicola*)

Symptoms. On seedlings, symptoms appear as small dark spots on the stems which eventually cause the seedling to topple over. Symptoms on the foliage also appear as small dark spots which enlarge rapidly. Within these infected areas, large masses of dark spores are produced. The pathogen may attack the heads of cauliflower and broccoli rendering them unmarketable. The disease is also a problem in storage of cole crops.

Disease cycle. The pathogen can overwinter on old, infected plant debris and in seed. The fungus produces masses of spores which are easily disseminated by wind, rain, or equipment. Warm, moist weather conditions favor disease development.

Control. Since the pathogen is carried in the seed, hot water seed treatment is an effective control measure. Application of fungicides such as maneb, chlorothalonil, or copper products will help control this disease (see *Midwest Vegetable Production Guide for Commercial Growers*, BU-7094-S). Begin fungicide application at the first sign of disease and repeat every seven to ten days, according to label directions.

White rust- (*Albugo candida*)

White rust is a disease in plants caused by *Albugo candida* . Plants susceptible to this disease generally include members of the Brassica family. White rust has been known to cause

agricultural losses in fields cultivating members of this family including broccoli, cauliflower, and Indian mustard. Despite the name, it is not considered true rusts Symptoms

Symptoms of infection include chlorosis on leaf surfaces, white blister-like growths on the underside of leaves and on the stems of the plant, and swelling of the roots. In addition, abnormalities in the growth of the host can occur with more serious infections. These

abnormalities can include deformation of flowers, twisting or distortion of the plant matter, and sterility.

The white blisters contain sporangia; these sporangia are released from these blisters by bursting through the plant tissue. The sporangia, if dispersed to a proper host, can undergo two processes to continue the infection cycle. The first is germination and creation of a germ tube which will penetrate and infect the host through a stoma. Alternatively the sporangia can create and release up to 14 flagellated zoospores. These zoospores travel through films of water to reach a proper site from which to infect the host, at which point they germinate and infect through a stoma. The penetrating hyphae will then grow between the plant cells, producing haustoria to siphon off nutrients from the host. Once established, more sporangia along with sexual oospores, which are used as overwintering survival structures.

White rust can cause considerable crop damage in areas that are dependent on the cultivation of members of the Brassica family. For example, India has sustained significant losses in the cultivation of oilseed brassicas. Losses in areas of India have ranged between 17% yield loss and 60% yield loss in the case of mustard seed alone. These yield losses include both amounts of raw material harvest-able and negative changes to the nutritional content of the product caused by the disease, making them less desirable.

Downy mildew

This disease, which affects all cole crops, is caused by the fungus *Peronospora parasitica*. Plants may become infected during any stage of growth, but usually the disease is more of a problem on early-seeded plant beds or on late-maturing crops.

Symptoms. Infection usually takes place on the underside of lower leaves where the fungus produces a white fluffy growth. As the disease develops, yellow spots develop on the upper leaf surface which later turn tan in color.

When the pathogen attacks cabbage heads, symptoms appear as small, dark sunken spots. Similar symptoms can be observed on curds of cauliflower and broccoli.

Disease cycle. The fungus overwinters on old crop debris where it produces masses of spores which can be disseminated by wind and rain. Cool, moist weather conditions favor disease development.

Control. Fungicides such as maneb, chlorothalonil, aluminum-tris, mefenoxam, or copper products provide good control of downy mildew.

Browning (Boron deficiency) Browning is caused due to boron deficiency. Generally, the deficiency symptoms of boron are externally visible on plants after the curd formation. In early stage, the water soaked areas appear on the stem and curd surface. As the plant grows, the stem becomes hollow with water soaked tissue covering the internal walls of the cavity. In advanced stage of deficiency, brown or pink coloured areas are seen on curd surface and therefore, it is also called brown rot or red rot or browning of the curd. Sometimes the stem may become hollow even without brown areas on the curd. The affected curds are bitter in taste. The foliage colour first changes to dull green and then greenish yellow at the apical margin of the older leaves. When there is severe deficiency of boron, then leaves are under developed and smaller. The growing point may die in young stage of plant itself.

Control: The deficiency of boron may be corrected by applying borax. The quantity of borax

depends on soil type, soil pH and the extent of deficiency. In acid soil, 10- 15 kg borax/ha is sufficient while larger quantity may be required as natural and alkaline soils.

Whiptail: Whiptail disorder is caused due to deficiency of molybdenum. In young plants the deficiency symptoms are chlorosis of leaf margins and the whole leaves may turn white. The leaf blades do not develop properly. When the deficiency is severe, only the midribs develop. This condition is commonly known as 'Whiptail'. The growing point of the plant is also deformed which prevents the curd development. The deficiency of molybdenum generally occurs in acid soils when the soil pH is below 5.5.

Control: Lime application in acidic soils is done to increase the availability of molybdenum. The quantity of lime is determined by initially measuring the pH of the soil. Alternately, soil application of Sodium Molybdate (10-15 kg/ha) effectively controls the deficiency symptoms.

Boron deficiency

Whiptail of Cauliflower

Deficiency of Molybdenum

Ex. 6: Diseases of Cucurbits, Onion and betel vine

Diseases of Cucurbits

Gummy stem blight/leaf blight/black rot

It is a major disease of cucumber, cantaloupe, pumpkin, and watermelon. The disease is transmitted through seed, soil, and air.

Symptoms

The leaf symptoms appear as small, circular tan spots, sometimes surrounded by a yellow halo. The leaf spots are larger than downy mildew. Under favorable conditions, the leaf lesions coalesce and the entire leaf may become blighted. The spots have a ringed appearance and can be observed on the mid-vein of leaves and petioles as water-soaked reddish-brown spots. The infection often begins at leaf margins . Main stem lesions enlarge and slowly girdle the main stem. The stems may split open to form open wounds or cankers. Characteristic red or brown gummy fluid oozes out of the cankers. The fungus also form tiny black pimple-like fruiting bodies on the stem or nodes. The cankers on the infected stems/vines girdle the entire stem and cause wilting.

The most important form of the disease is crown rot, which may kill plants.On fruits, the disease is known as black rot. Initially pale brown, then bleached patches develop on the fruit and \reddish gum oozes out from cracks. The affected areas are studded with pycnidia of the fungus.
The disease-infected conidia migrate through splashing rain, irrigation water, and winds from the source to the new crops. The optimum temperature for disease development is 20°C–24°C along with free moisture. The fungus is most devastating in warm and humid weather.

Management

•Procure disease-free seeds from reliable sources.
•Treat seeds with Thiram or Captan at 3 g/kg seed.
•Monitor crops and ensure proper disease diagnosis as charcoal rot and Fusarium wilt show similar symptoms.
•Crop rotation with nonhost crops should be followed.
•Overhead irrigation should be avoided.
•Remove and destroy infected fruits and vines at the end of the season.
•Spray Carbendazim (0.2%) as soon as the disease is noticed. In case the disease is not controlled, spray Dithane M-45 (0.25%) or Propiconazole (0.1%).

•Combined use of green manure with fungicide application, chlorothalonil (3.0 kg/ha),

Powdery mildew of Cucurbits (*Golovinomyces cichoracearum* (Syn. *Erysiphe cichoracearum*);

Erysiphe cichoracearum); *Podosphaera xanthii*(Syn. *Sphaerotheca fuliginea*) and *Leveillula taurica*

Powdery mildew is a serious disease and causes considerable loss to the number of cucurbitaceous crops grown in India. Its distribution and relative occurrence varies throughout the world. Most of the cucurbits are found susceptible to powdery mildew disease but few cucurbits are not much infected due to resistant cultivars. adversely affected the fruit quality. This disease is caused by three obligate biotrophic ectoparasites .

Although all these species are important in India but *G. cichoracearum*and *P. xanthii*are considered most important.

Symptoms

White, powdery fungal growth develops on both leaf surfaces, petioles, and stems. This growth is primarily asexual spores called conidia. It usually develops first on crown leaves, on shaded lower leaves and on leaf undersurfaces. Yellow spots may form on upper leaf surfaces opposite powdery mildew colonies. Older plants are affected first. Infected leaves usually wither and die. Plants may senesce prematurely. Fruit infection occurs rarely on watermelon and cucumber.

Disease development.

Source(s) of initial inoculum for powdery mildew have not been definitively determined. The primary initial inoculum is believed to be airborne conidia dispersed potentially long distances from other affected crops, starting in southern states where cucurbit crops are grown earlier in the year. Conidia remain viable for 7-8 days based on results from laboratory studies. The causal fungi are obligate parasites and therefore cannot survive in the absence of living host plants, except as cleistothecia. Cleistothecia are dark brown, small structures that are barely discernable without a hand lens. They develop late in the growing season. The sexual spores within these structures are protected from adverse conditions Possible local sources of initial inoculum include conidia. Powdery mildew develops quickly under favorable conditions because the length of time between infection and symptom appearance is usually only 3 to 7 days and a large number of conidia can be produced in a short time. Favorable conditions include dense plant growth and

low light intensity. High relative humidity is favorable for infection and conidial survival; Rain and free moisture on the plant surface are unfavorable.

Management

A programmed scouting for symptoms in cucurbit plants is always necessary to detect the beginning of a powdery mildew infection so that a pertinent treatment can be initiated. Strategies for the control of these three different fungal species are very similar and an integrated approach using a combination of several practices will be most effective in managing this disease. Healthy and vigorous plants grown under a good nutritional program and suitable sanitary conditions are less susceptible to powdery mildew.

Plant in sunny areas as much as possible, provide good air circulation, and avoid applying excess fertilizer. In cases dealing with susceptible cucurbits, fungicides may be used. A protectant fungicide prevents new infections from occurring whereas an eradicant can kill an existing infection.

Apply protectant fungicides (such as horticultural oils) to highly susceptible plants before the disease appears and use sulfur or biological fungicide eradicants at the earliest signs of the disease.

The fungicides that are registered for use on cucurbits to control powdery mildew include the systemic fungicide strifloxystrobin, azoxystrobin, and myclobutanil,and thecontact fungicide chlorothalonil (0.2%).

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Charcoal rot (*Macrophominaphaseolina*)

Symptoms

Infected leaves and stems near the crown of the plants have a bleached appearance and later turn brown to black. Symptoms of charcoal rot are very similar to gummy stem blight as the gum exudes from the infected plant tissues. But the symptoms of charcoal rot appear late in the season. The black sclero tia are visible on removal of the epidermis of the stem, while black streaks can be observed within the pith on cutting open the collar region. This disease has a wide range of hosts. The affected plants die under hot and dry weather conditions. The plants carrying latent infection survive under wet and cool weather conditions but they die as soon as favorable weather conditions for disease development prevail. The fungus persists in soil and crop residue as microsclerotia for 3–12 years and can infect 500 plant species. Roots become infected first, and the fungus later invades the plant crown. It occurs mainly in hot climate with prevailing temperature of at least 28°C. In infected tissues, profuse microsclerotia having irregular shape and black color are produced.

Management

•Grafting techniques that graft the susceptible scions onto resistant cucurbit rootstock can be utilized, which could be an effective management strategy for the control of soilborne root-infecting pathogens where the use of chemicals is not feasible or economical.
•Follow long-term crop rotation with nonhost crops.
•Destroy infected plant debris at the end of growing season.
•Biological control through seed treatment of melon with Streptomyces strain effectively regulates the mycelia growth of *M. phaseolina*. Different strains of *Trichoderma harzianum* (Bi), *T. harzianum*(T39), *Trichoderma virens* (DA R74290), *Trichoderma viride* (MO), *T. harzianum* (M), and Trichodermin (B) as a commercial formulation have been reported to be potential biological agents for the control of charcoal stem rot.
•Management of saline soils can effectively decrease charcoal rot severity.

Damping –offof Seedlings and fungal root rots(*Pythiumspp.*; *Rhizoctoniaspp.* and *Fusarium spp.)*

The seed and seedlings of cucurbits are affected by a number of soil-borne pathogens. Of these, damping-off and root rots caused by a complex of fungi, namely, *Pythium,Rhizoctonia*, and *Fusarium* are most common.

Symptoms

Damping-off affects the crop before (pre-mergence damping-off)and after the germination of the seed (post-emergence damping-off). Pre-emergence infection causesthe rotting of seed inside the seed coat. The seed may germinate but the radical and cotyledon turnbrown and soft and fail to grow further. The initial symptoms of post-emergence damping-off appearas yellow to dark brown, water-soaked lesions on the root and hypocotyl tissues. With time, thehypocotyl tissues shrivel, roots decay further, and the seedlings topple down or may wilt and eventually collapse. Plants that survive may show symptoms of root rot. Roots can have a watery gray appearance, particularly the fine feeder roots. Cool temperatures, high soil moisture, and poor aeration favor the disease development. When plastic mulches are used under moist, hot conditions, the roots of even older plants rot. The fungal complex can invade many plants species and can survive\even on decaying plant material. Usually, sporadic outbreaks are difficult to control.

Management

•Ensure proper drainage and avoid overwatering.
•Follow crop rotation with non-cucurbitaceous crops.
•Highly effective biological control of soil-borne pathogens can be attained only with the combined application of organic amendments and microbial bio-control agents.

Fusarium wilt(*Fusaium oxysporum f.sp. niveum; F. oxysporum f.sp. melonis; F. oxysporum f.sp. cucumerinum)*

Symptoms

*Fusarium spp.*causes wilt and root rot. The fungus invades the roots of the plant and progress into the stems. Plants in early stages of their growth may develop damping-off due to lower stem infections; as a result, the seedlings often show hypocotyl rot or may topple down at the soil line. It is characterized by loss of turgor pressure of the vines.

The wilting generally starts on the older leaves and advances to the young foliage. Older plants may first exhibit temporary wilting during peak heat periods of the day and revive during cool nights but eventually die within a few days. Wilt symptoms develop on one or few lateral vines in the beginning, while other branches remain apparently unaffected. However, the whole plant may wilt and die within a short time under high inoculum conditions or in highly susceptible host species. Vascular browning, gummosis, and tylosis in xylem vessels occur in mature plants. The disease may

invade the fruits through the stem end.
In wet weather, white-to-pink fungal growth may be visible on the surface of the dead tissues. High nitrogen, especially ammoniacal form, less than 25% soil moisture, and light, sandy, and slightly acidic soils (pH 5–5.5) favor disease development . The disease occurs when the soil temperature is between 20°C and 30°C and the weather is dry. The causal fungi survive in old infected plant debris, other host plants, seed, or soil. It is generally presumed to be monocyclic, that is,\it does not spread from plant to plant during the season. The spread within a field can occur by the movement of infested soil, while the spread across the fields can occur by using infected equipments and plants. Many Fusarium wilt pathogens including *F. oxysporum f. sp. niveum* arecapable of being seed-borne, although the extent of the contamination varies widely. Long-term survival of the pathogen in the soil and the evolution of new races make the management of Fusarium wilt difficult. On the other hand, Fusarium crown and foot rot [*Fusarium solani f. sp. cucurbitae* causes root rot in squashes.
The early symptoms appear as wilting of leaves, while the entire plant may wilt and die with the passage of time. The rot develops initially as water-soaked, light-colored areas that progressively turn darker. Thefungus is generally confined to the crown area of the plant and the infection starts in the cortex of the root. It causes the cortex tissue to slough -off and ultimately wipe out all the tissues except the fibrous vascular strands. The affected plants split easily about 2–4 cm below the soil line.

Management

•The exclusion of the pathogen is the best means to manage disease and, accordingly, procure disease-free seeds and seedlings from reliable sources.
•Grow resistant varieties/hybrids, which is the best and most economical method of control.
•Treat seeds with Benlate or Carbendazim (2 g/kg seed) or with hot water at 52°C for 30 min.
•Drench the soil with Captan (0.2%–0.3%) or Carbendazim (0.1%).
•Rotate with non-cucurbitaceous crops such as garlic, radish, onion, and beetroot.
•Soil solarization can be used to lower infection in soil sufficiently to delay the onset of wilt symptoms as well as to reduce the disease incidence; however, the disease cannot be eliminated.
•Use other cucurbit species resistant to *Fusarium*wilt as rootstocks for grafting.
•Destroy plant debris and weeds, especially cucurbitaceous weeds, after crop harvest.
•Soil amendment with *B. subtilis*(strain-B006 powder) as nursery substrate followed by drenching with B006 suspension during transplanting and 1 week after transplanting and addition of 10 g organic fertilizer at the time of transplanting significantly suppressed the disease development in cucumber. Use of antibiotic-producing soil fungi and bacteria, that is, *Gliocladium spp*., *Trichoderma spp., and Pseudomonas spp*. were found effective. Use non-pathogenic strains of *F. oxysporum* that compete with pathogenic forms for root colonization. Though none of these methods give adequate control in the field, integration of these management strategies may be useful. Cover crops such as hairy vetch as soil amendments can also be useful.

Phytophthora **blight or** ***Phytophthora*** **Crown and root rot**(*Phytophthora capsici*;

P. drechsleri; P. parasitica)

The saprophytic fungi, *Phytophthora capsici*affect most cucurbit crops but squash and pumpkin are the most affected. The disease is also common on tomato, eggplant, capsicum, beet, Swiss chard, lima bean, turnip, spinach, and many common weeds. It has also been reported to be caused by *Phytophthora drechsleri*and *Phytophthoraparasitica*
. The disease infects more than 50 plant species

in more than 15 families). The pathogen may afflict the crop right from preemer
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gence stage to maturity and cause a wide variety of symptoms. It may cause pre- and postemergence damping-off, stem and vine blight, and wilting of young shoots and leaves, followed by wilting and collapse of whole foliage or fruit rot. Mature plants may wilt suddenly even without appearance of any symptoms like stem or vine lesions. Upon uprooting the plants, tan to brown rotted root system can be observed. The fine feeder roots break off along with the withering of outer tissues of the tap root. Stem and leaf petiole lesions are light to dark brown, water soaked, soft, and irregular, which gradually rot, dry out, and become papery (Miller et al. 1996). Early symptoms on fruits appear as large, water-soaked or slightly sunken, circular lesions that enlarge and cover the fruit with white mold. The mold is the source of further infection as it consists of sporangia (spores) that are decidu
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ous and can be dispersed by wind and rain. Fruit rot can develop even after harvesting the fruits. The disease development is favored by high soil moisture (frequent and heavy rains/irrigation), warm temperature (optimum being 24°C–33°C), and poor drainage. In general, disease initiation is from the area where the plant is exposed to high moisture conditions for long periods as zoospores infect the crown and root tissues of the host plant. The initial inoculum consists of oospores that survive as dormant propagules in soil for prolonged period.
Phytophthora
foliar blight and fruit rot may result
in total loss of the crop.

Management

•Do not select low-lying damp area or poor draining and heavy textured soils for raising the crop.
•Follow long crop rotation with non-susceptible host crops.
•Avoid overirrigation and ensure proper drainage. Schedule irrigations so that excess water is not applied and fields drain properly.
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•Carefully discard the crop debris after the host crops are harvested.
•Ensure proper trellising of the vines so that the fruits on the vines do not come in contact with the soil.
•Preferably raise the bush type of cucurbits on dome-shaped ridges or raised beds and do not allow planting depressions that collect water near plants.
•Do not harvest seeds from the infested fruits.
•Seed treatment with fungicides (Apron XL LS at 0.42 ml/kg seed) or metalaxyl (0.98 mL/kg seed) can protect the seedlings up to 5 weeks of transplanting. Seed treatment with fungicides,metalaxyl (0.98 mL/kg seed) can protect the seedlings up to 5 weeks of transplanting.

Angular leaf spot (*Pseudomonas syringae pv. lachrymans*)

Angular leaf spot is the most widespread bacterial disease of cucurbits that causes reduction in fruit number, fruit yield, and quality.

The bacterium infection occurs on all aboveground parts of cucurbit plants. Initially, the symptoms appear on leaves as small, water-soaked lesions that later enlarge. The shape of older lesions tends to be angular as they enlarge and encounter veins. As the infection progresses, the affected tissues often dry and fall, and thus, the leaves are left with torn irregular-shaped holes. The shredded leaves have lower

photosynthetic efficiency, causing indirect yield losses. Under severe conditions, the leaves turn yellow, and occasionally, the growing tips of vines become water-soaked and yellow and growth ceases. On fruits, the infection appears as small, circular spots with a yellow halo. Later, the spots turn dull white. Dry cracks may occur, which are a little deeper, rendering
the fruits unmarketable. The cracks expose fruits to other secondary infections like soft rot, which usually follows the bacterial infection. Sometimes, the infection progresses up to the seeds.
Angular leaf spot is most active between 24°C and 28°C and is favored by high humidity.
Under very humid conditions and warm temperatures, white bacterial ooze may be found on the underside of lesions, which dries to form a thin, white crust. The disease is seed- and soilborne.
The bacterium does not have spores adapted to carry them over long unfavorable periods and survive as vegetative cells in seed, soil, diseased plant debris, or weed plants (Leben 1981). The pathogen is disseminated by splashing rain, irrigation water, soil, insects, farm tools, and field workers. Infection occurs through natural openings and wounds.
Resistance to *P. lachryman*sis controlled by a large number of recessive genetic factors . However, it has also been reported that the disease is controlled by a single recessive gene "pl". The use of resistant cucumber cultivars is effective in reducing damage and losses due to this disease.

Management
•Use only disease-free seeds.
•Treat seeds with mercuric chloride solution (1:1000) for 5–10 min. Also, hot water treatment of seeds at 50°C ±2°C can reduce the incidence but cannot eliminate.
•Practice a 3-year or longer crop rotation with noncucurbitaceous crops.
•Maintain field sanitation/hygiene during the crop-growing period and remove crop debris immediately after final harvest.
•Do not work in the crop when it is wet. Cultivation in dry soil is most effective in reducing bacterial survival.
•Also, follow deep plowing and soil solarization in summer months.
•A\void overhead irrigation as the spread of bacteria takes place by water and splashes.
•Avoid injury to the plants during intercultural operations.
•Suppression to an appreciable extent by managing
Nighttime humidity (to 80%–90%) with dehumidifiers under protected structures.
•Chemical controls are most effective when integrated with sound cultural control practices. Streptocycline is an effective antibiotic against bacterial plant pathogens at a rate of 400 ppm. Copper-based bactericides are often necessary at an interval of 4–7 days to reduce the severity of the disease.

Cucurbit Wilt (*Erwinia tracheiphila)*

Symptoms

Symptoms appear as drooping of one or more leavesof a vine followed by drooping and wilting of all the leaves of that vine and, subsequently, bywilting of all leaves and collapse of all vines of theinfected plant. Wilted leaves shrivel and dry up; affected stems first become soft and pale, but later they too shrivel and become hard and dry. In moderately resistant plants or under unfavorable conditions, symptoms develop slowly and may occasionally be accompanied by excessive blossoming and branching of the infected plants.
Under the microscope, sections of wilted stems and petioles reveal bacteria in xylem vessels and some or all of the xylem vessels clogged with almost solidified mixtures of polysaccharides, proteins, and so on that completely block passage of water and nutrients. When infected stems are

cut and pressed between the fingers, droplets of white bacterial ooze appear on the cut surface. The viscid sap sticks to the fingers or to the cut sections, and if they are gently pulled apart the ooze forms delicate threads that may extend for several centimeters. The stickiness of the sap of infected plants is frequently used as a quick diagnostic characteristic of the disease.
The slime rot of stored squash progresses internally while the exterior of the fruit may appear perfectly sound. Usually, however, as the internal rot progresses there appear on the surface dark spots or blotches that coalesce and enlarge. The disease develops over several months in storage. Infected squash fruits are further invaded by soft-rot microorganisms and are completely
destroyed.

The Pathogen
Erwinia tracheiphila. The bacterium survives for only a few weeks in infected plant debris. However, it survives over winter in the intestines of striped cucumber beetles (*Acalymma vittata*) and spotted cucumberbeetles (*Diabrotica undecimpunctata*), in which it hibernates.
Development of Diseases
In the spring, the insects that carry bacteria feed and cause deep wounds on the leaves of cucurbit plants; theinsects deposit bacteria in the wounds with their feces.Through the wounds, the bacteria enter the xylem vessels, multiply rapidly, and spread to all parts of the plant. As bacteria multiply in the xylem, they and their polysaccharides obstruct the vessels, as do gum deposits and tyloses formed in the xylem elements of infected plants. Stems of wilted plants allow less than one-fifth the normal water flow, indicating that extensive plugging of the vessels is the primary cause of wilting.
Bacteria are spread by contaminated mouthparts of the striped and the spotted cucumber beetles and by some other insects. Each contaminated beetle can infect several healthy plants after one feeding on a wilted plant. Only a rather small percentage of beetles, however, become carriers of bacteria. The first wilt symptoms appear 6 or 7 days after infection, and the plant is usually completely wilted by the 15th day. Bacteria present in the vessels of infected plants die within
1 or 2 months after the dead plants dry up.
Fruit infection of squash plants usually takesplace through infected vines and occasionally through beetles feeding on the blossoms and the rind of developing squash.
Management
The bacterial wilt of cucurbits can be controlled best by controlling the cucumber beetles, especially the early ones, with insecticides. To avoid squash rot in storage, only fruit from healthy plants should be picked and stored in a clean, fumigated warehouse. Resistant cucurbit varieties should be preferred to more susceptible.

Cucumber mosaic virus (CMV)

CMV is probably the most widely distributed and important virus disease of cucurbits. It infects all cucurbit crop plants and has a very wide range of natural hosts, including many other non - cucurbit crop plants and weeds belonging to different crop families.
On cucurbits, symptoms may occur on about 6-week-old plants at vigorous growth stage. The first
symptoms appear on young leaves that exhibit mottled mosaic leaf pattern of alternate light-green anddark-green patches with edges that curl downward. The characteristic symptoms are yellow-
colored mottling, leaf distortion, and stunted plant growth due to shortening of stem internodes. Older leaves develop chlorotic areas, which turn necrotic along the margins and later cover the entire leaf. Dead leaves either fall off or droop; wilting of the petioles occurs leaving the older vine mostly bare. The new leaves in case of muskmelon and cucumber may wilt and die, while

older crown leaves may turn yellow and later dry up, resulting in a slow decline of plant health The stem end portion of the infected fruits becomes mottled with yellowish-green and dark-green spots, and this mottling pattern gradually covers the whole fruit. The wart -like raised dark spots are usually formed on the fruit, and thus the fruit appears distorted. Fruits produced by the plants in the later stages of the virus infection are somewhat misshapen but have a smooth gray-white color with some irregular green areas, often called white pickle. The infected fruits of cucumber- varieties. The infected plants usually produce few runners, flowers, and fruits. CMV is transmitted through aphid vectors, namely, *Aphis gossypii* and *Myzus persicae*, and also through seeds and several weed hosts. The virus overwinters in many perennial weed sources especially attractive to aphids in spring. It can be transmitted through sap adhered on the hands.

Diseases of onion

Damping-Off

Cold, wet soils often encourage the development of damping-off symptoms very early in the seedlings' growth. Seedlings may fall over and die as a result of breakdown of plant tissues at the soil line. Sometimes damping-off occurs before the seedling even emerges. The disease is usually caused by *Pythium*, *Rhizoctonia* or *Fusarium* fungi, either alone or in combination. Damping-off can occur in the field, or in the greenhouse if conditions are too wet. In most cases, damping-off is not a serious problem in Ontario onions.

Onion Smut

Onion smut is caused by the soil-borne fungus *Urocystis cepulae* and infects the flag leaf (cotyledon) as it grows through the soil. Often the seedling survives this initial infection and the characteristic black streaks and blisters appear in the leaves and small bulbs later in the growing season as the fungus moves from the infected flag leaf to younger leaves. Some seedlings will be killed by the disease in most years. A cool, wet spring increases the incidence of smut infection because the onion seedlings grow slowly and the flag leaf is in the soil for a longer period. Similarly, planting onion seeds too deep will also make them more likely to be infected. Smut spores survive in the soil for many years, and even long crop rotations may not reduce disease incidence. Seed treatments can reduce losses to the disease and growing onions from transplants avoids the disease. The disease is spread when contaminated soil or set onions are transferred to smut-free areas.

Onion smut.

Botrytis leaf blight lesion.

Botrytis Leaf Blight

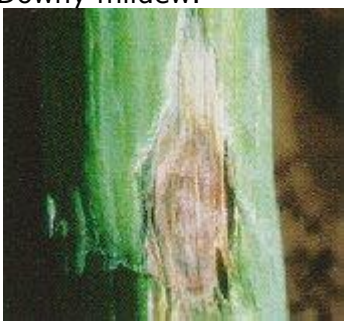
Botrytis leaf blight is a very common disease that is caused by the fungus *Botrytis squamosa*, which overwinters as sclerotia in soil, on onion debris and on bulbs in cull piles.

Description: The first symptoms of leaf blight are greyish-white, oval-shaped spots, about 1 to 3 mm in length that appear on the leaves. These spots are often surrounded by a distinctive silvery-white "halo" with uneven margins. The centres of many spots become sunken and straw-colored and when numerous, the leaf tips begin to dieback, eventually affecting the entire leaf.
This fungus disease usually develops when temperatures and leaf wetness are favorable for infection. Warm, (16-28 °C) wet weather is most favorable for disease development. Regular field scouting is still the best method to assess disease levels
Plant spacings that permit better air movement and irrigation schedules that do not extend leaf wetness periods may be helpful. To reduce the incidence and severity of Botrytis, remove cull piles and cull onions from field areas, rogue out volunteer onions and rotate crops.

Downy Mildew

Downy mildew of onions is caused by the air-borne fungus *Peronospora destructor*. This disease is not as common as Botrytis leaf blight, but when conditions are favorable for downy mildew, it can destroy an onion crop very quickly.
Description: The first sign of downy mildew is a purple-grey, velvety growth on otherwise green leaves (most easily seen in the early morning). The disease often starts in patches and is favored by cool, (less than 22°C) humid weather. Diseased leaves quickly turn pale-green, then yellow, and collapse and die. The pale-green and yellow phase is characterized by oval-shaped lesions that often become infected with other diseases such as purple blotch or bacterial infections. Several cycles of sporulation and infection can occur and three or four of these cycles can destroy an onion crop over a period of 30 to 45 days.

Downy mildew.



Purple blotch.

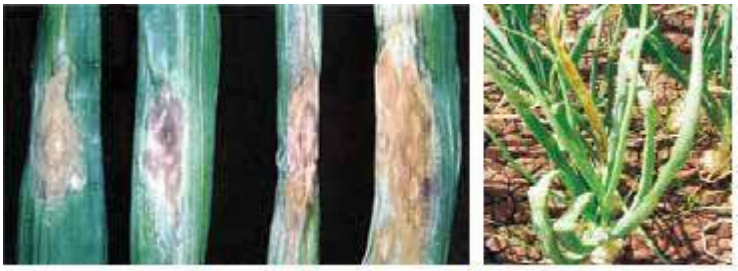
Purple Blotch

Purple blotch, which is caused by the fungus *Alternaria porri*, is a disease that often appears on leaves that have already been damaged by other diseases or environmental factors.

Description: Warm, (18-30 °C) wet periods favor the development of purple blotch. Small brown spots with purplish centres are characteristic of this disease. Under favorable conditions, the spots form into oval lesions that have a purplish tint with concentric rings. Older leaves tend to be more susceptible to the disease.

Stemphylium leaf blight (*Stemphylium vesicarium*)

Disease symptoms



***Stemphylium* leaf blight**

Infection occurs on radial leaves of transplanted seedlings at 3- 4 leaf stage during late March and early April.The symptoms appear as small yellowish to orange flecks or streaks in the middle of the leaves, which soon develop into elongated spindle shaped spots surrounded by pinkish margin .The disease on the inflorescence stalk causes severe damage to the seed crop.

Survival and spread

The fungus survives in plant debris or soil.
Favourable conditions-

Warm (18-25°C) humid conditions and long periods of leaf wetness (16 hours or more) favour disease development.

Pink Root (***Phoma terrestris***)

Pink root is caused by the soil-borne fungus *P. terrestris* and is present in many soils; however, losses to the disease are sporadic.
Description: Usually the main effect of this disease is reduced bulb size. The disease is easily recognized because the roots turn pink or maroon when infected. In severe cases the roots may die and the plants become weakened or stunted, especially in drier areas of the field. Unless the crop is suffering from heat or drought stress, yield losses are not likely to occur in good soils.

Figure . Pink root (bottom: healthy; top: infected).

White rot.

White Rot

White rot, caused by the soil-borne fungus *Sclerotium cepivorum*, is a very destructive disease that begins in the field and can carry over into storage.
Description: The first above-ground symptoms are a yellowing and dieback of the leaf tips, followed by a collapse of the affected leaves; however, these symptoms alone could easily be confused with other types of damage (i.e., onion maggot). When the bulbs and roots are examined, a white, fluffy mold and soft rot will be observed. Masses of tiny black sclerotia can also be seen within this mold. These sclerotia remain in the soil for many years. Infected bulbs can rot in storage boxes and stain other bulbs. White rot typically develops in patches in the field and is less of a problem when soils are warm (higher than 24 °C) and dry.

Fusarium Basal Rot

Basal rot is caused by the soil-borne fungus *Fusarium oxysporum* f.sp. *cepae* and generally occurs when soil temperatures are very warm (optimum 29 °C). This means that in Ontario the disease is not prevalent every year in all areas. It is often observed on Spanish onions growing in southwestern Ontario.
Description: The early symptoms in the field are yellowing of leaves and tip dieback. As the disease progresses, the whole plant may collapse and, if the plant is pulled, it often comes out without any roots attached since they have decayed. The basal plate of the onion becomes pinkish-brown and secondary bacterial rots may develop in the affected area. If infection occurs late in the season, the symptoms may not show up until the onions are in storage.

Fusarium basal rot.

Neck Rot

This common storage disease can be caused by various species of *Botrytis* fungi including *B. alli*, *B. aclada*, *B. byssoidea* and *B. squamosa.*
Description: Neck rot symptoms usually appear in storage; however, some necks may become soft and rotten immediately before harvest. There is usually a separation between healthy and diseased scales within the onion. As the disease progresses, the tissue becomes greyish and a grey mold may also develop. Black sclerotia eventually appear in the affected tissue. The decay symptoms can easily be confused with bacterial decay and eventually the whole bulb will break down. Sometimes both types of diseases are present.

Neck rot.

Diseases of Betel vine

Foot rot or Leaf rot or wilt–(*Phytophthora parasitica var. piperina*)

Symptoms

The fungus attacks the vines at all stages of crop growth. Initial symptom is sudden wilting of vines. The affected vines show yellowing and drooping of the leaves from tip downwards. The leaves become dull due to loss of lustre. The affected plant dry up completely within 2 or 3 days. The succulent stem turns brown, brittle and dry as stick. The lower portion of the stem near the soil level shows irregular black lesions upto second or third internode. The diseased intermodes undergo ‘wet rot’ and the tissue become soft, slimy with a fishy odour. The roots of the affected plants also show extensive discolouration and rotting.

In the young crop, the fungus produces 'Leaf rot' symptoms. The leaves near the soil region show circular to irregular water soaked spots, often starting from the edge. The spots rapidly enlarge and cover a part or whole of the leaf blade, which shows rotting. The leaves turn brown to dark brown or dirty black and defoliation occurs. The leaves with in 2-3 feet height of the vine show the leaf rot symptom.

The fungus produces hyaline, non septate mycelium. The sporangia are thin walled, hyaline ovate or learn shaped with papillae, measuring 30-40 X 15-20um. Zoospores, which are liberated from the sporangia, are kidney-shaped and biflagellate. Oospores are dark brown, globose and thick walled.

Favourable Conditions :September to February months with high atmospheric humidity and low night temperature (23˚C and below) are highly favorable.

Mode of Spread and Survival

The fungus is soil-borne and survives as facultative saprophyte in the infected plant debris and in the soil as oospores and chlamydospores. The fungus mainly spreads from field to field through irrigation water. The secondary spread is through sporangia and zoospores disseminated by splash irrigation and wind-borne rains.

Management

Select well matured (more one year old) seed vines from fields. Soak the seed vines in Streptocycline 500 ppm + Bordeaux mixture 0.05 per cent solution for 30 minutes. Apply 150 kg N/ha/year through neemcake (75 kg N) and 100 kg P2 O5 through Super phosphate and 50 kg Muriate of potash in 3 split doses, first at 15 days after lifting the vines and second and third dose at 40-45 days interval. Apply shade dried Neem leaf or Calotrophis leaves at 2t/ha in 2 split doses and cover it with mud. Collect and destory the infected vines and leaves. Regulate irrigation during the cold weather period. Drench the soil with 0.5 per cent Bordeaux mixture at 500 ml/hill during the cool weather period (October-January) at monthly intervals.

Sclerotium foot rot and wilt–(*Sclerotium (Corticium) rolfsii*)

Symptoms

The vines of all stages are susceptible to the disease. The infection usually starts at the collar region. Whitish cottony mycelium is seen on the stem and roots. The stem portion shows rotting of tissues at the point of attack and the plants show dropping of leaves and withering finally dry up.

The fungus produces white to grey mycelium which have profuse branching. Sclerotia are spherical smooth and shiny. Brown coloured mustard like sclerotia are seen on the infected stem and soil near the vines.

Favourable Conditions

May-July months with high temperature of 28-30˚C

Mode of Spread and Survival

The fungus is soil-borne and grow saprophytically in the dead plant tissue in soil. The fungus also survives as sclerotia in the infected plant debris in the soil for more than one year. The sclerotia spreads through irrigation water. The pathogen also survives on other hosts like chilli groundnut and brinjal.

Management

Remove the affected vines along with the roots and burn. Apply more of soil amendments like neem cake, mustard cake or farmyard manure. Drench the soil with 0.1 per cent Carbendazim.

Powdery mildew-(*Oidium piperis*)

Symptoms

The disease affects the crop at all stages of its growth and infection is mainly noticed on tender shoots and leaves. Whitish powdery growth is seen on both the surface of leaves which later enlarges and cover the major portion of the leaves. The affected tender shoots and buds are

deformed and shrivelled and margins of leaves turn inwards. When the disease advances, the whitish growth turns to brown blotches and in severe cases, the leaves turn yellow and defoliation occurs.

The fungus is ectophytic and produces profusely branched, hyaline and septate hyphae on the surface of the leaves. The conidiophores are short, club shaped, non-septate and hyaline and produce conidia in chains. Conidia are single celled, hyaline elliptical, and borne over short conidiophore.

Favourable Conditions

Dry humid weather during the months of May-July.

Mode of Spread and Survival

The fungus survives in the infected crop residues in the soil. The primary infection is from soil-borne inoculum. The secondary spread in the field is through wind-borne conidia and carried through splash irrigation.

Management

Collect and burn the infected leaves. Spray 0.2 per cent Wettable Sulphur or dust Sulphur at 25 kg/ha after plucking the leaves.

Anthracnose- (*Colletotrichum piperis*)

Symptoms

The leaves show small black circular spots initially which later enlarge and develop to a size of 2 cm in size, become concentric and covered with a yellow halo. The affected leaves turn pale yellow and dry up with large black dots in the centre of the spots. Black, circular lesions may develop on the stem, enlarge rapidly and gridle the stem resulting in withering and drying.

The fungus produces large number of acervuli containing short, hyaline conidiophores and black coloured setae. The conidia are single celled, hyaline and falcate.

Mode of Spread and Survival

The fungus remain in the infected plant debris in the field. The primary infection is through the soil-borne conidia, spread by rainwater splash or splash irrigation. The secondary spread in the field is aided by air-borne conidia.

Management

Collect and destory the infected vines and leaves. Spray 0.2 per cent Ziram or 0.5 per cent Bordeaux mixture after plucking the leaves.

Bacterial leaf spot or stem rot–(*Xanthomonas campestris p.v. betlicola*)

Symptoms

The disease initiates as tiny, brown water soaked specks on the leaves surrounded by a yellow halo, which enlarge later and become necrotic and angular, mostly confined to interveinal areas. The infected leaves loose their lustre, turn yellow, show withering and fall off. Under wet weather condition, infection spreads to stem showing small elongated black lesions on lower nodes and inter nodes. These lesions increase in size in both directions and blackening may spreads to the length of several nodes. The stem tissues become weak and break easily at the infected nodes and the vine show withering and drying.

Bacterium is a small rod with a single polar flagellum. It is Gram negative and non-spore forming.

Favourable Conditions

Cloudy weather with intermittent rains and high relative humidity. Two to 3 years old vines are highly susceptible.

Mode of Spread and Survival

The bacteria which are viable in the infected vines and leaves serve as a primary source of inoculum. Rain splashes and splash irrigation water help in the secondary spread.

Management

Remove and burn the infected vines and stubbles in the field. Regulate irrigation during cold weather season. Spray Streptocycline 400 ppm+Bordeaux mixture 0.25 per cent at 20 days intervals, after plucking the leaves.

Ex. 7: Diseases of Palms/ Coconut and Mulberry

Diseases of Palms/ Coconut

1. Basal stem rot- Thanjavur Wilt (*Ganoderma lucidum*)

Basal stem rot of coconut is also known as Thanjavur (Tanjore) wilt.

Symptoms

The diseased trees show the following typical symptoms in different parts of the palm viz., stem, leaves, inflorescence and roots.

The first visible symptom of the disease is found on the basal portion of the stem. Diseased palm shows exudation of reddish brown, viscous liquid from the basal portion of the stem upto three metres. Discolouration of the stem and internal rotting are commonly noticed upto the height of bleeding (exudation).

In advanced stages of basal stem rot the basal portion of the stem decays completely.

In diseased palms the leaflets in the outer one or two whorls show yellowing and drooping. In advanced stages of infection, the remaining leaves droop down in quick succession except the spindle leaf. Outer leaves fall off. In some trees, leaves break off near the base along the midrib. Under certain conditions, buds show soft rot and emit bad smell. In advanced stage of the disease, the crown is blown off leaving the decapitated stem.

In the diseased trees development of flowers is arrested and button shedding is common.

The quality of kernels from such bunches is poor, in most of the cases nuts are barren. When the disease progress is slow, only very few normal nuts are produced.

Most of the coconut trees bear profusely just prior to and at the time of initiation of symptoms. In severely diseased palms, nut and kernel weight, water content, copra weight and oil content decrease. Decay and death of finer roots preceeds bleeding symptoms in the them.

The disease appears to spread from a particular focus of infection towards the periphery in a concentric fashion, the annual rate being 0.2 to 4.8 per cent. The spread is mainly through root contact (root graft) between diseased and healthy palms.
Uncontrolled flood irrigation in the entire field or running irrigation channels along the palm rows where diseased palms exist or repeated ploughing in the affected garden aids in the rapid spread of the disease.
The disease incidence is more between the months of March and August. In general, bleeding symptoms and number of wilted trees are more during these months.

Management

Aureofungin-sol 2 g + one g Copper sulphate or 2 ml of Tridemorph dissolved in 100 ml water may be applied as root feeding. The active absorbing root of pencil thickness be selected and a slanting cut is made.
The solution is taken in a polythene bag or bottle and the cut end of the root is dipped in the solution.
Forty litres of 1% Bordeaux mixture should be applied as soil drench around the trunk in a radius of 1.5 metre. Neem cake (5 kg/tree can be applied along with fertilizers and Azotobactor (200 g/tree).
Application of phosphobacteria mixed in 10 Kg of FYM is effective in the management of Thanjavur wilt. Five Kg of Neem cake is to be applied in the basins of the diseased tree.
After one month, one packet of phosphobacteria (200 g) mixed with 10 Kg of FYM is to be applied. This may be done preferably between September and January months and trees should be given regular irrigation.

2. Bud Rot (*Phytophthora palmivora)*

Symptoms

Palms of all ages are susceptible, but it is more severe in young palms of 5-10 years. The first indication of the disease is seen on the central shoot of the tree (spindle).
The heart leaf shows discolouration which becomes brown instead of yellowish brown. This is followed by drooping and breaking off of the heart leaf.

With the progress of disease, more number of leaves get affected with loss of lusture and turn pale yellow.
The entire base of the crown may be rotten emitting a foul smell.
The central shoot comes off easily on slight pulling.
The leaves fall in succession starting from the top of the crown.
The leaf falling and bunch shedding continue until a few outer leaves are left unaffected.
But within few months the infection leads to complete shedding of leaves, with subsequent wilt and death of the tree.

Favourable conditions

High rainfall, high atmospheric humidity (above 90 pr cent), low temperature (18-20^{o}C) and wounds caused by tappers and Rhinoceros beetles (Oryctus rhinoceros)

Mode of Spread and Survival

The fungus remains as dormant mycelium in the infected tissues and also survives as clamydospores and oospores in crop residues in the soil.
The disease spread is mainly through air-borne sporangia and zoospores.
Rainfall also helps in spreading the disease.
Insects and tappers also help in the spread of the inoculum from diseased trees.

Management

The infected tissues from the crown region should be removed and protected with Bordeaux paste.

Bordeaux mixture at 1% may be sprayed so as to reach the crown region as pre-monsoon spray.

Top

3. Grey leaf blight (*Pestalotia palmarum)*

Symptoms

Initially symptoms develop only on the outer whorl of leaves, especially in older leaves.

Minute yellow spots surrounded by a greyish margin appear on the leaflets.
Gradually, the centre of the spots turns greyish white with dark brown margins and a yellow halo.
Many spots coalesce into irregular gray necrotic patches. Complete drying and shrivelling of the leaf blade occur giving a blighted or burnt appearance.
Large number of globose or ovoid black acervuli appear on the upper surface of leaves.

Favourable conditions

Ill drained soils, soils with potash deficiency, continuous rainy weather for 4-5 days and strong winds. **Mode of Spread and Survival**
The fungus remains in the infected plant debris in soil.
The disease is spread through wind - borne conidia.

Management

Remove and burn the infected, fallen leaves periodically.
Apply heavy doses of potash. Improve the drainage conditions of the soil.
Spray the crown with 0.25 per cent copper oxychloride or 1 per cent Bordeaux mixture before the onset of rains.

Nematode Management

The burrowing nematode Radopholus similis
Radopholus similis is the most important nematode pathogen infesting coconut.

Damage symptom

The burrowing nematode infested plants exhibit general yellowing and visible reduction in growth, vigour and yield.
The nematodes produce small, enlongate, orange coloured lesions on the creamy white coloured portion of main tender roots of coconut.
These lesions coalease and cause extensive root rotting. Tender roots become spongy in texture on heavy infestation.

Life cycle

The nematode takes three weeks to complete its life cycle from egg to adult at a temperature range of 24-32^{o}C
All larval stages and females except males are infective.
They enter into tender roots and feed in the cortical region of coconut.
It is a migratory endoparasite causing maximum root damage and is capable of spending its entire life in roots.

4. Root Wilt Disease (*Mycoplasma like organism (MLO)*

Coconut root (wilt) disease was first reported in Kerala.
Since then it has been spreading slowly towards North and South Kerala extending to adjoining Tamil Nadu.
In advanced stages of the disease there was 80 per cent reduction in nuts.
The disease is non-lethal but debilitating.

Symptoms

The characteristic symptoms are conspicuous bending of middle and outer whorls of leaves, flaccidity (ribbing of leaflets), yellowing and necrosis of leaflets.
In the diseased zone over 20 per cent of the affected palms succumb to leaf rot disease, rendering deterioration of such palms faster
Abnormal shedding of buttons and immature nuts, poor setting of nuts, inferior quality of nuts, lack of ability to produce female flowers and a degenerated root system are important symptoms of the disease.
In diseased palms drying up of the palms and necrosis of spikelets from the tip downwards are other symptoms.

Epidemiology

MLO is spread by lace wing bugs, *Stephanites typicus* . Palms of all ages and all soil types are affected, but those of pre-bearing and early bearing stages are more prone to infection. Palms contracting the disease in pre-bearing stage remain unproductive.

Management

Spray the leaves with Monocrotophos 0.05 ml/lit or Endosulfan (1 ml/lit).
Apply balanced doses of fertilizers (1 kg Urea, 1.7 kg Super phosphate, 1.7 kg Muriate of potash and 3 kg Magnesium sulphate per palm per year in two splits, 1/3 during April-May and 2/3 during September - October for rainfed palms and in 4 splits during January, April, July and october for irrigated palms).Apply 50kg of farmyard manure/palm/year.
.
Control the leaf rot disease by spraying 1% Bordeaux mixture or 0.3% (3 g/litre) Copper oxychloride or 0.3% (3 g/litre) Mancozeb.
Irrigate the palm during summer months at the rate of 600-900 litres of water/basin once in 4 to 6 days.
Avoid water logging by providing proper drainage during rainy seasons.

5. Stem bleeding (*Ceratocystis paradoxa)*

It is one of the mot important disease of coconut and mostly found in Tanjavur and Kanyakumari districts.



Symptoms

The characteristics symptom is the exudation of reddish brown fluid from the cracks in the stem. The fluid trickles down several feet on the stem and the exudate dries up forming a black crust.The tissues below the cracks turn yellow and decay.
As the disease progresses, more area underneath the bark gets decayed and the bleeding patch extends further up.The vigour of the tree is affected and nut yield is reduced.
The tree is not killed out right but becomes uneconomical to maintain.

Favourable Conditions

Copious irrigation or rainfall followed by drought, shallow loamy soils or laterite soil with clay or rock layer beneath the soil, poor maintenance of gardens and damages by beetles.

Mode of Spread and Survival

The fungus survives in the infected plant debris and soil as perithecia and conidia.
Spread is mainly through wind-bome conidia.
Irrigation and rain water also help in the disease spread.
Beetles which feed on the diseased plants also help in transmission.

Management

The bark of the trunk should be removed in the bleeding area and Bordeaux paste should be applied in this area.
Preparation of 1% Bordeaux mixture:
A quantity of 400 g of copper sulphate should be dissolved in 20 litres of water.
400 g of lime in another 20 litres of water separately.
The copper sulphate solution should be added to the lime solution constantly stirring the mixture.
Earthen or wooden vessels alone should be sued and metallic containers should not be used.
To find out whether the mixture is in correct proportion, a polished knife should be dipped in the mixture for one minute and taken out.

If there is reddish brown deposit of copper, additional quantity of lime should be added till there is no deposit in the knife.
Preparation of Bordeaux paste: Take 200 g of Copper sulphate and dissolve it in one litre of water.
Take 200 g of lime and dissolve in one litre of water separately.
Both are mixed simultaneously in a third vessel and the resultant mixture can be used as a paste.

6. Coconut cadang-Cadang

Cadang-cadang (dying) disease of coconut and other palms occurs in the Philippines, where it has killed more than 30 million coconut palms since it was first recognized.
The disease is of great economic significance to the Philippines because of the subsistence value of coconut palms to the local population as food and as a major cash crop from the export of coconuts and copra, the dried coconut "meat" from which coconut oil is extracted.

Symptoms

The symptoms of cadang-cadang in palms develop slowly over 8 to 15 years and are not particularly diagnostic of the disease unless observations are made over several years. Palm trees usually become infected with cadang-cadang after they have begun to flower. The first symptoms appear on the coconuts, which become rounded and develop scarifications on their surface, Three to 4 years later, the inflorescences are killed and, as a result, no more coconuts are produced. Five to 7 years from the beginning of symptoms, the constantly increasing number of leaf spots gives the whole crown a yellowish or bronze color while the number and size of fronds in the crown continue to be reduced. Finally, the growing bud dies, falls off, and leaves the palm trunk standing like a telephone pole.

In early stages of infection, the coconut cadang cadang viroid (CCCVd) consists of 246 nucleotides, making this the smallest viroid known.
In later stages of infection, two longer forms of the viroid appear and eventually replace the

smaller viroids. These forms, containing 296 and 297 nucleotides, are the result of duplication of part of the right-hand end of the viroid molecule of the short forms.
This pattern of changing molecular forms is unique to the *cadang-cadang viroid,* which is also the only viroid, so far, known to infect monocots and to kill its host
plants.

Development of the disease

The cadang-cadang viroid survives in infected coconut and possibly other palm trees. It survives in most palm tissues, including the husks and embryo of coconuts, and is transmitted through a small proportion (0.3%) of the seeds. It is also present in pollen of affected palms. It is not clear how CCCVd spreads from tree to tree. It is likely, however, that it spreads to a small extent on the mouthparts of various chewing insects.

Management

Cadang-cadang disease cannot yet be controlled by any available means and continues to spread outward from infected areas and into new areas of uninfected palm trees at about 500 meters per year. Eradication of infected trees and insect control have no effect on the spread of the disease.
So far, no resistant coconut cultivars are available for replanting or as breeding material; breeding efforts, however, continue. Production and use of viroid-free palm seedlings whether from seed or through tissue culture are extremely important.

7.Letal yellowing of Coconut (Phytoplasma)

Lethal yellowing appears as a blight that kills palm trees within 3 to 6 months after the first appearance of symptoms.

Symptoms

The first symptoms of lethal yellowing are the premature drop of coconuts of any size. Then, the next inflorescence that appears has blackened tips, almost all
its male flowers are dead and black, and it sets no fruit.

Soon the lower leaves turn yellow, and the yellowing progresses upward from the older to the younger leaves. The older leaves then die prematurely, turn brown, and cling to the tree while the younger leaves are turning yellow. Before long, all the leaves die, as does the vegetative bud. Finally, the entire top of the palm falls away and leaves nothing but the tall

trunk of the palm tree, which by now looks like a telephone pole.

Development of the Disease

The pathogen is a phytoplasma morphologically similar to all other such organisms observed in plants.

The pathogen occurs mainly in young phloem cells. Although the disease is obviously spreading rapidly in nature, the vector is not known with certainty.

The plant hopper, ***Myndus crudus*** has been implicated as one of the vectors.

Control of lethal yellowing depends on the use of genetically resistant coconut varieties and hybrids.

Malayan dwarf varieties, and certain other cultivars appear to be resistant or immune to lethal yellowing, and thousands of such trees, and hybrids of Malayan dwarf with susceptible palms, are now planted to replace the other coconut palms wherever lethal yellowing exists. Sanitation measures, i.e., removal and burning of diseased palms as soon as symptoms appear, and insecticidal sprays to reduce vector populations have not reduced the spread of lethal yellowing.

Management

Control of lethal yellowing by injecting infected trees with solutions of tetracycline antibiotics is effective and economically feasible in landscape plantings, but it is too expensive for coconut-producing regions.

Diseases of Mulberry

1.Leaf spot- (*Cercospora moricola)*

Symptoms

- Brownish circular or irregular leaf spots in the initial stage, enlarge, coalesce and form shot holes in later stage
- Severely affected leaves become yellowish and fall off prematurely

Management

- Spraying carbendazim @ 500-625 g/ha

2. Powdery mildew (*Phyllactinia corylea)*

Symptoms

- Initially, white powdery patches on lower surface of leaves are seen which later cover the entire leaf surface.
- Later turn black to brown in colour.
- Infected leaves turn yellow and fall off.
- High humidity (>70%) and low temperature (24-26oC) favour outbreak of the disease.

Management

- Providing wider spacing
- Growing resistant varieties like MR1, MR2 and China White
- Spraying Carbendazim @ 500-625 g/ha
- Releasing yellow lady bird beetles and white spotted lady bird beetles, since they feed on the mildew fungus.

3. Root rot- (*Macrophomina phaseolina; Fusarium solani)*

Symptoms

- Occurrence mostly seen in summer
- Initial stage, leaf blade turn to wilt and then spread to entire plant
- Later stage, black fungus are appear on branches and stem
- Spread through soil and water

Management

- Application of farm yard manure @20tonnes as basal
- At root surface pour copper oxy chloride(2gm/lit of water)
- Prevent the spread of disease to other healthy plant by basin irrigation
- Uproot the died plants
- Application of Trichodermaviride @ 25gm/plant
- Application of Bacillus substilis @ 25gm/plant at the time of planting or pruning

4. Root knot nematode- *Meloidogyne incognita*

Symptoms

- Growth and yield of plants affected.
- Stunted plants, marginal necrosis and yellowing of leaves, necrotic lesions on the root surface.
- Formation of characteristic knots or galls on the roots.
- Wilting of plants.

Management

- Deep ploughing in summer
- Applying neem cake @ 1000 kg/ha
- Applying Carbofuran 3G @ 30 kg/ha/year in four split doses
- (safe period is 50 days).

Ex. 8: Diseases of Tea and Coffee

Tea Diseases

Red root disease (*Poria hypolateritia*)

Fast spreading and slow killing pathogen; mycelium white, later turns red, in advanced stages may appear black; interwoven with adhering soil; on washing soil goes off – blood red mycelium seen. Wood spongy and sodden, fructification plate like with spores at collar – rarely seen and spreads mostly by root contact. Coffee is an alternate host.

Brown root disease (*Fomes noxius*)

The disease is common in low elevation area; slow spreading and quick killing pathogen; soil encrustation, which cannot easily be washed off; mycelium tawny brown resembling sambar skin; Wood turns soft and spongy and honey- comb like reticulations on the wood. Fructification seen on stumps- bracket shaped, irregular and hard; spores carried by wind, lodges on stumps of shade trees; infection spreads mainly through root contact and one of the alternate host is Coffee.

Black root disease (*Rosellinia arcuata)*

First identified root disease of tea, black, wooly mycelium on root surface and at collar while white and star shaped mycelium on wood surface.

Girdling and canker at collar region; black lead-shot like perithecia seen occasionally, on collar; mycelium grows freely through surface soil and organic matter and spreads rapidly in damp weather. Removal of surface mulch around 10 meters is suggested followed by drenching the soil with Dithane M 45/Captan 30 g/10 litres of water. Avoid soil rehabilitation.

Control measures of root diseases

Phytosanitary measures include isolation of infected area by taking trenches of 1.2 m deep and 45 cm width. Uprooting and burning the bushes *in situ* are warranted. Rehabilitate soil with Gautemala grass or thornless Mimosa. Soil treatment with tridemorph or hexaconazole 0.5% @ 100 ml/hole punched at every square foot. Soil treatment can be carried out after six months of planting during April/May or November/December. At the time of planting incorporation of biocontrol agents like *Trichoderma* species or *Gliocladium virens* @ 200 g per planting pit is recommended.

Collar canker (*Phomopsis theae*)

Observed mostly in young tea and pathogen invades the stem through open wound. Predisposing factors are deep planting, planting in gravelly soils, mulching closer to collar, wound caused by weeding implements, fertilizer application close to the collar, pegging, low moisture status in bark and surface watering during dry weather. Chlorosis, cessation of growth, profuse flowering and canker on stem are the symptoms of collar canker.

Preventive measures include avoid planting of susceptible clones in gravelly soils and drought prone areas, improving organic matter of marginal soils and using plants with good root system. Removal of affected portion by pruning to healthy wood and application of copper fungicide or spore suspension of biocontrol agents like *Trichoderma* and *Gliocladium* to cut ends are the curative measures.

Branch Canker (*Macrophoma theicola*)

Cancerous growth around the longitudinal wounds on the branches of tea bush. This fungus is a weak parasite affecting the bushes damaged by hail. Control measures are to cut off the affected branches and spraying any of the systemic fungicides (Tridemorph, hexaconazole and/or calixin) at 0.5 % (50g in 10L) over the infected portions.

Blister blight (*Exobasidium vexans*)

Favourable conditions for infection are cloudy weather (monsoon months); continuous leaf wetness for 11-13 hours coupled with relative humidity >60% and temperature between 17 to 22oC. Direct penetration of pathogen through upper surface of leaf; infects only tender leaves and stem (pluckable shoots); appearance of translucent spot and well developed lesion seen in 2 weeks. Lesions sunken on the upper surface and convex at lower surface where upper surface is smooth while lower surface is first dull then grey and finally pure white. Affected leaves are distorted- irregularly rolled, stem infection leads to goose neck shape, dieback and snapping at the point of infection. Sporulation occurs after 10-19 days and spore discharge period extends upto 8 days. The pathogen completes its life cycle 11- 28 days. Chemical fungicides such as copper oxychloride as protectant (inhibits germination of spores), tridemorph (Calixin), hexaconazole (Contaf 5E) and propiconazole (Tilt 25EC) are recommended for blister blight control in both pruning and plucking fields. Spraying schedules are issued for adoption in south Indian plantations.

Grey blight (*Pestalotiopsis theae*)

Pathogen gains entry through wounds and more prevalence in shear harvesting fields during monsoon, stripping, inadequate blister blight control leads to wounds. Spraying of mancozeb at 0.3% (30 g in 10 litres of water) or carbendazim or thiophanate methyl 0.05 % (5 g in 10 litres of water using hand operated knapsack sprayers at 10-15 days interval could be followed to control such diseases. Affected bushes should be thoroughly drenched with the fungicide suspension. The spray volume can be adjusted between 175 and 300 litres per hectare.

Coffee diseases

1. **Coffee Leaf Rust** (***Hemileia vastatrix*.)**

Symptoms

Yellow to orange spots on lower surface of leaves with powdery mass of uredospores.

Pear shaped teliospores seen from January to April.

Severe attack results in defoliation, die- back, and debility and crop loss up to 70% if timely control measures are not taken up.

Usually occurs during monsoon months in endemic areas with high humidity and hanging mist.

Management
Maintain optimum shade.

Spray 0.5% Bordeaux mixture during Pre-monsoon (May- June) and Post-monsoon (Sept.- October) period Or Spray 0.5% Bordeaux mixture during Pre-monsoon and Bayleton 25WP @ 0.02 a.i. during post-monsoon.
In endemic areas, maintain thin overhead shade bush sanitation by removing shade
Spray 0.5% Bordeaux mixture during Pre-monsoon (May- June) and Post-monsoon (Sept.- October) period.

2. **Black Rot** ***(Koleroga noxia)***

Symptoms
Usually occurs during monsoon months in endemic areas with high humidity and hanging mist.
Blackening and subsequent rotting of young leaves, berries and shoots.
Diseased leaves get detached from branches and hang out by means of slimy fungal strands.

Management

In endemic areas, maintain thin overhead shade bush sanitation by removing shade trees leaf litter on bushes,

Adopt proper handling and centering of bushes and provide proper drainage to minimize build up of humidity.

Spray 1.0 % Bordeaux mixture before the onset of south-west monsoon.

If disease is noticed, remove the diseased leaves and berries and bury them and Spray Bavistin 0.03 % a.i. (120 g/ 200 l water) during break in monsoon.

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3. **Brown Root disease**
   (*Fomes noxious*)

Symptoms

Brown root disease also known as 'Stump Rot,' is mostly associated with rotting stumps of shade trees in the plantation. Disease spreads by means of root contact. Internal portion of rot shows dark brown to black wavy lines.

Management

Uproot the affected coffee plants along with the root system and burn them

4. **Red Root disease**
   (*Poria hypolateritia*) .

Symptoms

Red root disease normally infects shade trees such as Silver Oak or Syzigium (nerale), followed by adjacent coffee plants. Root system shows red encrustration covered by *Syzigium* (nerale), followed by adjacent coffee plants. Root system shows red encrustration covered by soil and gravel. The rhizomorph appears deep red in colour.

Management

Syzigium (nerale), followed by adjacent coffee plants. Root system shows red encrustration covered by soil and gravel. The rhizomorph appears deep red in colour.

Add agricultural lime @ 1-2 kg to each pit and fallow the pits for 6 months before planting.

Uproot the shade trees along with stumps whenever, it is felled, to avoid root diseases in future.

5. **Black root rot disease (*Rosellinia bunodes: R. arcuata)*)**

Symptoms

In Black root disease, fungal rhizomorphs or black wooly mycelium are seen on the affected roots. On stem near the ground level, fan- shaped fungal mats with pellet like fructation are also seen.

Management

Drench the soil with Bavistin 0.4 % @3 l/plant (24g/3 l of water) or vitavax 75 WP 0.3% @ 3Litre/ plant (12 g/3)@12g/3
liter/plant (12g/3 liter of water) in the initial stage of wilting

Application of biocontrol agen,t *Trichoderma* in affected blocks is useful in reducing disease incidence.

5. Santavery Root disease
(*Fusarium oxysporum f.sp. coffeae*)

Symptoms

The Santavery root disease is characterized by sudden wilting, yellowing of leaves followed by defoliation and death of aerial parts.

A transverse section of the root shows brown to pinkish discoloration.

Scrapping of the bark of the stem near the ground level reveals discoloration.

Management

Uproot the dead and dying plants and burn them. Maintain adequate overhead shade
Apply well-composted organic manure @ 10- 15 kg per plant to improve soil fertility.

6. Die-back (***Colletotrichum gleosporoides***.)
Symptoms

Yellowing or blighting of any leaf on the green wood, yellowing, necrosis of nodes and internodes towards the tip. Twigs wilt and defoliate, die forward towards the apex and depict a die back appearance. Floral buds on the infected branches fail to open..

Management

Prune badly affected plants in February- March.

Protect the plant by spraying 0.5% Bordeaux mixture in February- March (pre blossom), April- May (pre monsoon) and September- October (post- monsoon).

Maintain adequate overhead shade and leaf mulch around the plants to conserve soil moisture during dry weather.

Apply balanced nutrients to maintain the vigour of the plants.

7. Nematodes (*Pratylenchus coffeae*)

Symptoms

Affected young plants are lean and lanky. Older leaves become yellow and drop, leaving very few undersized, chlorotic and crinkled leaves at the tip of the stem giving a 'tufted'

appearance. Affected bearing plants show thinner stem and have in adequate foliage to support the crop.

Management

In nursery dig and expose the soil for one summer and thoroughly dry the jungle soil while preparing nursery mixture. In the main filed, uproot and burn the affected plants, dig the affected soil and expose for one year.

Take care to keep the pits free from weeds- Plant the affected area grafted plants of arabica on robusta rootstock.

Ex. 9: Diseases of Rose

Black Spot (Diplocarpon rosae syn. *Marssonina rosae – Marssonina rosae*)

Symptoms

The spots, which may be as much as 12mm across, are generally circular and have an irregular edge often with a yellow halo. Leaves frequently turn yellow and fall early. Sometimes new leaves are produced, and these may also become affected. Continual defoliation will cause weakness, die-back or death of the plant. Some very susceptible species may have stems affected with a considerable reduction in plant vigour.

Management

Collect and destroy fallen leaves in the autumn, or bury under a layer of mulch. Prune out all stem lesions in spring before leaves appear. These actions will help delay the onset of the disease, but are of limited value because spores are bound to blow in on wind-blown rain from elsewhere.The fungicides tebuconazole with trifloxystrobin and triticonazole @0.1% are recommended for the control of rose black spot.

Powdery Mildew (*Podosphaera pannosa*)

The fungus produces a very fine, powdery coating on the surface of buds and leaves. Significant cases have stems and particularly thorns, infected. Attacks on young leaves and buds will cause deformity with retardation of growth. Infected buds will fail to open. The disease is likely in hot, humid weather, with fungal spores overwintering on the stems and fallen leaves.

Remove and dispose of infected parts; disinfect pruning tools regularly with a 70% isopropyl (rubbing) alcohol solution.

In hot, dry weather: spray the foliage with a hose to slow the growth of the fungus; avoid wetting the foliage late in the day, so as not to encourage other fungal diseases.

Never compost infected plant material.

In case of a serious infection in the previous year or years, as a preventive measure, apply a low-impact pesticide with sulphur, calcium sulphide or calcium polysulphide (lime sulphur).

Downy mildew (*Peronospora sparsa*)

Peronospora causes purple-red to dark-brown spots on the leaves with irregular margins, however, often angular. Stems, petioles and flower stalks can split and spotted with purple marks. Buds, sepals, petals and calyces can be affected and will present purple spots. New growth affected will be deformed. The disease is spread by wind.

Rust (*Phragmidium mucronatum*)

Rose rust appears as yellow patches on the surface of leaves, with orange pustules of spores underneath the leaf. The fungus is spread by wind. Affected leaves fall prior to healthy ones and plants may be defoliated in serious infections.

Remove and destroy all infected leaves.
If your roses were severely infected in the previous year(s), use a low-impact pesticide in which the active ingredient is sulphur, calcium sulphide or calcium polysulphide (lime sulphur). Read the product label carefully and follow the manufacturer's recommendations.
A baking soda solution may also be used

Anthracnose (*Sphaceloma rosarum*)

Spots caused by this fungus originate from a point where leaves are water soaked, usually unnoticeable at first, until they turn black with a very distinct defined edge. As the spots enlarge the centre becomes gray and may fall out resulting in a shot-hole appearance. Defoliation may occur but is often not serious.

Grey mould (*Botrytis cinerea*)

On roses grey mould is primarily a disease of the flowers and buds, leaves are infrequently attacked. Infected buds rot on the stem and infection may progress down the stem. On petals *Botrytis cinerea* produces pink rings.

Cut off and dispose of affected parts; destroy severely affected plants.

Regularly disinfect tools with a 70% isopropyl (rubbing) alcohol solution.

Ex. 10 : <u>Diseases of Chrysanthemum and Jasmine</u>

1. **Wilt (*Fusarium oxysporum f.sp. chrysanthemi*)**

Symptoms

Initial symptoms are in the form of yellowing and browning of leaves. Affected leaves die from the base of the plant upward. Infected plants are stunted and often fail to produce flower. Wilting may cause rotting of root or the base of the stem.

Mode of spread

The fungus is soil borne. The disease spreads through cuttings.

Management

Drenching the soil with or Carbendazim 0.1% is effective. Before planting dipping the rooted cuttings in a solution of Thiram @1.5g/litre of water.

Since the disease spreads mostly through cuttings, it is important to use disease free planting material. Disease can further be minimized by following strict sanitation; periodical monitoring; crop rotation and roguing of infected plants.

2. **White rust of Chrysanthemum (*Puccinia horiana*)**

Symptoms

Following infection, pale-green to yellow spots, up to 5 mm diameter, develop on the upper surface. The centres of these spots become brown and necrotic with ageing. On the corresponding lower surface, raised, buff or pinkish, waxy pustules (telia) are found. As the spots on the upper surface become sunken, so these pustules become quite prominent and turn whitish when basidiospores are produced. Telia are occasionally found on the upper leaf surface. Severely attacked leaves wilt, hang down the stem and gradually dry up completely.

Management

Preventive spraying with fungicides is effective but costly. Active ingredients found useful include oxycarboxin, triforine, benodanil, triadimefon, diclobutrazol, dibitertanol and propiconazole. Propiconazole had sufficient eradicative activity. Hexaconazole also has good eradicative activity.

Verticillium lecanii, used for biological control of aphids on chrysanthemums is also efficacious against *P. horiana*.

3. **Brown Rust *(Puccinia chrysanthemi)***

Symptoms

The disease symptoms are in the form of brown blister-like swellings, which appear on the undersides of leaves. These burst open releasing masses of brown, powdery spores. Severely infected plants become very weak and fail to bloom properly.

Chrysanthemum is also sometimes affected by brown rust, caused by the closely related *Puccinia chrysanthemi*. This differs by producing dark brown pustules on the undersurface of the leaf, often in concentric circles. Brown rust is not as damaging to chrysanthemum as white rust.

Management

Early removal of infected leaves/plants helps to prevent the further spread of the disease. Spraying the plants with Karathane @ 0.025% or Wettable Sulphur @ 0.3 % is effective in controlling the disease.

4. **Septoria Leaf Spot (*Sepotria chrysanthemella*)**

Symptoms

Leaf spots occur during cool-wet periods of the rainy season. Since the pathogens are spread through rain splashes the lowermost leaves get infected first. Serious infection may result in premature withering of the leaves; the dead leaves hang to the stem for some time. When flowering starts the infection occurs on flower buds, which rot completely.

Pathogen

Pycnidia are numerous, amphigenous, sub epidermal, globose or lens shaped. Conidia are hyaline, filiform, straight or flexuous often curved or worm like.

Mode of spread and survival

Infected debris in the soil appeared to be primary source of infection or systemic infection carried through suckers. The fungus do not infect other members of the family compositae and is specific to chrysanthemum cultivars only.

Management

This disease can be controlled by spraying Carbendazim 0.1% six times at 15 days intervals from the end of July or spraying Benomyl (0.1%) followed by Captafol (0.2%) Destruction of disease debris and avoiding excessive irrigation is recommended.

5. **Powdery Mildew (*Oidium chrysanthemi*)**

Symptoms

Infection is more severe in older plants under humid conditions. The growth of the fungus on the leaves appears as powdery coating. Infected leaves turn yellow and dry out. Infected plants remains stunted and fail to flower.

Management

Disease can be effectively controlled with Sulphur fungicides or Captan (0.2%). Good ventilation and proper spacing for free circulation of air is recommended.

6. **Foliar nematode (*Aphelenchoides ritzemabosi*)**

Symptoms

The symptoms on chrysanthemum include characteristic brown spots limited to the veins, and a progressive yellowing of the whole leaf. Leaf symptoms on infested Chrysanthemum maximum include reddish-yellow lesions on the lower leaves of young plants; in older plants these leaves are markedly chlorotic and a large area of the leaf surface becomes necrotic. The foliage is scanty and the flowers are few and deformed. Leaves in the upper part of plants have shown slightly higher resistance than those in the lower part. Direct effects are mechanical damage caused by the stylet, and damage due to hormones of growth and division.

A. ritzemabosi survives unfavourable conditions through anhydrobiosis, as it possesses multiple contraction ability. *A. ritzemabosi* overwinters in dormant buds and growing points of chrysanthemum stools; stools rather than the soil serve as the source of infestation.

Management

Treatment of chrysanthemum nursery soil with an organophosphorous nematicide was very effective in control of this nematode.
Recommended control measures include cleaning and burning infested leaves, submerging infected cuttings in hot water, spraying of foliage with chlorpyriphos. Foliar sprays of quinalphos successfully controlled *A. ritzemabosi* on *Zinnia elegans*, reducing both the symptoms of infestation and the final nematode population.

Diseases of Jasmine

1. **Cercospora leaf spot (*Cercospora jasminicola*)**

Symptoms

Circular to irregular reddish brown spots of 2-8 mm dia. appear on the surface of the leaves. Later the spots become irregular covering larger areas of the leaves.

Pathogen

Stromata are pale to dark brown, globular, filling stomatal openings. Fascicles are mostly dense. Conidiophores are pale olivaceous brown, narrow, sparingly septate and straight or sinuous. It has bluntly rounded tip and are 2 to 4 x 5 to 25 micron meter. Conidia are pale to pale olivaceous obclavate cylindric, indistinctly septate and straight to mildly curved. Its base is obconically truncate and tip is subobtuse and 20 to 66 x 2 to 4 micron meter.

Mode of spread and Survival

It attacks all species of Jasminum. The disease spreads through wind borne conidia.

Management

Spraying with Mancozeb 0.25% (or) Carbendazim 0.1%

2. Alternaria leaf blight (*Alternaria jasmine; A. alternata*)

Symptoms

In the leaves dark brown spots appear. On fumed condition the spots enlarges covering larges area causing blighting of leaves. Concentric rings can be seen the lesions. The disease also affects stem, petiole and flowers.

Mode of spread and Survival

The disease spreads through wind borne conidia.

Management

Collection and removal of fallen leaves. Spray with Copper oxychloride 0.25% or Mancozeb 0.25%

3. Collar rot and Root rot (*Sclerotium rolfsii*)

Symptoms

Plants at all stages are infected. First the older leaves become yellow followed by younger leaves and finally death of the plant. In the root black discoloration can be seen. On the infected tissues and stem surface white strands of mycelia and mustard like sclerotia are seen.

Management

Soil drenching with Copper oxychloride 0.25%. Heavy application of FYM with *Trichoderma viride.*

4. **Phyllody (Phytoplasma)**

Symptoms

Leaves become small malformed and bushy. In the place of flowers green leaf like malformed flowers are formed. Mode of spread The disease is transmitted by grafting and whitefly, *Dialeurodes kirkaldii*.

Management

Selection of cuttings from healthy plants. Spraying insecticide to control the vector.