Diseases of Fruit, Plantation, Medicinal and Aromatic Crops

3. Diseases of Fruits, Plantation and Medicinal & Aromatic Crops (HPI 201) 3 (2+1)

Etiology, symptoms, mode of spread, epidemiology and integrated management of the diseases of fruits, plantation, medicinal and aromatic crops viz mango, banana, grape, citrus, guava, sapota, papaya, jack fruit, pineapple, pomegranate, ber, apple, pear, peach, plum, almond, walnut, strawberry, areca nut, coconut, oil palm, coffee, tea, cocoa, cashew, rubber, betel vine senna, neem, hemp, belladonna, pyrethrum, camphor, costus, crotalaria, datura, dioscorea, mint, opium, Solanum khasianum and Tephrosia. Important post-harvest diseases of fruit, plantation and medicinal and aromatic crops and their management.

***Practical**: Observations of disease symptoms, identification of casual organisms and host parasite relationship of important diseases. Examination of scrapings and cultures of important pathogens of fruits, plantation, medicinal and aromatic crops.*

DISEASES OF MANGO

Mango is considered to be the king of fruit. India is the largest producer and exporter of mango in the world. Mango possess unique nutritional and medicinal qualities apart from being a rich source of vitamins A & C, besides its attractive form and appearance, delicious taste and appetizing flavor, the ripe mango fruit according to nutritional experts is also highly invigorating, fattening, laxative and diuretic. Every part of mango from root to tip is used in a variety of ways. This crop is affected by many fungal, bacterial and other non parasitic diseases.

Major Diseases

- Malformation: *Fusarium moniliformae* var. *subglutinans*
- Powdery mildew-*Oidium mangiferae*
- Anthracnose-*Colletotrichum gloeosporioides*
- Die-back-*Botryodiplodia theobromae*
- Sooty mould- *Capnodium ramosum*
- Grey blight-*Pestalotiopsis mangiferae*
- Stem-end rot-*Diplodia natalensis*
- Red rust- *Cephaleuros virescens*
- Bacterial canker- *Xanthomonas campestris* pv. *mangiferae indica*
- Giant mistletoe- *Dendrophthoe spp.*

MINOR DISEASES

- Black banded disease- *Rhinocladium corticolum*
- Pink disease- *Pellicularia salmonicolor*
- Blight – *Macrophoma mangiferae*
- Scab- *Elsinoe mangiferae* and *Sphaceloma mangiferae*
- Phoma blight-*Phoma glomerata*

- Black-mould rot- *Aspergillus niger*
- Alternaria rot –*Alternaria tenuissima*
- Bacterial leaf spot- *Pseudomonas mangiferae-indicae*
- Dodder-*Cuscuta* spp

Mango Malformation Disease (MMD)

Mango Malformation Disease is a fungal disease of mango caused by several species of *Fusarium*, some yet to be described. Mango is the only known host of the disease.

The disease spreads on a tree very slowly, but if left unchecked, can severely reduce yields. The main method of spreading MMD to new areas is through infected vegetative planting material. There is no evidence that the disease can spread on fruit or the seeds, or that it affects human health. It usually associated with the bud mite, *Aceria mangiferae* but the mites have been shown to spread the disease within a tree and not between the trees.

Mango malformation, also known as bunchy top, is a very serious threat to the mango industry, particularly in northern India. The etiology of the disease still remains obscure and diverse claims have been made about its causes, e.g., physiological, viral, fungal, acarological and nutritional.

Symptomatology:

Three distinct types of symptoms are produced.

1. Bunchy top of seedlings (BT)
2. Vegetative malformation (MV)
3. Floral malformation (MF) (fig-1)

Bunchy top of seedlings (BT):

- Bunchy top phase (BT) appears on young plants in the nursery beds when they are 4-5 months old.
- Formation of a bunch of thickened small shootlets bearing small rudimentary leaves or occasionally several bunches arising from a leaf axil at the top or lower down the main shoot.
- These shoot lets are much thicker than main axis from which they arise. The shoot remains short and stunted.
- The growth of the plant is stopped and it gives an appearance of bunchy top.

Vegetative malformation:

- Induces short internodes forming bunches of various sizes. They are found at the top of the seedling and give a bunchy top appearance.

Floral malformation (MF):

- Variation in the panicle formation, the malformed heads dry up in black masses and persist on the tree for a long time.
- And the secondary branches are transformed into vegetative buds and large number of small leaves and stems, which are characterized by appreciably reduced internodes and are compacted together giving a witches 'broom appearance.
- In other cases, the flower buds seldom open and remain dull green.

http://www.apsnet.org/publications/imageresources/Pages/IW00012a.aspx

Fig. 1. Floral malformation

Etiology:

- *Fusarium moniliformae* var. *subglutinans*. Wollenw. &Reink. Micro conidia are one or two-celled, oval to fusiform and produced from polyphialides.
- Macro conidia are rarely produced and are 2-3 celled and falcate.
- Asexual fruiting body of the fungus is sporodochium.
- Chlamydospores are not produced.

Mode of spread and survival:

- Diseased propagated materials help in the spread of the disease.

Epidemiology:

- The disease is serious before flowering in the northwest region where the temperature is between 10-15^{o}c during December-January.
- The disease is mild in the areas where temperature is between 15-20^{o}c, sporadic between 20-25^{o} c and nil beyond 25^{o} c. the occurrence of malformation differed according to the age of the plants. 4-8 years old trees are highly susceptible.

Management:

- Spraying with NAA at 100-200 ppm during October reduces the disease incidence.

- Eradication of malformed shoots and panicles after spring and autumn flushes (April and October),
- spraying with acaracide (phosphamidon 0.05%) immediately after 3 flushing (February, May and October),
- Spraying with chelated copper (40 ppm) (mangiferin chelate or amino acid based chelate or copper fungicide) twice (August-September and December –January) before advent of the peak period of the fungal population,
- Spraying with chelated Zn++ twice (40 ppm) (December and February) to replenish the deficiency in the plants suffering long from the disease.
- In in vitro test mangiferin Cu++ chelate killed the conidia and mycelia,
- *Aspergillus niger* parasitized the Fusarium
- While carbendazim arrested germ tube growth and reduced conidia production thus affected infection rate (r) of *F. moniliforme* var. *subglutinans*.
- Followed by spraying of Carbendazim 0.1% or captafol 0.2% effectively controlled the disease.

Powdery mildew

Powdery mildew is one of the devastating foliar diseases of mango affecting almost all the cultivars. In India, the disease is wide spread including in the hill valleys and plains of U.P. and it is a serious threat to mango production. Its severity mainly depends on climatic conditions. The losses have been estimated upto 20% in Maharastra and 30-90% in Lucknow and U.P.

Symptoms:

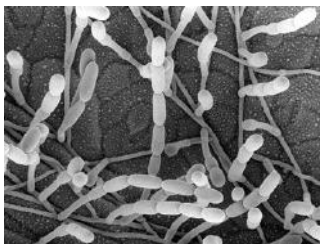
- A whitish powdery growth covers the stalks of the panicle, flowers and tender fruits.
- The whitish growth of the fungus comprising of asexual fruiting body an oidi*a*.
- The affected flowers and fruits drop prematurely reducing the setting of fruits.
- At higher altitudes, the infection extends to the young leaves and twigs.
- Many of these are covered by the white powdery fungal growth and may exhibit distorted growth. On younger leaves it induces leaf curling.

http://www.ctahr.hawaii.edu/nelsons/mango/,
http://www.hort.purdue.edu/ext/senior/fruits/images/large/mangolvs2.jpg
http://www.infonet-biovision.org/default/images/81/pests

Fig: 2. Powdery mildew on leaves and flowers

Etiology:

- *Oidium mangiferae*, Berthet. It produces septate mycelium and is hyaline, branched and superficial. Haustoria are sub epidermal.
- Conidia are hyaline, unicellular, elliptical and are borne singly or rarely in chains.



http://www.bitterrootrestoration.com/mango/powdery-mildew.html

Mode of spread and survival:

- During off-season, the pathogen survived in intact green malformed panicles mostly hidden under dense foliage and its sexual forms has not been recorded.
- During flowering period, the conducive environmental condition activates the dormant mycelium in necrotic leaves.

- Abundant conidia are produces and blown over to the flushes through the wind on young panicles which provides spore load for initiating the disease.
- Fresh infection on young leaves happens during first week of the December.

Epidemiology:

- It usually occurs during Dec-Mar. The disease is particularly destructive in the coastal areas of Maharastra during cold and wet seasons.
- Rains or heavy mist in the morning accompanied by cool nights during the flowering period favors the disease.
- Predominance of susceptible variety, high wind velocity for 3-4days with maximum temperature above 30^0c, minimum temperature around 15^0c and maximum relative humidity of 73.3-83.9% and minimum of 23.4-25.5% are found conducive for quick spread.

Management:

The disease can be managed by pruning of diseased leaves and malformed panicles and three sprays of fungicides at different stages starting with Wettable Sulphur (0.2%) at the panicle size of 7.50 -10.00 cm followed by Dinocap (0.1%) after 15-20 days of first spray and Tridemorph (0.1%) after15-20days of second spray. Wettable Sulphur (0.2%) can be used in all the three sprays and number of sprays may be reduced as per appearance time of disease.

Mango anthracnose:

Anthracnose is also known as blossom blight, leaf spot, fruit rot and twig blight. This disease is severe both in field and storage. The disease is present all mango area of India The verities neelam and bangalora are highly susceptible to this disease.

Symptoms:

Leaf spot:

- The fungus attacks tender shoots and foliage. Brown or dark circular or irregular spots are formed on the leaves and such leaves are crinkled.
- The affected portion dry up and fall off and leaf ragged margins. Often these leaves are shed leaving the twigs bare.



Die back:

- The infection spreads to the green twigs and forms dark brown lesions on them. Young branches dieback.
- On the lesions and dead portions, minute, pink, cushion-shaped fructifications of the pathogen are seen during moist weather.

Blossom blight:

- Small dark spots are formed on the main stalk and lateral branches of the panicle. Individual flower stalks are also infected.
- The flowers wither and shed. When severely infected. All the flowers destroyed and no fruits are formed.

Fruit rot:

- The tender fruits turn black and fall off. Often dark lesions develop on the fruits and cause partial of complete shriveling, blackening and shedding.
- Matured fruits are also infected. Black, round or irregular, sunken spots are formed on the skin. as the fruit ripens the spots extend over the whole surface accompanied by the softening and rotting of the fruits.
- This type of injury is observed while the fruits are on the trees. it also occurs during transit and in storage. Spoilage of ripen fruits is common.
- Fructification of the pathogen is formed on the spots.

Etiology: *Colletotrichum gloeosporioides*. Penz, Spauld&Schrenk.

- Acervuli developed on diseased parts of the plants.
- They are irregular and appear as brown to black dots. Setae are common on twigs but not on fruits.
- The acervuli when mature exude pink masses of conidia under moist conditions. Marginal setae are rare.

- Conidia are borne on hyaline conidiophores. The conidia are straight, cylindrical or oval, hyaline with two oil drops and are non-septate with round ends.

Mode of spread and survival:

- Inoculum remains on dried leaves, defoliated branches, mummified flowers and flower brackets and they serve as primary inoculum.
- Secondary spread is through air born conidia. The fungus can enter the pores of green fruits.
- The latent infection of mature fruits may takes place through lenticels. The fungus apparently infects the fruit while it is green and develops in flesh during ripening.
- The latent infection is carried from the field to storage. Healthy fruits develop infection after in coming in contact with disease ones.
- The latent infection does not begin to spread until it reaches eating maturity.

Epidemiology:

- The acervuli are abundant on the dead twigs and 80% of the spores on them are viable. Fresh acervuli continued to appear on dead twigs and persist on the tree.
- The optimum temperature for infection was found to be 25oc and relative humidity 95-97%. The perithecial stage of the fungus is not very common.
- There is no evidence to show that fungus perpetuates through ascospores.

Management:

- Diseased twigs, leaves and fruits, which fall on the ground in the orchard, should be collected and all infected twigs should be pruned and burnt.
- Spraying of Bordeaux mixture 0.6% in the young plants during Feb, April and sept controls the disease. Spraying carbendazim 0.1% or thiophanate-methyl0.1% or chlorothalonil 0.2% for 15days interval until harvest effectively controls anthracnose.
- Before storage, fruits should be treated with hot water at 50-55^{0} c for 15min. or thiabendazone 1000ppm for 5min. Spraying of coc +zineb after completion of

heavy showers followed by wettable sulphur 0.2% before flowering and carbendazin 0.1% at 15days interval from fruits formation proved effective.

Dieback

This disease is prevalent in all mango-growing states in India. In U.P.30-40% of road this disease affects side and other plantation.

SYMPTOMS

- The disease is characterized by dieing back of twigs from tip downwards particularly in older leaves.
- It is giving an appearance of scorching by fire followed by complete defoliation. Barks are discolored and darkened at certain distances from tip.
- Such dark patches are generally seen on young green twigs. When the dark lesion increase in size, dying of young twigs begin at the base affecting leaf mid ribs extending along the veins.
- The upper leaves use their healthy green color and gradually turn brown accompanied by upward rolling of leaf margin. In, advanced stage, such leaves shriveled, fall off in a month are more, leaving the shriveled twigs.
- Internal browning in the wood tissue is observed on the slitting along the long axis. Cracks appear on branches, which exude gum. In fruits, the pericarp darkens near base of the pedicel.
- The affected area enlarges to form a circular, black patch, which under humid atmosphere extends rapidly and turns the whole fruit completely black within 2/3days. The pulp becomes brown and softer.

Etiology: *Botryodiploidia theobromae* Pat.

- It is a Pycnidial fungi. Pycnidiospores are hyaline and thin walled, becoming thick walled, and dark brown and one septate.

- They have longitudinal striation and measures 20-30* 10-15micrometer with paraphyses upto50micrometer long.

Mode of spread and survival:

- The fungus is a wound parasite. Dead twigs and bark of the trees harbor the fungus. The spores are spread through rain splashes.

Epidemiology:

- High temperature during summer predisposes the trees to the disease.
- Relative humidity of about 80%, max. &min. temperature of 31.5^0 c and 25.9^0 c respectively and rains favour the disease development.
- It causes great damage and when mango grafts are kept in humid propagation shed.

Management:

- Fruits should be harvested on clear dry days.
- Injuries should be avoided on fruits at all stages of handling.
- Care should be taken to prevent snapping off of the pedicel.
- Dipping of mangoes in 6% solution of borax at 43^0c for 3min. gives effective control. Carbendazim 0.1% or Thiophanate-methyl 0.1% or chlorothalonil 0.2% spraying in the field before harvesting gives effective control.

Sooty mould:

The disease is of common occurrence and affects many kinds of fruits and plantation crops.

SYMPTOMS:

- The fungi produce mycelia, which is usually superficial and dark. They grow on the flowers, both tender and old leaves, stems and fruits.
- They grow and thrive on the sugary secretions of the plant hoppers and other insects.

- Black encrustations are formed on the surfaces of different parts of the plant. The photosynthetic ability of the plant is highly reduced because of sooty mould covering the photosynthetic area.
- During flowering time, its attack results in reduced fruit set and cause fruit fall. Black coating is also found on the fruits.
- Appearance of the affected fruits is lost and the price for such ugly fruits is usually low.

Mode of spread and survival: affected leaves and other crop debris serve as primary source of inoculum

Etiology: *Melioa mangiferae* Earle. *Capnodium ramosum* Cke. *C. mangiferae* Cke. & Brown and *Trichospermum acerinum* (Syd). Speg.

Epidemiology:

- High infestation with plant hoppers and the sugary substances (including excreta) secreted by them and other insects favour development of sooty mould. This is not a parasite or pathogen and do not draw any nutrient from the plants.
- Disease is severing in old and dense orchards where light intensity is low. Trees exposed to eastern side have fewer incidences while the trees in center of the orchard have more incidences.
- Continuous and heavy rainfall washes down these substances but high humidity proved congenial for growth of the fungus.

Management:

- Both the insects and sooty moulds are to be simultaneously controlled in the eradication process. The insects are to be controlled by spraying with carbaryl or phosphamidon 0.03%.
- It is followed by spraying with a dilute solution of starch or maida 1%. On drying, the starch comes off in flakes and the process removes the black mouldy growth fungi from different plant parts.
- Spraying insecticide followed by spraying with fungicide viz., Bordeaux mixture 1% is also recommended.
- Spraying of wettable sulpher, methyl parathion+gum acacia (0.2+0.1+3%) at 15days interval reduces the sooty mould incidence.

Grey Blight/ *Pestalotiopsis* Leaf Spot:

In India, this disease has been reported from many states.

Symptoms:

- Brown spots develops at the margins and tip of the leaf lamina and distributed irregularly on entire leaf.
- Initially the spots are brown and minute and they gradually increase in size and become dark brown. Black dots appear at the center of the spots represent the acervuli.
- On mature green fruits, small brown spots appear with grayish white center which later turns to bigger lesions with large number of acervuli seen as black dots.
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Etiology: *Pestalotiopsis mangliferae* (P.Henn.) Stey.

- The fungus produces septate mycelia and acervulus as an asexual fruiting body.
- Conidia are5-celled, oblong to clavate or clavate to fusiform, colored cells are 15-16 micro meter long, upper two of them slightly darker than the lowest olivaceaus colored cells, septa and walls sometimes black and will have long pedicel; setulae 3, coarse, widely divergent and 19-26 micron long.

Mode of spread and survival:

- The fungus present in stem is multiplies under favorable conditions. It spread through wind- born conidia.

Epidemiology:

- The fungus is capable of growing at temperature between 20-25^{0} c. mycelia growth sporulation takes place at pH 5.5-6.0. Wounding leads to more disease incidence.

Management:

- Carbendazim 0.1% after heavy rains followed by wettable sulphur 0.2% before flowering controls the disease. Bordeaux mixture 1.0% can also used for the control.

Stem-End Rot

It is a destructive disease of mange and it is known to occur in India and other mango growing countries. In India it was first described during 1945. Since then it has been observed in Delhi, Rajasthan, U.P` and other states.

Symptoms:

- The onset of die back becomes evident by discoloration and darkening of the bark some distance from the tip.
- The dark area advances and young, green twigs start withering first at the base and then extending outwards along the vines of the leaf edges.
- The affected leaf turn brown and its margin roll upward. At this stage, the twig or branches dies, shrivels and falls.

- This may be accompanied by exudation of the gum. Infected twig show external discoloration.
- Brown streaking of vascular tissues is seen on splitting the twigs lengthwise.
- The fungus also infects the fruits.
- Infected fruit pericarp darkens near the pedicel base. More portions of fruit turn black to soften.

Etiology: *Diploidia natalensis* (Pole Evans.)

The fungus produces brown to black, globouse to sub globose, pyriform, erumpent pycnidia that are ostiolate. Two types of conidia are produced within a pycnidium. Hyline and olive-brown. The former are thin walled and unicellular, while the later are thick walled and bicelled with 4-6 longitudinal striations.

Mode of spread and survival: the fungus persists in infected plant parts, which serve as source of inoculum.

Epidemiology:

- Relative humidity above 80%, max. &min. temperature of 31.5^0 C &25.9^0 C respectively.
- Rains favor the disease development.
- Nutritionally deficient plants are heavily affected.

Management:

- Plants with balanced fertilization resist the disease.
- The coating of stem with fungicidal paints immediately after harvest or packing of fruits directly in the cellophane bags the infections completely.
- Removal of infected pedicel during fruit ripening also helps in keeping the disease under control.

Red Rust

The algal disease of mango has been observed in India and else where. Its major distribution in India has been in Bihar, Karnataka, and U.P. the disease appeared in an epidemic form in the state orchards in Tarai in 1956. Reduction in photosynthetic activity and defoliation as a result of algal attack lower vitality of the host plant.

Symptoms:

- The disease is characterized by initial green coloured patches, as and when disease advances the organism turns red rusty spots on the leaves and young twig.
- The spots are initially circular, slightly elevated and later coanesce to form irregular spots.
- The upper surfaces of the spot consist of numerous, unbranched filaments, which project through cuticle.
- Some of the filaments represent sterile hairs while others the fertile ones.
- Spores mature, fall off and leave cream to white velvet texture on the surface of leaf.

Etiology: *Cephaleuros virescens* (Kunze).

- The algae after a period of vegetative growth develop its reproductive structure.
- Certain cells become sporangia. They are of 2 types.
- Those formed directly on the thallus are sessile and thick walled, 40-50micrometer in diameter with orange pigments.
- They are formed singly on the vegetative filaments. Some are produced above the surface on special sporangiophores consisting of thick, rigid, septate hairs with a length of 50micrometer, swollen into a vesicle at the tip. Each vesicle carries 3-6 sporangia on curved pedicels.
- When the sporangia are riped, the contents are converted in to zoospores and liberated through an opening in the wall.
- The zoospores are orange in color, ovoid and swim actively by means of cilia.

Epidemiology:

- The disease is more common on close plantation.
- The zoospores cause initial infection.
- High moist condition favours development of fruiting bodies of the algae.

Management: it is controlled by spraying with Bordeaux mixture 1.2% or COC 0.1% or limesulphur.

Bacterial Canker

In India it was first reported from Pune. It occurs in Bihar, Karnataka, maharastra, tamilnadu, U.P.

Symptoms:

- The disease attacks the leaves, leaf stalks, stem and fruits.
- On the leaves disease first manifests itself as minute, water soaked irregular lesions, black and is surrounded by chloratic haloes.
- Due to vein limitations the spots become angular and result in cankerous patches, which sometime dry up.
- Sever infection results in defoliation. The bacteria also infects the fruits first showing water soaked lesions, which later become dark brown to black and causes sever cracking of fruits, accompanied by heavy bacterial exudation.
- There may be only a few lesions on each fruit but more lesions on tender fruits may lead to sever fruit drop.
- On branches on twigs the lesions become raised with longitudinal fissures, and are accompanied by the bacterial gummy ooze.

Etiology: *Xanthomonas campestris* pv.*mangiferae-indicae* (Patel et al.) Robbs et al. it is a gram negative rod, motile by monotrichous flagella

Phylum:Proteobacteria

Class:GammaProteobacteria

Order:Xanthomonadales

Family: Xanthomonadaceae

Genus: *Xanthomonas* sp: *campestris* pv. *mangiferae-indicae*

Mode of spread and survival:

- Infected nursery trees have been a major source of BBS in new orchards
- Bacterium enters the leaf through stomata and lenticels in fruit and through lenticels in twigs. The bacterium survives in infected parts on the tree.
- The pathogen survives up to 8months in the leaves. Bacteria from cankers on the twigs are the cause for primary infection on the fruits.
- Disease spread is rapid during rainy days. Disease spread to the new area through infected planting material.
- When fruits are found in bunches disease spreads when they contact each other.

Management:

- Use of clean planting and grafting material and Use of certified seedlings

- Two sprays of streptocycline200-300ppm at 20days interval reduce fruit infection. Dipping the fruits in 200ppm solution of agrimycin-100 is effective.
- Mango verities like Bombay green, fazali, Jehangir and suvarnarekha are resistant.

Giant mistletoe: *Dendrophthoe* spp.

Sytmptoms:

- Infect mango trees. The flowering plant parasitizes slendour branches of host tree at intervals by means of bulged haustoria which serve has absorbing organs.
- It derives nutrient and water from the host and makes the host to die.
- The severely attacked trees are weakened and their productivity is lowered. Some times the trees die.

Phanerogamic Parsites: *Dendrophthoe* (=Loranthus) ampullaceus D. calcycalatus, D. involucratus, D. longiflorus, D. parasiticus and D. philippensis, D. scurrula are partial stem parasites.

Mode of spread and survival:

- The flowering parasite survives in the host plant.
- The parasites flowers profusely in the host plant and produces fruits.
- Birds eat the fruits and excrete seeds on branches of other trees.
- Seeds of the parasites germinate during wet condition and establish on the new host.

Epidemiology: trees in poorly maintained or neglected plantations are highly susceptible.

Management:

- The parasite is cut before berry formation.

- The branches or twigs showing the parasites should be cut about 2.5cm below the point of attachment.
- The cut ends should be protected with Bordo paste.

MINOR DISEASES

Black banded / black stem:

Rhinocladium corticolumn Massee – [Syn. *Pexiotruchum corticolum* (Massee) Subram.]. The occurrence of disease in mango was recorded at Pune. Now it occurs in A.P., Goa, Gujrat, Karnataka, maharastra, T.N, and W.B.

Black, velvety or fe s and bark of twigs and branches of mango. The disease is very low on main branches. The fungus develops on the colonies of scale insects and therefore it is not responsible for the death of branches but the scale insects are the primary causes for the damage of twigs. It presence a characteristic and conspicuous black banded appearance. The mycelia growth and

clusters of conidiophores present a velvety appearance during rainy seasons which drop off in summer months leaving light black bands on the affected portions. Badly infected twigs and branches are to be cut and destroy. The surface of twigs or branches may be scraped off and brushed with a solution of COC with insecticide to get rid of attack of both.

Pink Disease

Pellicularia salmonicolor (Berk. &Br.) Dater (Syn. *Corticium salmonisolor*) Berk. &Br. Pinkish powdery coating on twigs and branches due to profused conidial production are the symptoms. Cutting infected branches and protecting the cut wounds with Bordeaux paste controls the pink disease.

Blight:

Macrophoma mangiferae Hingoraniand Sharma. Leaf tips dry. Infection spreads towards leaf petiole and causes blighting. Removal and destruction of infected plant parts and spraying with Bordeaux mixture 1.5% at weekly intervals controls the disease.

SCAB:

Elsinoe mangiferae and *Sphaceloma mangiferae* (Patel et al.) Dye. Round or irregular pale brown to grey lesions are formed on leaves with intensification of infection. The leaves become crinkled, deformed and defoliation occurs. Grey or brownish spots develop on young fruits. They enlarge; become corky leading to spoilage of fruits and

reduction of the market value. Repeated spraying with Bordeaux mixture 1% controls the disease.

Phoma blight:

Phoma glomerate (Corded) Woolly and Hochapf. The symptoms appear on old leaves only. Initially the lesions are minute, irregular, and yellow to light brown and scattered over the leaf surface. As the lesions enlarge their colour changes from brown to cinnamon. Fully developed spots are characterized by dark margins and dull grey necrotic centers. In severe cases withering and defoliation of infected twigs occur. Spraying with benomyl 0.2 % followed by COC 0.3 %was found effective.

Black- Mould Rot

Aspergillus niger v. Tieghem. The affected fruits show yellowing of base and development of irregular, hazy, grayish which coalesce into dark brown or black lesions. The mesocarp of the rotted area becomes depressed and soft. The stalk and infection results in premature fruit drop. A fruit dip treatment with benomyl 155ppm can control the rot.

Alternaria rot:

Alternaria tenuissima (Kuntze: Pers) Wiltshire. The disease appears in the small, circular and brownish spots, which enlarge and become irregular to form big water-soaked patches. Reddish patches develop on the flesh below the spotted area of fruit.

Bacterial leaf spot:

Pseudomonas mangiferae-indicae. The disease manifests by forming minute water soaked spots towards the leaf tip. These spots form in groups and become black as the disease advances, which are usually haloes. In severe cases these spots form in groups and become necrotic. The leaf dries up in patches. The fruits may drop off.

DODDER: *Cuscuta chinensis*

Mango trees are attacked by the total stem parasite, *Cuscuta* spp. The first appearance of the parasite, dodder in the field is noticed as small masses of branched, thread like, leafless stems which are devoid of the green pigment and which twine around the stem are leaves of the host. The common colour is creamy yellow or orange. The leaves are represented by minute functionless scales. When the stem comes in contact in host, minute root like organs penetrate the host cortex reaching into the fibro vascular bundles. The tiny, white, pink or yellowish flower occurs in clusters. A single plant may be produces many as 3000 seeds. It perpetuates through seeds, which fall on the ground and remain dormant until a favorable seasons returns. Clover, be seem, flax and many oil seed crops are commonly attacked. The crop seed should be properly cleaned and should be free from dodder seeds. Grazing animals should not be allowed to move through dodder-infested area. Badly infested crop should be burnt and destroy before the parasite produces flowers and seeds. Field should be left fallow after selected eradication measures have been completed. Higher crop rotation beginning with non-host crop should be followed to reduce its infestation.

I. Choose the correct answer

1. *Pellicularia salmonicolor* is causal organism for

a. powdery mildew b. Red rust c. Sooty mould d. pink disease

2. Bacterial spot is caused by

a. xnthomonas b. pseudomonas c. Erwinia d. None

3. Mango malformation caused by

a.xnthomonas b. Fusarium sps c. virus d. none

4. The disease which requires honey dew secretion on leaves

a. Powdery mildew b. red rust c. sooty mould d. anthracnose

5. Bacterial spot is controlled by

a. Bavistin b. Ridomyl MZ c. monocrotophos d. streptocyclin

II. Fill in the blanks

1. Causal organism for powdery mildew ---------
2. Causal organism for stem end rot ----------
3. Important post harvest disease in mango ----
4. powdery mildew fungi requires ------ weather
5. Important nursery disease of mango----------
6. Asexual fruiting body in anthracnose disease---------

III. Match the following

1. Blossm malformation ---------- Glomerella

2. Whitish powdery growth------ xanthomonas

On aerial parts

3. Bacterial spot---------- powdery mildew

4. Black velvety covering on leaf surface------- *Fusarium moniliformae*

5. Colletotrichum---------- Sooty mould

IV. State true or false:-

1. Soft rot is post harvest disease.
2. *Diplodia natalensis* is causal organism for Black mould rot.
3. Powdery mildew is controlled by Bordeaux mixture 1%.
4. Sooty mould is viral disease.
5. Black tip is fungal disease.

REFERENCE BOOKS; Diseases of Horticultural Crops

Dr.G Arjunan

G.Karthikeyan

Dr.D.Dinakaran

Dr.T.Raghuchander

BANANA

Scientific name- *Musa paradisiaca*

Family- Musaceae

Origin- South East Asia

Introduction:

They are herbaceous perennial with underground, horizontal rhizome from which roots develop. It contains pseudostem. Each leaf is about 2-2.5mt long. It is monocorpic; flowers are male, female, hermaphrodite. The fruits fingers become negatively geotropic as they grow as a result they turn upward during the first week or 10 days and propagated by suckers.

It is both sweet desert cultivar and the starchy cooking plantains and are important food items throughout the tropics and leading tropical fruit in the world market with high degree of export potentiality.

Varieties: Dwarf Cavendish, Robusta, Nendran, Hill banana, co-1, Virupakshi, Poovan, Kadali, Nanjangud Rasabale etc.

Importance:

Rich source of energy, multiple uses of fruit and hence also called as *Kalpatharu*. The fruits are used both for cooking and table purposes, the leaves as dishes, male flower bud and stalk as vegetables, pseudostem and rhizome as cattle feed also used to prepare baby food, paper board and tissue

paper etc. Some products like chips, powder, soft drink, jam, beer, and confectioner could be prepared from pseudostem. Such an important crop is afflicted by several fungal, bacterial, viral and nematode diseases.

Diseases

1. PANAMA DISEASE- *Fusarium oxysporum* f.sp. *cubense*

2. MOKO WILT / DISEASE (Bacterial wilt)-*Ralstonia solanacearum*

3. SIGATOKA LEAF SPOT-*Cercospora musae*

4. ANTHRACNOSE-*Colletotrichum musae*

5. BUNCHY TOP-*Banana bunchy top virus*

6. STEM END ROT-*Ceratocystis paradoxa*

7. BURROWING NEMATODE- *Radopholus similis*

8. BLACK SPOT- *Phyllosticta musarum*

9. INFECTIOUS CHLOROSIS- *Cucumber mosaic virus*

MINOR DISEASES

1. CROWN ROT – Several fungi

2. BLACK SPOT/BLACK TIP/SPECKLE/PIN SPOT/ - *Deightoniella torulosa*

3. FINGER ROT – *Botryodiplodiplodia theobromae*

4. PITTING DISEASE OR JOHNSON SPOT – *Pyricularia grisea*

5. DIAMOND SPOT – *Cercospora hayi* and *Fusarium* spp.

6. CIGAR END ROT – *Trachysphaera fructigena* and *Verticillium theobromae*

7. SQUIRTER DISEASE – *Nigrospora sphaerica*

1. PANAMA DISEASE

C.O-*Fusarium oxysporum* f.sp. *cubens* (E.F SMITH)

Panama wilt is one of the most devasting diseases of banana crop in the world being reported for the first time from Australia in 1874. In many countries banana trade was affected because of the wide spread occurrence of this disease, Rasthali, groups are susceptible. It is vascular pathogen

Symptoms

- Fungus blocks the vascular system and causes wilting.
- Older leaves yellowing is the Initial symptom
- The infected plant shows yellowing of leaf blades developing as a band along the margin and spreading towards midrib
- The leaf wilts and the petiole buckles
- The leaf hangs between the pseudostems while the middle of lamina is still green.

- After four to six weeks, only the pseudostem remains, with dead leaves hanging round it. The cut stem smells like rotten fish
- Pseudostem splitting is common in Fusarium affected plants
- The plants from suckers growing out of diseased corms also wilt and the whole plants die.

Etiology

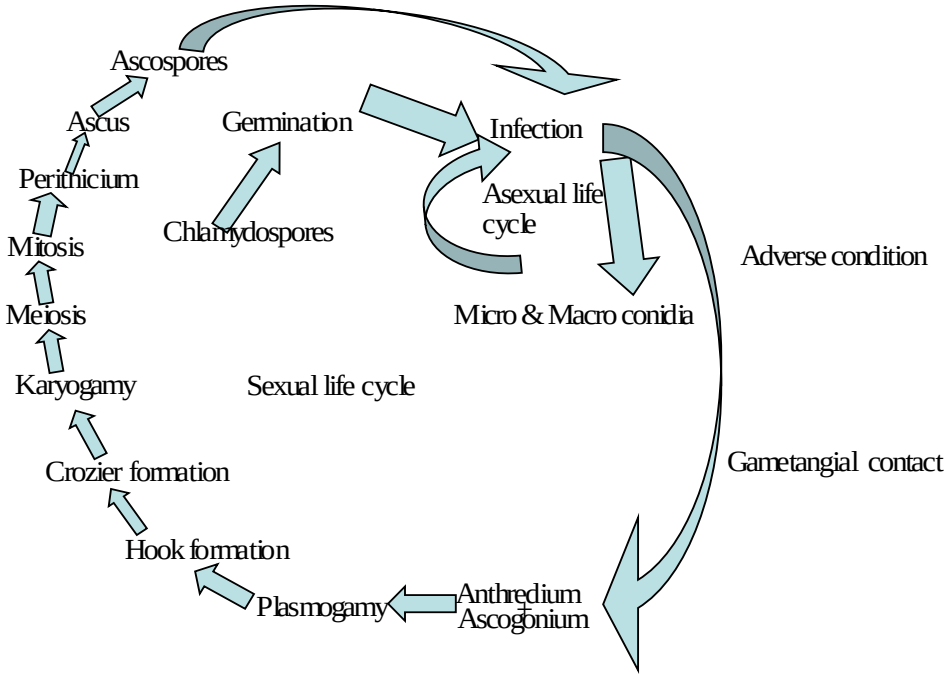
- Mycelium-septate, sporodochium is asexual fruiting body.
- Asexual spores are micro and macro conidia borne on sporodochium.
- Sexual fruiting body is perithecium and it produces ascospores in the ascus.
- Vegetative, resting structures are chlamydospores

Mode of spread and survival

- Primary source of inoculum: The pathogen is both soil and water borne and also spreads through infected suckers (rhizomes) and survives in soil as chlamydospores for long period.
- Primary spread through infected rhizomes.
- Secondary source of inoculum: Soil and water borne micro and macro conidia.

Epidemiology:

- Soil temp-28 -32^{0}c, Relative humidity-85-90%
- Acidic soil P^{H} (5.5 to 6.0)
- Red loamy and sandy loam soil and Susceptible host.



LIFE CYCLE OF PANAMA WILT

(***Fusarium oxysporum f.sp. cubensis***

Management

- Use healthy planting material. Collect the planting material from disease free area.
- Paring and pralinage, rhizomes are treated with dung solution and Smear with Carbendazim powder.
- Use resistant verities like Robusta, grand naine.
- Based on Soil P^H apply lime@.100-150gm per plant. Select nematode free soil, follow drip irrigation.
- Chemicals-carbendazim@1.0gm per lit,(as soil drenching) or capsule (carbendazim) insertion to the base of the rhizome or injection of carbendazim @ 10g/lit. to the rhizome.

- Bio control-*Pseudomonas fluorescens* 60mg per capsule. Each capsule applies to the corm. OR Trichoderma viride application to the soil along with FYM.

2. MOKO DISEASE (WILT)

C.O –*Ralstonia solanacearum* (Yubucchi *et al*.)

It was first recorded in Guyana in 1840. In India, the disease was first reported from West Bengal. Susceptible varieties are Robusta, Poovan from Tamilnadu.

Symptoms:

- Younger leaves yellowing are the primary symptom.
- Gradually yellowing progresses downward leading to drooping and drying of leaves
- Fruit bunch size gets reduced with immature and irregular ripening of fruits. Affected fruits shows cracking with bacterial ooze
- Vascular browning of the fruit could be seen and light coloured vascular discolouration is common.

Etiology: Gram negative, lopotrichus bacteria. (More than one polar flagellum), multiplication by bacterial fission.

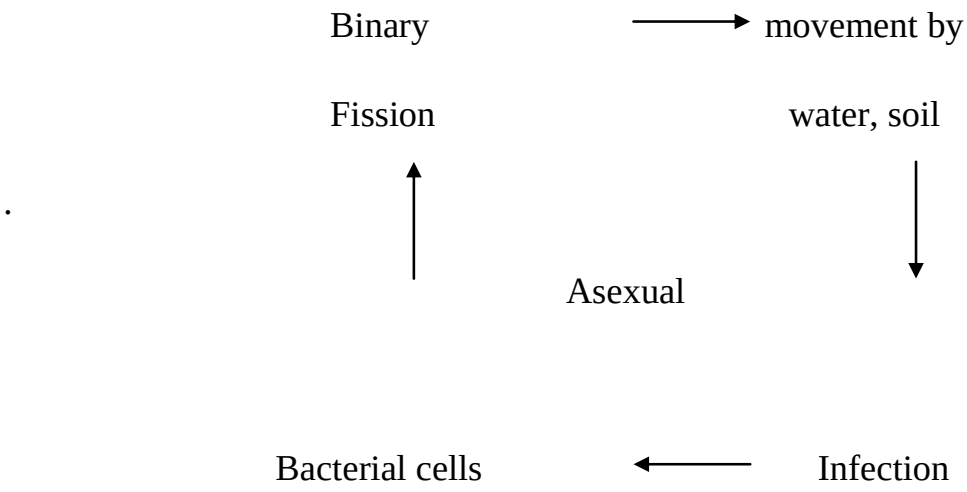
Mode of Survival and spread:

- Primary source of inoculum: The bacterium is soil/water borne and also spreads through infected suckers/rhizomes. It survives in susceptible host like banana and heliconia.
- Secondary source of inoculum: Bacterial cells spreads through irrigation water and also through suckers uses for planting.

Epidemiology: Soil temp 28-32^{0}c, Relative humidity 87-92%, P^{H} slightly acidic to neutral, clay loam and sandy loam soil and Susceptible Variety.

Life Cycle:

- The bacteria survive through infected rhizomes and also in soil for 6 months to 2 year.
- The spread is through use of infected rhizome, cutting machetes at the time of planting, and through insects which carry the bacteria from oozing suckers and male flowers and bracts to healthy inflorescence and other parts of the plant.
- Entry into the host is mainly through wounds such as those caused during various cultural operations and during attack of insects and nematodes.
- The bacteria multiply rapidly in the xylem. Auxin balance of the plant is disturbed.
- IAA is synthesized by the bacterium and by the host and accumulates due to inhibition of the auxin degrading system.
- Loss of virulence in the bacterium is generally accompanied



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Management:

- Use disease free planting material
- Use resistant verities like Robusta and Grand naine.
- Affected plants should be collected and burnt.
- Give proper drainage and avoid movement of water from affected to healthy plants
- Drip irrigation method reduces the spread of bacteria.
- Chemicals: apply Copper Oxychloride @ 3gm per lit and Sreptocycline @ 0.5 gm per lit as a soil drench
- Use bio agent like *Pseudomonas fluorescens*.

3. SIGATOKA DISEASE

First observed in Java, it has also been reported to cause severe losses in banana crop in countries like Columbia, Mexico, Jamaica, Panama, and

India. In India Andra Pradesh, Assam, Bihar, Karnataka, Kerala, Maharashtra.etc

C.O-*Cercospora musae* (Zimm.)

Symptoms:

- Light yellow or brownish green narrow streaks which enlarge in size developing into linear, oblong muddy brown to black spots.
- In central portion necrotic circular spots on older leaves, this spot leads blight and splitting of leaf lamina. Then complete leaf drying followed by defoliation.

Etiology:

- Conidia are elongated, narrow and multi septate borne on conidiophore
- Perithecia is dark brown to black. Asci are oblong. Ascospores is septate. Hyaline, obtuse ellipsoid with upper cell slightly broader.
- Ascospores are sexual spores.

Mode of survival and mode of spread:

- Primary source of inoculum: dormant mycelia present in affected debris.
- Secondary source of inoculum: Air borne conidia

Epidemiology:

- Warm temp 23 - 25^0c, rainy or humid weather

- Poor or badly drained soils and in shady areas
- Closer spacing, heavy Weed or grass cover and neglected crops

Life Cycle:

- The pathogen can survive on dry infected leaves on the field soil.
- It is spread through conidia and ascospores as air borne.
- Conidia are formed in humid weather throughout the year but their release and germination depends on water or high humidity.
- They are dispersed by rain drop splashes and by wind. Ascospores are shot out violently through the ostiole in response to wetting of perithecia and are dispersed by air currents. They are responsible for long distance spread of the pathogen while conidia are generally the most important means of local spread.
- The infection by both types of spores produces the same type of spots and subsequent development of the disease.
- Sigatoka spreads fast in a humid weather or periods pf high rainfall at 23^0 -25^0 c. little infection occurs at temperatures 21^0c- even if humidity is optimum.
- In dry weather with high day temperature and little dew during night the disease fails to spread. Soils with poor drainage and low fertility favor the disease.
- Conditions which are conducive for increased humidity in the plantation are favourable for the disease. Thus thick planting, presence of weeds and increased number of suckers promote disease development.

Management:

- Removal and destruction of affected leaves followed by spraying with Bordeaux mixture 1% +linseed oil 2% is recommended
- Spray with oil based copper fungicides is also found effective. Carbendazim @ 0.1 % or Mancozeb @ 0.25 % spray with spreading agents like teepol is also recommended
- Propiconazole @ 0.1% spray with spreading agent effectively manage the disease

4. ANTHRACNOSE/ FRUIT ROT:

It is serious disease in banana growing areas especially in Bihar, Karnataka, Tamil Nadu. Almost all varieties are susceptible, but severity may vary, owing to severe infection on table varieties. The disease is also called by different names viz., stem end rot, neck rot, back end, finger stalk rot etc.

C.O –*Colletotrichum musae* (BERK AND CURT)

Symptoms:

- It can be seen in the distal end of banana. The skin turns black. Shrivels and covered with characteristic pink colored asexual fruiting body acervulus.
- As the disease advances, it spreads to entire finger, entire bunch and resulting in premature fruit ripening.

- The shrivelled fruits covered with pink spore masses, which finally rot. Ripe fruits are more susceptible than unripe fruits
- Latent Infection: usually originated in the field on uninjured fruits. When fruits approaches maturity, the fungus resumes activity and cause typical lesions on ripe fruits.
- Non-latent Infection: usually begins during or after harvest as small peel wounds and continue to develop without dormancy.

Etiology:

- Asexual fruiting body is Acervulus. Conidiophores are cylindrical, septate, branched and sub hyaline towards the base.
- Conidia are hyaline, aseptate, oval to elliptical, flattened at the base.

Mode of spread and survival:

- Primary source of inoculum: The fungus survives as dormant mycelia for long time in the fallen leaves.
- Secondary source of inoculum: Air and splash borne conidia produced from the acervuli.

Epidemiology:

- The disease is favored by high temp and humidity. 30 -35 ^{0} C temp and 85 -100% relative humidity and also by fruit damage. Black end is the name given to the decaying of stem end on single fingers whereas, Finger stalk rot are also known as Santa Marta stem end rot or Neck rot and is common in complete bunches.

- Disease is more abundant during rainy season. Ripe fruits in storage are more susceptible than the unripe fruits in the fields. Cavendish is more susceptible variety.

Management:

- In the field, distal bud should be removed when all the hands have opened to prevent infection.
- Infected materials must be burnt.
- Fruit should be free from infection and as sound as possible before it is transported, stored and ripened.
- Banana bunches should harvested at correct stage of maturity. After harvested of the bunches, they should be transported to the storehouse without causing any bruises to them. The transported bunches should be carefully and cooling should be done.
- Fruit stored at 7-10^0 c.
- Pre harvest spray with Carbendazim@ 0.1% four times at fortnightly interval is highly effective.

5. BUNCHY TOP DISEASE:

Also called as cabbage top disease, first recorded in Fiji in 1889. Cavendish banana and local plantations. Around 1940, bunchy top disease was observed in Indian states Assam, Bombay, Kerala, and Tamilnadu.

C.O:- *Banana bunchy top virus*

Symptoms:

- The affected leaves shows green streaks on the secondary veins on the under side of lamina and on the midrib and petiole
- The powdery bloom covers the midrib and petiole, if this is rubbed off the dark green line with a ragged edge
- Leaves become dwarf, they also show marginal chlorosis and curling. The leaves are brittle in texture petioles are incompletely elongated
- The leaves become smaller and eventually the crown of the plant become composed stunted growth, the rosette or bunchy leaves
- Fruit bunches are reduced, the lower hands of the bunch often die off

Etiology:

- Virus is semi persistent in nature, aphids are act as vector (*Pentalonia nigronervosa* f.sp. *cocquerelli*)
- Virus particles are isometric and are 18-20 nm in diameter. Acquisition feeding period 2- 4 hours , incubation period 6-8 hours, inoculation period 2-4 hours

Mode of spread and survival:

Primary source of inoculum: Affected plants and affected suckers.

Secondary source of inoculum: Vector borne virus particle, spread more in summer through aphids.

Epidemiology:

The disease is spreading very quickly in hill zone, because the hill banana is cultivated as a perennial crop and the aphid population in the hill areas is more due to conducive atmosphere in these areas.

Management:

- Selection of healthy planting materials
- Regular field visits and removal of affected plants and suckers at periodical intervals
- Select disease free area for new plantations
- Avoid excess application of nitrogen, apply recommended dose of potassium, FYM.
- Proper drip irrigation in summer season is good
- Chemicals: For aphids control, application of monocrotophos @ 1.2 ml/lt, it is inject by banana injector. And suckers planted in field, pits should be applied with 40 gm of carbofuran granules
- Application of dimethoate (rogor) @2ml/ lt.
- Capsule application of 2, 4 D.
- FERNOXONE (5 ml is injected into the pseudo stem.)

6. STEM END ROT:

C.O: *Ceratocystis paradoxa* (DADE)

Symptoms:

- Brown or water soaked patches on the rhizome.

- The stalks decay rapidly and their tissues become soft and blackened have a characteristic sweet smell.
- The fungus spreads to the fruit where it causes uneven black discoloration of the skin. The pulp is reduced to a dark brown soft wet mass and premature ripening of fruits.

Etiology:

- Mycelium is hyaline or light brown, micro conidia are small, cylindrical.
- The conidiophores are slender, septate, the macro conidia are produced on short lateral conidiophores.Perithecia are light brown. Ascosoores are ellipsoid.

Mode of spread and survival:

The fungus is both air borne and soil borne and plants are more prone to infection on land where infected banana.

Epidemiology:

The black head disease is most commonly found on plants showing abnormally slow growth, particularly during dry weather.

Management:

It depends upon eradication of infected plants, planting healthy corms and protecting wounded surfaces.

7. BURROWING NEMATODE:

C.O:- *Radopholus similis*

SYMPTOMS:

Gradual yellowing of leaves, root discoloration, later it forms tunnels on suckers then root decay, finally complete plant collapse.

Etiology: Migratory endoparasite and obligate in nature.

Mode of spread and survival:

- Primary source of inoculum: Affected soil and suckers.
- Secondary source of inoculum: soil borne, water borne nematodes (2 stages).

Epidemiology:

High soil moisture and neutral ph and sandy loam soils.Suceptible host.

Life cycle:

- The burrowing nematode has a migratory endoparasitic habit.
- Although the stages remain vermiform, sexual dimorphism is apparent with adult males being somewhat degenerate and probably no parasitic.

- Eggs are normally laid infested tissue over 7-8 days at the rate of about 4 eggs/day.
- The life cycle from egg to egg extends over 20-25 days at 240 -250 with eggs taking 8-10 days to hatch and the larvae 10-13 days to mature.
- All larval stages and female except male are infective. They invade at any portion of the root, causing more root damage and are capable of spending their entire life in the root.

Management:

- Use disease free suckers collected from disease free area for plantation.
- Initially affected plants should be pulled out and burnt.
- Use disease resistant cultivars.
- Avoid excess nitrogen application
- Give proper dose of potassium.
- 5-10 kg of FYM apply root zone per plant.
- Carbofuran @ 10 -15 gm/plant with FYM, also application of neem cake @ 5kg/plant
- Paring pralinage should be followed (Shaving the discoloured parts on rhizome, treating such rhizome with mud mixed with Carbofuran granules).

8. BLACK SPOT

C.O: *Phyllosticta musarum*

Symptoms

- Minute black spots on leaves and fruits
- The spots are brown to dark brown initially
- Spots are abundant on the upper surface and are raised
- Leaf become yellow in colour in advance stage
- On the fruits the pathogen is confined to the skin.

Spread

- PSI- The fungus produces pycnidium pycnidiospores
- SSI- Spores are disseminated by wind

Management

Spraying copper oxychloride 0.25% or Bordeaux mixture 1%

9. INFECTIOUS CHLOROSIS

C.O**:** *Cucumber mosaic virus*

Symptoms

Chloratic or yellow green lands on leaves, upward curling of leaves, mottling of young leaves.

Sometime heart rot symptom

Diseased plants do not reach maturity.

Spread

- Through infected sucker and *Aphis gossypii* (an aphid)

Management:

- Destroy infected plants.
- Use disease free suckers.
- Arrest vector by systemic insecticide.
- Dry heat treatment of sucker at 40°C for 1 day.

MINOR DISEASES:

1. CROWN ROT: *Botryodiplodia theobromae, Colletotrichum musae, Botryodiplodia theobromae, Fusarium roseum, Verticillium theobromae and Acromonium sp.*

Symptoms:

- The disease is implicated in the more severe forms of main stalk rot in which splitting of stem occurs.
- The disease is problem only when shipment is done in boxes and not in bunches. Most of the deheaded bunches are susceptible as they are cut from main stalk and dipped in water for removal of latex. Softening and blackening of the crown tissue during ripening of fruits are the first symptoms.
- The fungus also extends through the cushions and causes finger stalk rot and finger dropping.

- It is some times associated with fruit spots and blemishes and in most varieties causes extensive finger tip rot.
- The infection originates in or immediately below the decayed perianth or styles and spreads uniformly along the fruit and cause a progressive brownish black discoloration and softening of the pulp.
- The skin becomes soft, black, wrinkled and encrusted with pycnidia. Infection may lead premature ripening of the fruits.

Etiology:

- Asexual fruiting body is Pycnidia and up to 5mm in diameter.
- Conidia are asexual spores, thin walled at first and become thick walled, septate mycelia is present.

Mode of spread and survival:

- Primary source of inoculum: Dormant mycelia
- Secondary source of inoculum: Soil and airborne conidia.

Epidemiology: Temperature at 25^0 - 30^0 C, high relative humidity and wounds are the predisposing factors.

Management: avoid creation of wound, Use resistant varieties, storage of fruit at 10^0 C, dipping of fruits in 100 -400 ppm benomyl.

2. CIGAR END ROT: *Verticillium theobromae* (TURC) and *Trachysphaera fructigena*

In India it is reported in Andra Pradesh and madya Pradesh. It is directly related with rainfall, and other countries like India, Egypt, and Australia.

Symptoms:

- It attacks even in the immature fruits. In some bunches only some fruits are affected and in others each and every finger shows the disease symptoms.
- The initial infection in the perianth slowly spreads along with the finger and it causes blackening of the skin and shrinkage and folding of tissues.
- The corrugated diseased portion becomes covered with powdery conidiophores and conidia of the fungus and resembles the ash on a cigar end and hence the name cigar end disease.

Etiology:

- Conidiophores are usually solitary or in small groups. Conidia are hyaline, oblong to cylindrical.
- They are borne at the ends of tapering phialides, aggregated into round heads. Conidia are asexual spores.
- Primary source of inoculum: Dormant mycelia
- Secondary source of inoculum: soil and air borne conidia

Epidemiology:

High rainfall, high humidity (90-92%), low temp, (18-22^{0}c) and susceptible host.

Management:

- The disease can be carried by other alternate host so eradication of alternate host is important
- Removal of pistil and perianth by hand immediately after the fruits are formed is considered as an effective control method the plantation should have enough aeration by avoiding overcrowding of plants
- Placing polythene sleeves over the stems before hands emerge
- The bunches may be sprayed with copper oxychloride @ 0.25% solution along with a wetting agent @ 0.5ml/ lt of spray fluid

3. BLACK SPOT/BLACK TIP/SPECKLE/PIN SPOT/ - *Deightoniella torulosa*

Symptoms:

- The fungus causes complex symptoms. It causes black spot on leaves, black tip or black end and hand speckle on fruit and also causes rotting of leaves and pseudostem.
- Fruit speckling or spotting are the most common symptoms and reddish to black in colour with a dark green halo around each spot
- Finger tip or black tip are associated with injury to the tip . Black discolouration appears just below the flower ie., fruit tip.

4. FINGER ROT – *Botryodiplodiplodia theobromae*

The fungus invades the fruits through wound and the pulp turn rapidly into a black, watery mass. It spreads more rapidly as the fruit ripened and may affect the whole finger. Greyish black mycelia on the surface is the characteristic symptom of the disease.

5. PITTING DISEASE OR JOHNSON SPOT – *Pyricularia grisea*

It begins as small reddish spot on the skin of the green fruit which are nearing maturity. These develops into typical black pits of 4 to 6 mm diam. Spotting on bunch stalk.

6. DIAMOND SPOT – *Cercospora hayi* and *Fusarium* spp.

Raised yellow spots of 3-5 mm on the peel is the first symptoms. The infected cells are unable to expand as the fruit grows and as a result, a longitudinal crack develops, surrounded by a yellow halo and are necrotic. These spots then shows characteristic diamond spot. Pulp may be exposed in some cases.

7. SQUIRTER DISEASE – *Nigrospora sphaerica*

This pathogen penetrates through broken stem ends and converts the pulp inside into a dark watery fluid. When a badly affected banana is squeezed, the contents are ejected and hence the name, which is common on singles.

A) Multiple choice:

1. The distinctive diagnosis of Panama wilt of Banana is……..
   a) Lengthwise splitting of pseudostem b) Horizontal splitting of pseudostem
   c) Initial younger leaf yellowing d) All

2. Anthracnose of Banana is…….
   a) Field disease b) Post harvest disease c)Soil borne disease d) Both a and b

3. …… is/are the complete loss causing disease/s of Banana.
   a) Panama wilt b)Anthracnose c) Moko wilt d) Both a and cooling

4. Fusarium in Banana always enters through……
   a) Stomata b) Wounds on leaves c) Wounds on roots d) All

5. Bacterial leaf blight is characterized by…….
   a) Black streak along veins b) Distortion of blade c) Withering of leaves d) All

B) Fill in the blanks:

1) Virus vector relationship in Banana Mosaic disease is……..

2*) Radopholus similis* also spreads …… disease in banana

3) The vascular discoloration found due to Moko wilt in Banana is of ……..

4) Bunchy top of Banana is transmitted by ……..

5) The primary source of inoculums for Panama wilt of Banana…….

C) Match the following

1) Cigar end rot	a) *Rhizophus stolonifer*
2) Anthracnose	b) *Fusarium monaliformae*
3) Crown rot	c) *Verticillium sps.*
4) Black heart	d) *Botrydiplodia sps*.
5) Rhizophus rot	e) *Colletotrichum musae*

D) State whether the following sentences are true or false

1. Heart rot of Banana is a viral disease.
2. Banana bunchy top disease will cause 100% loss.
3. The distinctive symptom of Moko wilt is splitting of pseudostem.
4. The bacterium in Moko is transmitted through pruning knives during pruning.
5. Burrowing Nematode of Banana will cause complete death of plant.

Key answers

A) 1. a 2. d 3.d 4. c 5. a

B) 1. Non presistant 2. Panama 3. Yellow to dark brown 4. *Pentagonia nigronervosa* 5. Chlamydospores

C) 1) Cigar end rot — a) *Verticillium sps.*
2) Anthracnose — b) *Colletotrichum musae*
3) Crown rot — c) *Botrydiplodia sps.*
4) Black heart — d) *Fusarium monaliformae*
5) Rhizophus rot — e) *Rhizophus stolonifer*

C) 1. True 2. False 3. False 4. True 5. False

REMARKS:

REFERANCE BOOK AND AUTHOR:-

- DISEASES OF HORTICULTURAL CROPS

BY:- Dr. G. ARJUNAN, Dr.G. KARTHIKEYAN,

Dr. D. DINAKARAN, Dr. T.RAGHUCHANDER

- GOOGLE. COM

PAPAYA: (*Carica papaya*) Family : Caricaceae

INTRODUCTION:

Papaya is an ideal fruit for growing in kitchen gardens, backyards as well as in orchards. Papaya is a quick growing tree, bearing at age of about 8-10 months of transplanting. Papaya is indeed, very remunerative if done on modern methods. Papaya is a tropical fruit crop that is normally consumed fresh and is valued as a health food because it's rich in vitamins C and A. Papaya is a whole some, refreshing and delicious fruit. It is a rich source of vitamins. It is rich in Calcium and other minerals. Unripe fruits are also used as vegetable. Papaya is used in pickles and preserves of various kind. The fruits are beneficial in curing of piles, dyspepsia of liver spleen and digestive disorders. Ripe fruits are used in the preparation of jam, jelly, nectar, soft drinks, ice cream, flavoring crystallized fruits and are canned as syrup.

It is now being grown under 39,000 ha with production of 9.05 lakh ha. Its productivity is highest among all fruit crops. However, papaya is severely damaged when infected by fungal and viral diseases.

Diseases of papaya:

(A) FUNGAL DISEASES:
(1) Powdery Mildew: *Odium indicum* Kamat, Odium caricae Noack, *Leveillula taurica* (Lev.) Arnauld
(2) Leaf- Blight: *Corynespora cassiicola* (Burk and Curt).
(3) Damping-Off : *Pythium aphanidermatum* Nirvan; *Rhizoctonia solani* Subramaniam.
(4) Foot Rot : *Pythium aphanidermatum* Nirvan.
(5) Anthracnose: *Colletotrichum gloeosporioides* Penz.

(B) VIRAL DISEASES
Papaya Mosaic
Leaf Curl of Papaya
Papaya Ring Spot Virus (PRSV)
(C) POST HARVEST DISEASES OF PAPAYA:
(A)FRUIT ROT OF PAPAYA:
(1). Macrophomina Rot: *Macrophomina phaseoli* (Maubl).
(2) Rhyzophus Rot or Soft Rot: *Rhizophus stolonifer* (Ehr.)
(3) Phomopsis Rot: *Phomopsis caricae* (Pterrak and Cif)
(4)Anthracnose: *Colletotrichum gloeosporioides*

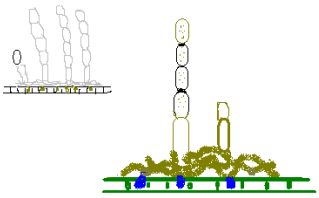
1.) Powdery Mildew (*Odium indicum*, Odium caricae, *Leveillula taurica*):

Symptoms

- 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 chloratic and distorted before falling. Affected fruits are small in size and malformed.
- In more severe cases dieback symptoms develop.

Causal Organism:

- *Odium indicum* belongs to the Phylum: Ascomycota, and Order: Erisiphales.
- The pathogen is an obligate parasite. The mycelium is septate, hyaline.
- Odium caricae is in conidial form. Mycelium is hyaline, ectophytic; creeping.
- Conidia are formed in chains of 2-4, hyaline and elliptical.
- The asexual spore is conidia; are borne on long chains and are barrel shaped.
- The sexual spores are the ascospores, globose, and are gregarious. Each ascocarp contains one ascus.



Epidemiology:

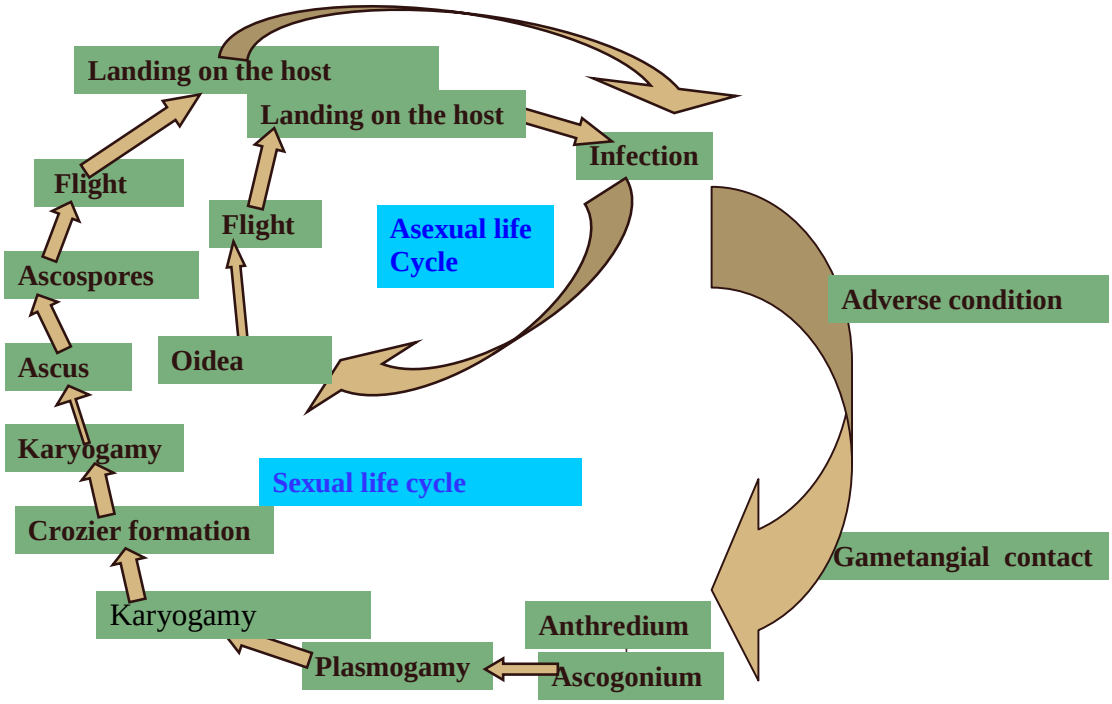
- The development of powdery mildew in papaya is promoted by high humidity (80-85%) and a temperature range of 24-26°C; sunshine duration for 9.1 hours.
- Susceptible varieties are more prunes to infection.

- **Mode of survival :**
  Primary source of inoculum Dormant mycelia
- Secondary source of inoculum: Air borne conidia.

- Spread: Air borne.

Disease cycle:

- Ascospores produced in the cleistothecium are the resting spores present in the debris.
- The primary infection may be initiated either from ascospores released from cleistothecia or conidia carried by wind from collateral hosts to papaya.
- The spores after falling on healthy leaves germinate, produce germ tubes and produce haustoria's inside the leaf tissues, develop a fungal vegetative body and produce conidia. The conidia are blown away by wind and cause secondary infections. The fungus is strictly an obligate parasite.



Management:

- The important criterion in reducing infection is the clean cultivation.
- Maintain sanitation in the field. Follow scientific method of cultivation practices.
- Increase the application of potassium and inversely reduce application of nitrogen in order to improve resistance in plants.
- As soon as the disease symptoms are observed, dusting Sulphur (30 g/10 liters of water) is found effective.
- The first spray of Triademefon (0.1%) during September and repeated at 15 days interval.
- Spraying Calixin 75 EC (5 ml/10 liters of water) at 15 days interval helps to control the disease.

Leaf- Blight (*Corynespora cassiicola*):

Symptoms:

- 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.

Management:

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

Damping-Off (*Rhizoctonia solani;* *Pythium aphanidermatum* Nirvan):

It also one of the serious disease caused by the fungi.

Symptoms

- This is a disease of young seedlings. On collar region discoloration takes place initially.
- Lesions are seen on the stem at or just above soil level.
- The stem becomes watery and shrinks, followed by death of the plant.

- Primary source of inoculum : Dormant mycelia as the mode of survival of the organism:

- Secondary source of inoculum: Sclerotial bodies.
- Spread: The disease spread by way of cultural operations in the soil, irrigation water and wind blooms.

Epidemiology:

- The young seedlings are more susceptible to the disease than elder ones.
- The disease is more severe in warm wet weather and becomes worst when seedlings are crowded.

Management:

- 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* (5 g/kg of seed) or Captan (3 g/kg of seed) to protect the newly emerging seedlings.

Damping off; Foot Rot (*Pythium aphanidermatum*):

Foot rot is also known as collars rot or stem rot or root rot and damping off ; is the most serious disease of papaya. In India, the disease appears during the rainy season and is prevalent throughout the country. It is more common in trees of age 2-3 years.

Symptoms

- In case of nursery plants damping off symptoms are produced whereas in adult plants foot rot, collar rot symptoms are produced.
- Foot rot 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. The affected internal tissues give a honey comb like appearance.
- Simultaneously, the terminal leaves of infected plants turn yellow, start drooping and fall off.

- 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.

Causal organism: *Pythium aphanidermatum*

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Kingdom--------Chromista
Phylum---------Oomycota
Class----------Oomycetes
Order----------Peronosporales
Family----------Pythiaceae

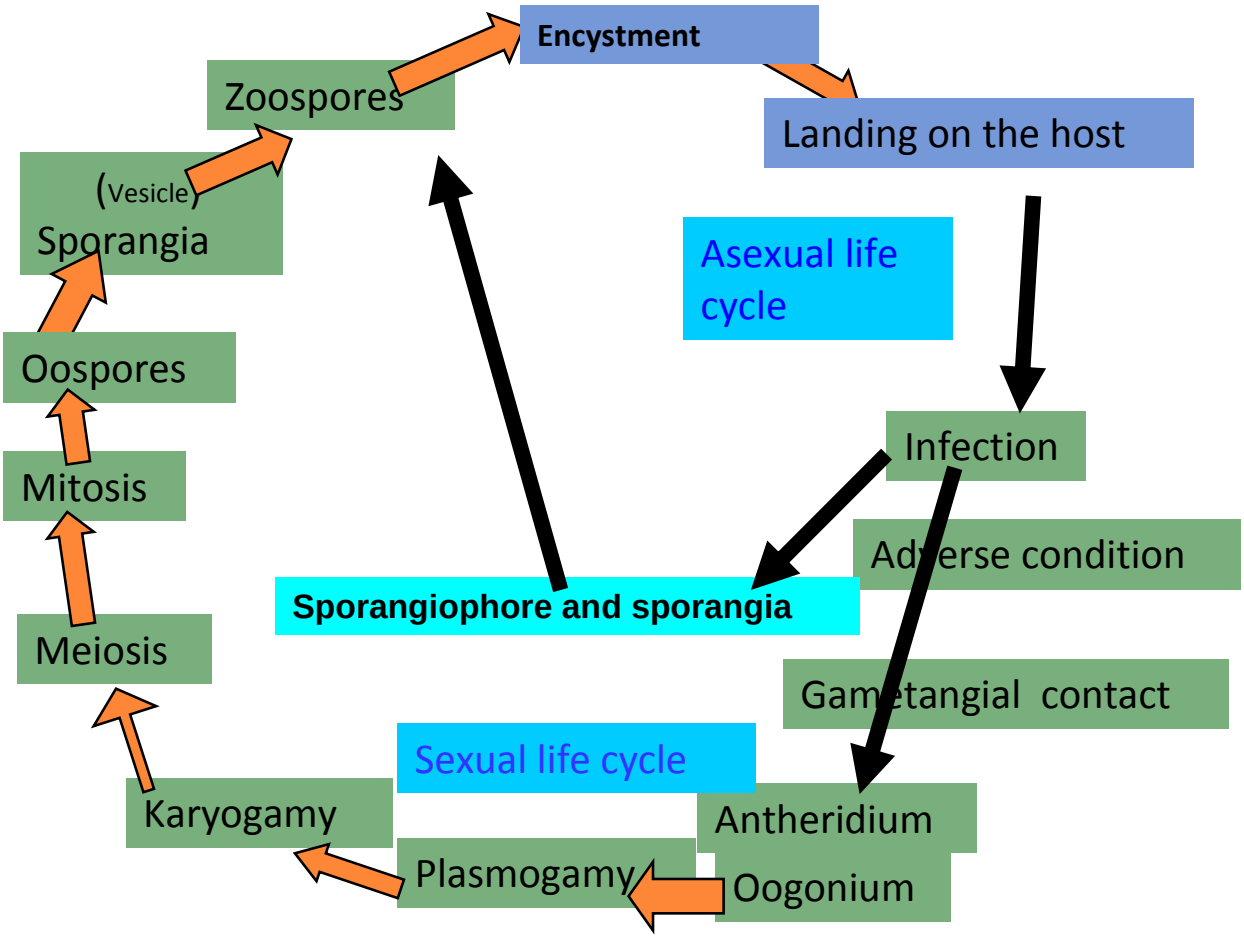
- Mycelium is well developed, wooly and coenocytic, hyphae 2.8-7.5 micron in diameter.
- Sporangia loculate, toruloid, and vesicle formed at the time of germination, zoospores 30-40 in number present within the vesicle and are born on spherical oogonia.
- They germinate by producing a germ tube.
- The sexual spores are the oospores, born singly and moderately thick walled.

Epidemiology:

- A number of factors like inoculums density, soil moisture, temperature, pH, light intensity have influence on pathogen development.
- One week old seedlings are more susceptible than one year old trees.
- But stem rot caused by *Pythium aphanidermatum* is common in plants of age 2-3 years. The disease usually appears during rainy season and severity increases with the intensity of rainfall.
- Optimum temperature of 36 36^0 c excessive moisture level, uncontrolled irrigation, heavy rainfall, and water logged condition are favorable for disease development. Abundance of moisture around the base is conducive for disease development and its spread.

Disease cycle:

The pathogen is soil inhabitant and is capable of growing and surviving on the residue left in the soil where it produces abundant oospores in the decaying organic matter.



Management:

- 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 oxy chloride (0.3%)/
- 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 (0.25%) may also be applied.
- In the case of disease attack in existing crops, the rotted portion of the plant should be scraped
- The base of the plant should be drenched with three litres of Copper oxychloride (0.3%).
- 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*):

Anthracnose causes considerable losses and is very common in all the papaya growing areas.

Symptoms:

- The disease prominently appears on green leaves and also 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.

Causal organism:

- *Colletotrichum gloeosporoides* is mainly responsible for anthracnose in papaya.
- It belong to the Kingdom-Fungi, Class-Filamentous, Ascomycetes; Order-Phyllachorales.
- The mycelium is branched, sparsely septate, hyaline hyphae. Setae are 1-4 septate and swollen at the base.
- Conidiophores are hyaline and unbranched. The conidia are sub hyaline and variable in shape.
- The sexual spores are the ascospores, born on perithecia.
- The perithecial stage develops on stromatoid cushions in which the perithecia are immersed.

Epidemiology:

- The pathogen is more severe at 25-30 o c and at relative humidity of 85-90%.
- The conidia of pathogen are disseminated by raindrops splashes and insects. The susceptible varieties are prune to infection.

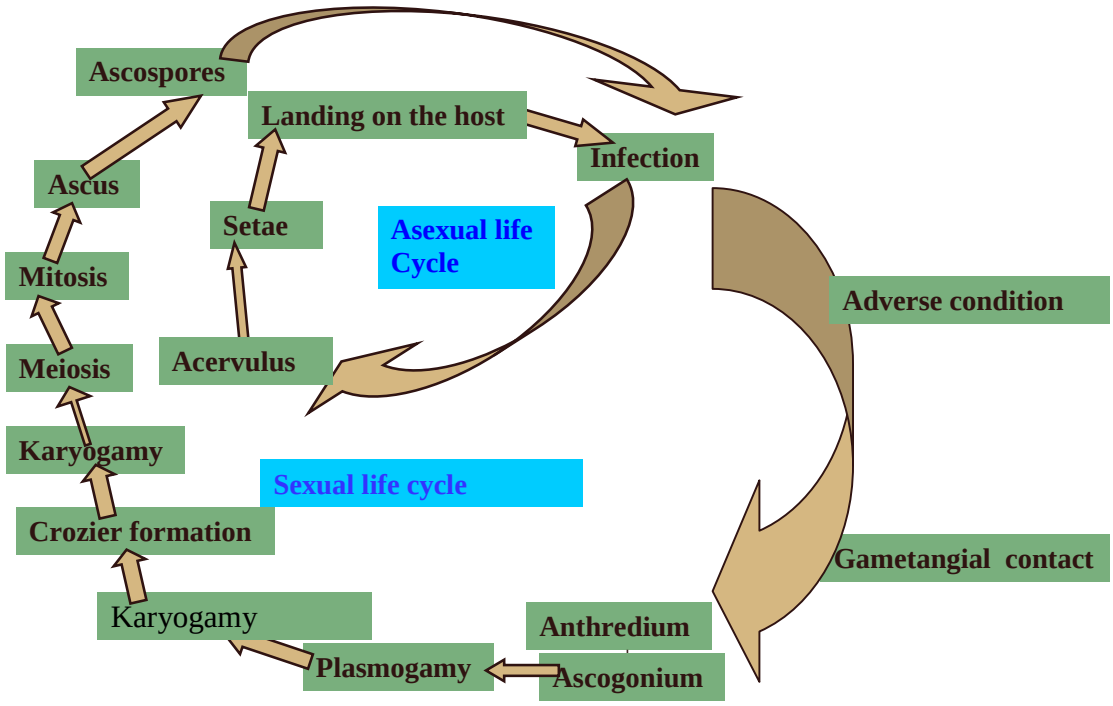
Disease cycle:

- The pathogen is able to survive saprophytically for a long duration on fallen leaves, petioles, and fruits.
- Infection on fruits can take place right from blossoming onwards till their maturity.
- The fungus enters through pores of fruits where it is still green and develops further in the flesh during ripening period.
- The pathogen produces ascospores in the senescing petioles which becomes airborne, lodge on fruit surface, germinate and produce appressoria.
- The pathogen can cause latent infection in mature fruits though lenticels.

- The fungus grows in fruits flesh hydrolyzing sucrose during the course of infection.

Mode of spread and survival:

- Primary source of inoculum: The fungus survives as dormant mycelia for long time in the fallen leaves.
- Secondary source of inoculum: Air and splash borne conidia produced from the acervuli.



Management:

- The affected fruits should be removed and destroyed.
- The fruits should be harvested as soon as they mature.
- Spaying with Copper Oxychloride (0.3%) or Carbendazim (0.1%) or Thiophanate Methyl (0.1%) 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:

Symptoms

- The disease attacks the papaya plants of all age groups, but is most serious on young plants. The aphid species 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.

It is a viral disease, transmitted by aphid; they are Aphis gossypii, A.malvae.

Management:

- Good field sanitation such as removal and destruction of affected plant reduce the spread of the disease.
- Also, losses can be minimized 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 effects yield and quality of fruits and serious losses are caused in terms of production and productivity.

Symptoms

- The disease is transmitted by the vector white fly (*Bemisia 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.

Causal virus:

- The disease is caused by Tobacco leaf curl virus, belonging to Gemini virus group.
- It is neither seed nor soil borne nor sap transmissible but is transmitted by grafting and white flies.
- The germinate particle contain ssDNA.

Epidemiology:

The virus causing leaf curl disease of papaya has wide host range like Zinnia elegance, tomato, tobacco, and datura. White fly is the major vector transmitting the disease.

Management:

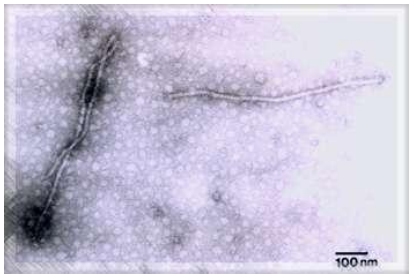
- Removal and destruction of the affected plants is the only control measure to reduce the spread of the disease.
- Checking the population of white flies also can reduce the infection severity.
- Soil application of Carbofuran (1 kg a.i./ha) at the time of sowing and 4-5 foliar sprays of Dimethoate (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

Symptoms:

- 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.
- Vigor 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.
- Other key symptoms are intense yellow mosaic on leaf lamina and numerous "oily" streaks on petioles.
- The leaf canopy becomes smaller as the disease progresses due to the development of smaller leaves and stunting of the plant.
- Fruit yield and brix levels are markedly lower than fruit from healthy plants. Leaf and fruit symptoms are most intense during the cool season.
- Leaves often develop a shoe-string appearance caused by the extreme reduction of leaf lamina similar to that caused by broad mites.
- Papaya trees of all ages are susceptible and generally will show symptoms two to three weeks after inoculation.
- Trees infected at a very young stage never produce fruit but rarely die because of the disease.
- There are, however, some severe strains, which cause wilting and sometimes death of young trees.

Biology: These viruses typically have long flexuous rod-shaped particles about 800-900 nm long and are transmitted by numerous species of aphids in a non persistent manner. Papaya ring spot virus is grouped into two types, PRV-p and PRV-w. The former type infects both papaya and cucurbits while the latter type infects cucurbits but not papaya. In fact, PRV-w causes major damage to cucurbits and was previously referred to as watermelon mosaic virus I. Both types cause local lesions on Chenopodium quinoa and C. amaranticolor.



Papaya ring spot virus

Spread

- The virus is spread from plant to plant by any species of aphids, in non-persistant manner.
- Many species of aphids are capable of transmitting the virus and it takes only a few seconds of feeding time for an aphid to acquire the virus onto its mouthparts.
- It is then able to spread the virus to other plants during brief feeding probes.
- Papaya ring spot virus is not spread by other insects and it does not survive in soil or dead plant material.
- The virus can also be spread by the movement of infected papaya plants and cucurbit seedlings. Once infected, plants cannot be cured by spraying with pesticides or removing plant parts showing symptoms.

Epidemiology

- Papaya ring spot virus can be rapidly spread by several aphid species in a non persistent manner.

- Though many cucurbits are susceptible to PRV-p, they do not serve as an important alternate host. Instead, the dominant strain in cucurbits is PRV-w.
- Therefore, the spread of the virus (PRV-p) into and within an orchard is primarily from papaya to papaya.
- There is no evidence that PRV can be transmitted through seeds from infected papaya or cucurbits.
- The development of the disease in an orchard follows the general pattern of viruses that are spread by aphids in a non persistent manner.
- The amount of primary infection increases as the distance from infected papaya trees decrease.
- Secondary infection spreads rapidly and an orchard can become totally infected in three to four months.
- This situation occurs in young orchards located close to infected plants and during periods when populations of winged aphid flights are high.

Management

Non-Chemical Control

Efforts to control papaya ring spot in papaya have included roguing, breeding for tolerance to PRV-p, cultural practices, and cross protection. None of these methods, individually, provide ideal control of the disease. In most cases, the best control is achieved by using a combination of these approaches.

- Quarantine measures: The most effective control is to prevent the introduction of PRSV-P into the major growing areas of papaya.
- Roguing infected plants. Our experience is that early detection of infected plants and prompt removal can contain an outbreak. However, rouging is unlikely to be effective once the disease becomes established in a plantation. .
- The most important is to establish orchards with seedlings that are not infected with PRV-p. Secondly, new orchards should be situated as far as feasible from infected orchards.
- Orchards should not be established by inter-planting seedlings among trees that are infected with PRV-p. Additionally, disease incidence can be reduced by

planting a non-host crop, such as corn, around the orchard and even between rows.

- The rationales for this is that aphids flying into the papaya orchard would first land and feed on the alternate crop and lose their ability to transmit the virus to papaya due to the non persistent mode of transmission
- 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 of10 days starting from 15-20 days after sowing.

POST HARVEST DISEASES OF PAPAYA:

Fruit Rot of Papaya:

(1). Macrophomina rot: Caused by *Macrophomina phaseoli*

SYMPTOMS: *Macrophomina* rot appears as small water soaked spots on fruit surface. Gradually, such spots become deeper and sunken causing rotting of inner tissues. Subsequently, small sclerotia develop on these spots. The inner tissues of such fruits develop brownish black color having dark mycelial growth.

Causal Organism: Caused by *Macrophomina phaseoli* .The conidiomata is pycnidial, pycnia is brown colored and thick walled. Conidia are septate. Sclerotia are black colored and hard.

epidimiology: It prefers warm weather and usually invades immature unthrifty damaged or senescent tissues. Maximum decay occurs at 300 c and 100% RH.

(2)Rhyzophus rot or soft rot: Caused by *Rhizophus stolonifer*

SYMPTOMS: Rhizophus fruit rot or watery fruit rot develops on injured fruits, which develops irregular water soaked lesions. These lesions are in due course, covered with whitish fungal growth which later on turns dark brown. The fruit becomes watery and emit foul smell. Infection spread quickly to the adjoining fruits.

Causal Organism: Caused by *Rhizophus stolonifer* .The sporangiophores are produced on arching stolons, usually born opposite tuft of rhizoids and and typically unbranched sporangiophores not in umbels

Epidimiology: Factors such as nature and type of wounds, rainfall, pre and post harvest treatments and shipment conditions influence the development of rot.

(3)**Phomopsis rot**: Caused by *Phomopsis caricae*

Symptoms: In this, initially water soaked spots appear which will become sunken and dark brown to black in advance stages. Some times such spots are surrounded by white raised tissues on the side. The whole area becomes soft and pulpy giving the typical appearance of soft rot.

Causal Organism: It is caused by *Phomopsis caricae*. The hyphae are hyaline initially which turn to sub hyaline later. The conidiophores are rod shaped tapering towards the apex. Conidia are mostly rod shaped. Pycnidia are flask shaped.

(4). Phytophthora rot: *Pytophthora palmivora*

Symptoms: *Phytophthora* rot appears as small water soaked lesions on fruit surface. Gradually, such lesions become deeper and sunken causing rotting of inner tissues. Subsequently, it produces white coating and covers all external surface of the ripened fruits. Whitish coat comprising of sprangio phore and sporangia.

Causal organism: *Pytophthora palmivora*. Mycelium is aseptate, asexual spores are zoospores borne in sporangia.

Epidemiology: It prefers cool weather and usually invades mature, damaged or senescent tissues. Maximum decay occurs at 18^0 c and relative humidity of 100%.

Management of post harvest diseases:

- Harvesting at proper maturity and cool hours is necessary to avoid post harvest disease
- Post harvest dipping of fruits for 5 min in TBZ (1000) ppm or benomyl (20) has been observed to reduce storage decay
- Dusting of fruits with benzoic acid (0.1%) coated in koaline also reduces the rotting.

- The disease free plantations should be selected for raising new plantations.
- The harvested fruits should be dried in sun for 2 hrs and the packing boxes should be sprayed with 3 % formaline.

1. Fill in the blanks:

a) Important nursery disease in papaya……..
b) casual organism for papaya anthracnose is ……
c) Papaya ring spot is ……disease.
d) Powdery mildew resistant variety of papaya is……
e) In heavy rainfall area ……..disease is sevear to papaya.

2. Match the fallowing:

a) *colletotrichum gleosporoides*	a) oideopsis
b) Virus	b) sclerotial bodies
c) *Rhizoctonia solani*	c) Oospores
d) *Leveillula taurica*	d) Vector
e) *Phythium aphanidermatum*	e) Acervulus

3. Choose the correct answer:

a)The disease we never seen in papaya ……..
a.Anthracnose b.Rust c.Downey mildew d.Both b & c
b)Congenial temperature for Phythium aphanidermatum infection in papaya…….
a.28-32^{0}c b.45-50^{o}c c.18-22^{o}c d.None.
c)It is the important post harvest disease in papaya…….
a.Anthracnose b.Powdery mildew c.Damping off d.None.
d)Causal organism for papaya black leaf spot ……
a.Cercospora spp, b.Alternaria spp, c.Asperisporium spp, d.None.
e)papaya ring spot disease is spread through……
a.Vectors b.Air c.Water d. Allof these.

4.Tick true or false:

a)Papaya ring spot is sevear in summer .
b)Acervulus is a asexual fruiting body of colletotrichum gleosporoides .
c)At green stage itself fruit shown symptoms of papaya anthracnose.
d)Seed treatment is effective remidy for collar rot disease of papaya.
e)Papaya ring spot is controlled by bavistin.

REFFERANCE: 1) DISEASES OF FRUIT CROPS.
BY V.K. GUPTA

2) DISEASES OF FRUIT CROPS
BY R.S SINGH

3) WWW.GOOGLE .COM

DISEASES OF PINEAPPLE –*Ananas comosus*

INTRODUCTION

Pineapple (*Ananas comosus* Linn.) Merrill is native to tropical America and it is cultivated in many parts of the world including India for its delicious fruit having pronounced flavour and also for fibre. The pineapple is a herbaceous perennial plant which grows to 1.0 to 1.5 meters (3.3 to 4.9 ft) tall with 30 or more trough-shaped and pointed leaves 30 to 100 centimeters (1.0 to 3.3 ft) long, surrounding a thick stem. The pineapple is an example of a multiple fruit: multiple, helically-arranged flowers along the axis each produce a fleshy fruit that becomes pressed against the fruits of adjacent flowers, forming what appears to be a single fleshy fruit.

The fruit of a pineapple are arranged in two interlocking helices, eight in one direction, thirteen in the other, each being a Fibonacci number.[4]

The leaves of the cultivar 'Smooth Cayenne' mostly lack spines except at the leaf tip, but the cultivars 'Spanish' and 'Queen' have large spines along the leaf margins

MAJOR DISEASES

1. Heart rot: *Phytopthora cinnamomi* and *Phytopthora parasitica.*

2. Base rot: *Ceratocystis paradoxa*

3. Wilt: pine apple wilt virus

4. Pink disease: -*Pantoea citrea*

MINOR DISEASES:

1. Fruit let core rot: *Penicillium spp.*

2. **Bacterial fruit rot**: *Pantoea ananas* pv. *ananas.*

MAJOR DISEASES

1. Heart rot

Causal organism*: Phytopthora cinnamomi* and

Phytopthora parasitica.

Symptoms

- In the field, heart rot of young plants is seen as a change in the colour of leaves from normal green to yellowish green and browning of leaf tips.
- The based of the leaves shown yellowish white rotten area bordered by a distinct and characteristic brown margin.
- The chlorophyll region commences.
- The affected area has a fetid odor due to secondary bacterial invasion.
- The rot extends into the stem of the plant producing a soft cheesed-like rotting condition.
- The roots of plants are largely destroyed with the result that the plants are stunted and fruit formation is delayed or dose not occurs at all.

Etiology:

- Aseptate mycelia, inter & intra cellular Haustoria.
- Sexual spores – Oospores (oogonium).
- asexual spores – Zoospores and sporangium

Primary source of inoculum – oospores & Chlamydospores present in debris.

Secondary source of inoculum – air & splash borne zoospores

Mode of spread:

- The fungus inhabit sand survive in the soil in the form of oospores.
- The spores spread through runoff water, rain splash.

Epidemiology:

- Heart rot under warmer and somewhat drier conditions is frequently associated with alkaline soils and poor drainage.
- It is serious in cool, wet soil.
- Temperatute:25^0c, heavy rain soon after planting leads to heavy disease incidence.
- Plants of one or two year old age are more susceptible.

Management:

- Deep planting should be avoided.
- Soil should not be allowed to enter the hearts during planting.
- Diseased plants should be removed and burnt
- Bordeaux mixture(1%) spray reduces the disease

2. Base rot

Causal organism: *Ceratocystis paradoxa*

Symptoms:

- It is typically black rot of the butt of the plant.
- The softer tissues are destroyed and only stringy fibers remine decay of the butt is followed by wilting of the foliage and the diseased plant break off at low level
- The leaves show grey spots with dark margin the spots turn olive brown or white. With advance of the diseases tissues dry and leaves become destroyed.
- Finally skin flesh and core disintegrated.
- The fruit decay is accompanied by a sweetish odor, during such times the fungus is found on rotting tops and sucker left lying in heaps in damp sutiation.

Mode of spread:

- It a parasite.
- The fungus survives in the form of black spores in the soil.
- Infection takes place during picking and packing by spores distributed by wind or rain or affect parts.

Epidemiology:

- The disease is prevalent in warmer months following wet weather.
- The disease development is favored by warm weather.
- Wet soil or storage condition, serious losses occur when the suckers have been kept in a damp place or when the planting has been followed by prolonged wet weather.

Management:

- The planting material should be cured for at last two are three days in the sun before planting or packing for transport
- Dipping of the plant captofoln13.5kg/ha.
- Dipping of fruits after harvest for three minutes in benomyl 0.2% or thiabendazole 0.1%.

3. WILT

Causal organism: pine apple wilt virus

Symptoms:

- Leaves develop characteristic bronzing starting from third or fourth whorl on words.
- The leaves show bright pink colour browning of the tips with downwards curling of the margin.
- The pink colour becomes more pronounced and leaves from the top dry downwards
- . Finally the tips dry up completely.
- The bright pink colour becomes dull and the root system collapses.

Mode of spread and survival:

- The disease is transmitted through mealybugs, Dysmicocus brevipes.

Management:

- Higher levels of nitrogen decreased the disease incidence.
- Wilt incidence has lesser in plots having a plant population.
- Diseased sucker can be recovered within 30-50 days by hot water or heat treatment at 50^{o}c for 3 hours.

4. PINK DISEASE: - ***Pantoea citrea***

History

- Pink disease was originally described in 1915 in Hawaii.
- The pathogen responsible for causing pink disease remained obscure and the nature of the pink color formation of the pineapple fruit tissue was not understood.
- A myriad of bacteria associated with the pineapple plant, many of which originated from the surrounding soil, made identifying the primary cause of the disease extremely difficult.
- The biochemical basis of the disease was thought to be complex and difficult to elucidate, and was therefore left uncharacterized.
- Attempts at identifying the pathogen led to implicating several distinct bacteria as the causal agents of pink disease. *Gluconobacter oxydans*, *Acetobacter aceti*, and *Erwinia herbicola* were the prominent suspected species.

SYMPTOMS

- Pink disease symptoms are difficult to observe in the field since outward symptoms are not apparent.
- Infections of the foliage are not usually found. Under severe invasion of the fruit by *P. citrea*, a translucent appearance of the sub-dermal fruit tissue occasionally can be observed.
- The most common appearance of symptoms occurs when infected fruit preparations are heated as a result of the canning process.
- Heating causes the formation of red to rusty brown coloration of the usually golden yellow tissue.

The Pathogen

- *Pantoea citrea* is a Gram-negative, facultative anaerobic, non-spore forming, bacilliform bacterium with physiological and biochemical as well as 16S rDNA features corresponding to those of the Enterobacteriaceae.
- On nutrient agar and trypticase soya agar, the colonies are entire, smooth, glistening, translucent, but not mucoid. The colonies become taupe in color. *Pantoea citrea* grows readily in pineapple juice as well as in fresh pineapple fruit tissue.
- Unlike other *Pantoea* species, *P. citrea* is unable to utilize citrate or tartrate. Besides the genetic makeup that causes the pink disease reaction in the pineapple fruit, the bacterium elicits the hypersensitive response in tobacco.
- Many strains harbor pUCD5000, a small plasmid containing genes that help promote the development of pink coloration.
- The pathogen is amenable to genetic manipulation and is compatible with many plasmid vectors used as molecular biological tools.
- The sequence of the entire genome is forthcoming and should shed a complete picture on the organization of operons and genes involved in causing the pink disease in pineapple.

Management:

- Although there are no experimental evidence attributing insects directly with the transmission of *P. citrea* to the fruit, the high correlation of higher pink disease incidence with lowered application of insecticides tend to suggest that this assumption is correct.
- Plant breeding for resistance to pink disease has shown some promise.
- Crosses between the wild-type resistant varieties with the horticulturally acceptable varieties such as Smooth Cayenne cultivars are currently being screened to develop successful resistance.
- Plant genetic engineering strategies are also being considered.
- Genes used to lower the substrate that leads to 2,5-diketogluconate formation and genes used to inhibit the growth of *P. citrea* in fruit tissue are some examples that can be incorporated in the transgenic pineapple.

- Biological control methods also have been assessed. Several bacterial species that are antagonistic to *P. citrea* have been tested in the laboratory and in the field.
- The most promising biocontrol isolates, such as *Bacillus gordonae*, further reduced disease incidence in combination with insecticides.
- From a practical view point, the requirement of relatively large fermentation facilities to produce and process large quantities of bacteria is a key limiting factor.
- Production, supply, maintenance, and trained labor are needed to continually produce the biocontrol agent.
- This end of the biocontrol program is not cost effective when compared with insecticides. Outside suppliers of the biocontrol agent would help alleviate some of the production cost.
- However, for one pineapple producing company alone, more than 60 square miles (15,540 hectares) of pineapple are propagated year round. Hence, the application of a biocontrol agent (e.g., at the rate of 1 kg of biocontrol inoculum [wet packed weight] per hectare requires 50 liters of culture medium) to such a vast area is perceived as economically unfeasible.

Multiple choice:

1. Heart rot causal organism is ……
   a)phytophthora cinnamomi b)ceratocystis paradoxa c)fusarium sp.

2 Serious disease of pineapple is

A)heart rot b.wilt c.basal rot

3. pineapple wilt virus is transmitted by

a. White fly b.aphid c.mealy bug

4.drying and wilting of leaves from tip down wards accompanied by radish yellow discolation is

a. Wilt b. heart rot c. root rot

5 minor diseases of pineapple is

a. Basal rot b.bacterial fruit rot c.root rot

A) Fill in the blanks:

1) primary source of inoculums for heart rot is …….

2*) water soaked spot appear then turn to darken color and finally internal tissue rot is……..rot*

3) secondary source of inoculums for heart rot is ……

4) …… is transmitted pineapple wilt virus

5) fruit let core rot is also called as ……..

B) Match the following

1) heart rot	a) *brown spot*
2) wilt virus	b) fungus
3) bacterial fruit rot	c) *bacterial disease*
4) basal rot	d) *mealy bug*
5) fruit let core rot	e) *phytophhtora cinnamomi*

C) State whether the following sentences are true or false

1. Heart rot of is a fungus disease
2. Water soaked spot appear turn to dark colour and finally inter tissue rot is a symptom of stem rot.
3. Primary source of inoculums for fruit rot is affected debris .
4. Pineapple wilt virus is transmitted whitefly.
5. Pineapple wilt virus is a fungus disease.

Key answers

A) 1. a 2.a 3.c 4. b 5. a

B) 1.oospores 2. Stem rot 3.zoopsoreas 4. Mealy bug 5.brown rot

C.1-e ,2-d,3-c ,4-b 5-a

D) 1. True 2. true 3. true 4. false 5. False

GUAVA (*Psidium guajava* L.)

Guava it is hardy, aggressive, and a perennial that has only recently become a cultivated crop. The guava (*Psidium guajava* L., Myrtaceae), is one of 150 species of Psidium most of which are fruit bearing trees native to tropical and subtropical America. Guavas are plants in the myrtle family (Myrtaceae) genus *Psidium*. This crop is incited by different diseases.

1. Wilt: *Fusarium oxysporum* f. sp. *psidii,*

2. Fruit canker : *Pestalotiopsis psidii*

3. Stem canker: *Physalospora psidii*

4. Anthracnose: *Gloeosporium psidii* (=*Collectotrichum psidii*)

5. Red rust: *Cephaleuros virescens*

Minor diseases

1. Leaf spot: *Cercospora psidii*

2. Phomopsis fruit rot: *Phomopsis psidii*

1. Fusarium wilt : *Fusarium oxysporum* f.sp. *psidii*

Occurrence of serious wilt was reported from Haryana, Punjab, Rajasthan, Uttar Pradesh and West Bengal.

Symptoms:

The disease is characterised by yellowing and browning of leaves, discolouration of the stem and death of the branches along one side. Sometimes the infection girdles the stem and the whole plant may wilt. Leaves die and the twig barks split.

Pathogen: *Fusarium oxysporum* f.sp. *psidii* Prasad, Mehta and Lall. *F.solani* (Mart.) Sacc., Mycelium is white or pink with a purple tinge. Microconidia are borne on simple phialides arising laterally on the hyphae. Microconidia are oval to ellipsoid, cylindrical, straight to curved and 7 to 10 x 2 to 3 pm. Macroconidia are 3 to 4 septate and 32 to 50 x 3 to 7 um in size. They are fusoid to subulate and pointed at both ends. Sporodochia and spinanodes are present. Chlamydospores may be intercalary or terminal.

Asexual spores : Micro & macro conidia

Vegetative spores : Chlamydospores (Resting spores)

Sexual spores : Ascospores borne in ascus

Primary source of inoculum: Soil borne inoculum in the form of chlamydospores and infected plant parts.

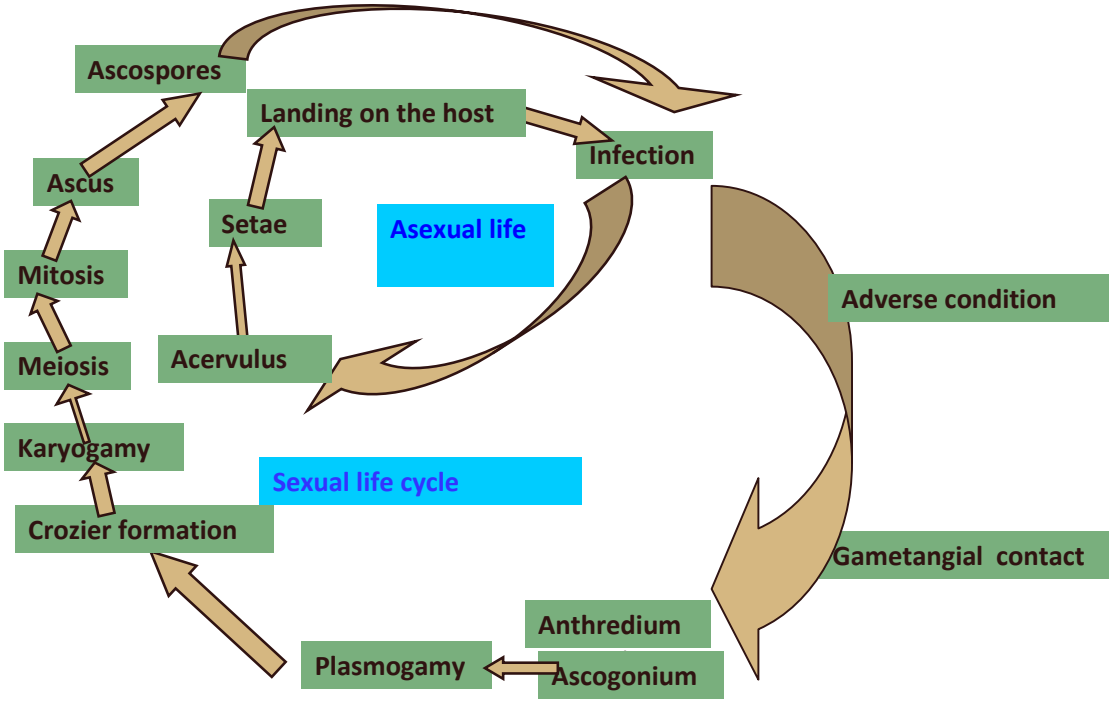
Secondary source of inoculum: inoculums produced on the infected host

Mode of spread and survival: The fungus first colonizes on the surface of the roots and enters the stem tissues at the basal portions near the ground level. It multiplies in vascular region and affects the cortical cells.

Epidemiology: Higher disease incidence is noticed during the monsoon period. The disease appears in August and increases sharply during September - October. It is severe in alkaline soils.

Management:

- Dry branches should be cut off and wilted plants uprooted.
- Soil should be treated with lime or gypsum to make the soil pH 6.0 to 6.5 balanced nutrition of host reduces seventy of the disease when organic nitrogen is supplied.
- The soil of the pits should be treated with 37 to 40 per cent formaldehyde (45ml of formaldehyde plus 270 ml of water plus 35kg of soil).
- This treatment has to be covered with a polythene sheet for at least 15 to 20 days. When the traces of formalin disappears, the pits are filled with this soil after planting the tree
- Soil drenching of Carbendazim 1.5g/lit considerably reduces the disease



2. Fruit canker/Scab/Grey blight: *Pestalotiopsis psidii*

Symptoms:

- Infection generally occurs on green fruits.
- Minute, brown or rust- coloured, unbroken, circular, scabby lesions of 2 to 4 mm dia appear on the fruit which later tear the epidermis open in a circinate manner.
- The margin of the affected area becomes raised.
- The scab disfigures the fruits and their market value is highly reduced.

- Primary source of inoculum: Dormant mycelia. *Helopeltis antonii*, a kajji bug which punctures the young fruit sucking juice and that damage exposes the fruit to infection by the pathogen.
- Secondary source of inoculum: Air borne conidia
- Mode of spread: spread is through the wind-borne conidia.

Epidemiology:

- The fungus is capable of growing at temperature between 20 and 25°C.
- Mycelial growth with intensive sporulation takes place at 5.5°C.
- Wounding results in quick attack by the fungus.

Management:

- Since the wound by insect predisposes the fruit to infection, spray the young fruits after pollination with a suitable systemic insecticide (Dimethoate – 2ml/l) will take care of the infection.
- Spread of the disease can be checked by three or four spraying with Bordeaux mixture1.0 percent or copper oxy chloride 0.2 per center.
- Summer irrigation +Nutritional management reduces the disease

3. Stem canker: *Physalospora psidii*

Symptoms:

- Affected twigs show wilting and death.
- Cracks and lesions are formed along the stem, ar- resting translocation of nutrients.
- Infected fruits turn dark brown to black and dries up resulting in die-back symptoms.
- Fruit rotting takes place, blighting of leaves to enlargement
- Fungus: *Physalospora psidii* Stev. & Pier. Perithecia is glabrous with a fleshy wall. Ascospores are hyaline, narrow, ellipsoid and one celled.
- Conidia are single celled, ovoid with a rough wall and measure 20 to 26 x 9 to 12 jam. On the stems and fruits pycnidia are formed in stroma.
- **Mode of spread and survival:** The pathogen remains in the infected tissues beneath the bark and become active under favorable conditions.

Management:

- In severe infection, the disease can be prevented by the removal and destruction of the infected stem.
- In mild infection, pruning of infected stem and branches is done and the cut-ends are painted with Bordeaux paste (1 part copper sulphate and 2 parts each of lime and linseed oil) or Chaubatia paste (copper carbonate - 800 g, red lead - 800 g and linseed oil - 1 litre).
- Spraying the trees with copper oxychloride 0.2 per cent after pruning reduces canker incidence.

4. Anthracnose/Die-back/Fruit spot/Twig blight: *Glomerella psidii (= Colletotrichum psidii*)

The disease is a serious problem in Karnataka, Punjab and Uttar Pradesh.

Symptoms:

- The disease attacks all plant parts except roots.
- Severity of the disease may show die-back of main branches resulting in death of plants.
- The most characteristic symptoms appear during the rainy season as small pin-head sized spots on the unripe fruits.
- They gradually enlarge to form sunken and circular, dark brown to black spots.
- The infected area of the unripe fruits become harder and corky.
- Acervuli are formed on fruit stalks.

Pathogen: *Gloeosporium psidii* Delacr. (Perfect stage: *Glomerella psidii* (Del.) Sheld.) Conidia are hyaline, aseptate, oval to elliptical or straight, cylindrical, obtuse apices or flattened at base. Conidiophore is cylindrical and tapers towards apex.

It is hyaline and septate with single terminal phialide. Acervuli are dark brown to black.

Mode of spread and survival:

- The pathogen remains dormant for about three months in the young infected fruits.
- It becomes active and incites rot when the fruit begins to ripe. In moist weather, acervuli appear as black dots scattered throughout the dead parts of the twigs.
- From the twigs, the fungus penetrates the petioles and attacks the young leaves, which become distorted with dead areas at margins or tips. The conidia are spread by wind or rain.

Epidemiology:

- The cool season (Jan - Mar) and the hot, dry weather (Apr-Jun) prevent the spread of infection.
- In moist weather, acervuli are produced in abundance on dead twigs and pinkish spore masses are seen. Conidia initiate fresh infection.
- The temperature for disease development on fruits ranges from 30 to35°C.

Management:

- Spraying the trees with Bordeaux mixture 1.0 per cent or copper oxychloride 0.2 per cent or Carbendazim 0.1% before the onset of monsoon reduces the disease incidence.
- Apple Guava (light red fleshed) is moderately resistant to anthracnose.

5. Red rust: *Cephaleuros virescens*

This disease is exceptionally severe in guava.

Symptoms:

- The alga produces specks to big patches on the leaves. They may be crowded or scattered.
- The pathogen extends between cuticle and epidermis and penetrates the epidermal cells.
- Fruit infection by alga is not common on fruits. Fruit lesions are usually smaller than leaf spots.
- They are dark green to brown or black in colour.
- Primary source of inoculum: Dormant mycelia
- Secondary source of inocu,um: Zoospores

Alga: *Cephaleuros virescens* Kunze

Mode of spread and survival:

- The disease is more common on closely planted mother plants. The zoospores cause the initial infection.
- High moist condition favours the development of fruiting bodies of the alga.

Management: This algal disease is controlled by spraying with Bordeaux mixture 1.0 per cent or copper oxychloride 0.3 per cent..

Minor diseases

1. Leaf spots: *Cercospora psidii*

- The disease appears as water-soaked, irregular patches which look brown on the lower surface of the leaves.
- Old leaves are mostly affected and the severely affected ones curl and subsequently drop off.
- Affected leaves show round or lightly irregular spots, brownish-red in colour.
- The central portion of the spot turns white. These spots coalesce to form large irregular, white patches surrounded by a brownish margin.
- These leaf spot diseases are checked by spraying with copper oxychloride 0.3 per cent.

2. Phomopsis fruit rot: *Phomopsis psidii* Camara.

- The symptoms appear on unripe fruits at the blossom-end.
- Infected fruits show small, conspicuous, white or light brown and circular spots. Some of the infected fruits are shed prematurely.
- As the fruits ripen, the spots extend and cover the fruit surface. The infected tissues become softer and emit an undesirable odour.
- Weekly sprays with Bordeaux mixture 1.0 per cent or copper oxychloride 0.3 per cent are required for the control of fruit rot.

- Six monthly sprays with Mancozeb 0.2 per cent during fruiting stage are helpful in controlling fruit rot.

3. Sooty mould: *capnodium psidii*

Symtoms:

- It is ectophytic fungus and not a parasite. Black superficial growth on entire surface of leaves and twigs. Under dry spell such affected leaves curl & shrivel.
- During flowering time the appearance of the disease results in reduced fruit set and fruit fall. Blackish powder like fungal conidial structures covered on the leaf surface.
- The fungus grows on the excreta and honey secretions of insects as black sooty mass of spores and will not invade plant tissue.
- Disease severity increases in increased population of leaf hoppers, aphids and other insects. Impact of this disease on host is photosynthesis activity and yield decreases.

- Primary source of inoculum: Dormant mycelia :
- Secondary source of inoculum: Air borne conidia: Spread : Insects, Aphids, wind
- Epidemiology: 28 -32^{0}C Temperature 85-90% RH, Warm Weather and susceptible host

Management

- Sprays of wettable sulphur 0.2% along with insecticide Dimethoate 1.5ml/lit
- Spray of 1% starch solution makes flakes of the fungus and due to small wind falls of from the plant.

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DISEASES OF HORTICULTURAL CROPS

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Dr. D. DINAKARAN, Dr. T.RAGHUCHANDER

CITRUS

Citrus fruits have a prominent place among popular and extensively grown tropical and sub- tropical fruits. After grapes and olives they are cultivated on larger area than any other fruits of these zones in the world.Their wholesome nature,multifold nutritional and medicinal values have made them so important .Citrus fruits possess greater adoptability to different climatic conditions, so are grown with equal success in tropical and subtropical regions.

DISEASES OF CITRUS:

1) CITRUS GUMMOSIS: *Phytophthora citrophthora*
2) CITRUS POWDERY MILDEW: *Oidium tingitaninum*
3) CITRUS SCAB*: Elsinoe fawcetti*
4) CITRUS SOOTY MOULD:*Capnodium citris*
5) CITRUS ANTHRACNOSE: *Colletotrichum gloeosporioides*
6) CITRUS CANKER: *Xanthomanas campestris* pv. *citri*
7) CITRUS TRISTEZA/ QUICK DECLINE- Virus disease
8) CITRUS EXOCARTIS- Viroid disease
9) CITRUS GREENING- Phytoplasma disease
10) CITRUS ROOT KNOT NEMATODE: *Meloidogyne incognita*

1. DISEASES CAUSED BY FUNGI:

a) CITRUS GUMMOSIS/ LEAF FALL/ FOOT ROT: *Phytophthora citrophthora*

Symptoms:

- This is soil borne fungi. Primary colonization is on roots as discolouration, root decay, bark regradation at collar region and leaf falling.
- The exudation of gum like substance from the bark of the trunk, the bark cracks open and in the later stages dries up and fall off.

Etiology:

Aseptate mycelia, zoospore are asexual spores produced in the sporangium, oospore are sexual spores or resting/dormant spores borne in oogonium

PSI: Dormant mycelia and oospore present in effected debris and infested soil.

SSI: Zoospore spread through soil, irrigation water.

Epidemiology:

Cool weather, temperature 18-22^{0}C: 90-95% RH, High soil moisture, PH 6-7.

Life Cycle:

There are 3 stages: 1) ASEXUAL STAGE: Zoospores borne in sporangium

2) SEXUAL STAGE: Oospores borne in Oogonium

3) VEGETATIVE STAGE: Mycelia with haustoria

- Oospores are sexual spores and also resting spores, present on affected debris for a longer time (6-8 months). When the conditions are favourable, these oospores germinate by producing germ tube, the tip of the germ tube swells to form sporangium.
- Initially sporangium is multinucleated structure, then each nuclei starts formation of zoospore wall. Once these zoospores matures, they start moving randomly and burst open the sporangium wall and become air borne.
- Air borne zoospores move certain distance, then they loose their flagellum and forms circular which is the encystment of sporongia.
- Haustoria is intercellular, Mycelia is intracellular. Once the conditions are adverse temperature increases, dried humidity, due to this fungi switch on to the sexual reproduction, here male reproductive organ is Antheridium and female reproduction oogonium between 2 gametangial processes.
- Oogonium is circular in nature, eunucleated, sometimes 1 cell or 4 cells are there. Antheredium tubular in nature and multinucleated, Gametangial contact.Once union of

oogonium and gametangial takesplace Plasmogamy takesplace. After Antheridium lesicata takesplace karyogamy.

Management:

- Provide good drainage, there by it creats adverse condition and asexual reproduction reduces and inoculum decreases
- Uproot severly infected plants, Replant with tolerant varieties.
- Application of *Trichoderma* (100 g per plant.)
- Chemical soil drenching of Bordeaux mixture 1%, Copper oxy chloride 3gm per lit, and aerial spray.
- Use are resistant root stock for grafting.
- Avoid low lying areas for citrus.
- Avoid exess N application,apply recommended K Application

b) POWDERY MILDEW: *Oidium tingitaninum*

Symptoms:

- Whitish powdery growth on young leaves & twigs.The affected leaves get distorted and in severe condition drop down.
- Infected twigs exhibit characteristic die back symptom.
- Young fruits are are also covered by whitish powdery mass of the fungus and drop off prematurely, resulting in poor yield.

Etiology and Spread:

- Comparatively cool and moist regions are prone to disease development.
- Damp mornings with are few hours of sunshine favour onset of the disease.
- The fungus is an ectoparasite and absorbs food materials from the epidermal cells of leaf through houstoria.

- It is a wind- borne disease. Septate mycelia, barrel shaped conidia born in chains, ectophytiic, sub epiderml haustoria, external mycelia.

PSI: Dormant mycelia.

SSI: Air borne barrel shaped conidia.

Life cycle:

- Dormant mycelia present in the affected parts. During congenial conditions germinates and produce oidea.
- After maturity barrel shaped conidia releases, flight and land on host.
- Infection takes place by producing sub epidermal haustoria & plant start producing powdery growth comprising of oidea.
- Oidea is an asexual fruiting body of the powdery mildew, barrel shaped conidia borne in chains on oidiophore.
- Then they release, flight & landing on their respective host.
- Infection process continues asexually:

Management:

- Prophylactic measures: cloudy warm weather, spray Wettable sulphur 3gm/ lt
- Aerial spray: Bavistin 1.25gm/lt,calixin 1ml/lt
- Wider spacing
- Avoid high density planting
- Avoid excess N application
- Provide recommended K application

C) CITRUS SCAB/ VERRUCOSIS: *Elsinoe fawcettii* and *Sphaceloma fawcettii*

Commons cab or sour orange scab - *Elsinoe fawcettii*

Sweet orange scab – *E. australis*

Tryone scab – *Sphaceloma fawcettii* var. *scabiosa*

Symptoms:

- Whitish, raised, circular, scabrous growth on the fruits, later the color turns to grayish color, decreases the fruit size, quality and fruit fall off.
- Leaves: on lower surface of leaves whitish scaborous growth corresponding upper surface, concave dippression can be seen.

Etiology and spread:

- It is believed that the pathogen perpetuates and survives in off season as perithicium.
- Secondary spread may be through the conidial stage, which is mostly produced on the host.
- Conidia are produced between 7 degree & 33 degree celcius at 66-100% RH on young lesions.
- Conidia from old lesions are dispersed during rains, but only to short distance.

Management

- Collect the infected leaves and burn it.
- The disease can be controlled by spraying with 1% Bordeaux mixture, difolatan and benomyl.
- Chemical:Carbendazin-1.25gm/lit
- Avoid excess N application
- Provide recommended K application.

d) CITRUS SOOTY MOULD: *Capnodium citris*

It is not actually a disease of plants. The fungi purely grows on the surface by utilizing the inset excreta or honey secretions by insects and plant. By growing such blacky mold on the surface, abstructing the sunlight to reach the photosynthetic area (green chlorophyll) of the plant and thus interfering in photosynthesis.

Symptoms:

- Black colored sooty mass covering the leaf surface, sometimes on young stem, fruit surfaces.
- Black sooty mass comprising of conidia and mycelia.
- Affects normal photosynthesis, thereby plant growth decreases.
- This is purely ectophytic and not plant parasitic fungi. By utilizing leaf exudates and honey like substances secreted by insects and also insect excreta, this fungi grows on the surface.

Etiology and Spread

Management:

- 1% Starch sprays, after it forms flakes on the sooty mass, along with flakes sooty mass fall off from the leaves after drying.
- Spraying systemic insecticides to manage the insects population could help in avoiding or reducing the sooty mold.

E) CITRUS ANTHRACNOSE: *Colletotrichum gloeosporioides*

Symptoms:

- The disease leads to defoliation and tip drying of twigs, it is called whither tip.
- Shedding of leaves and dieback of twigs.
- On the dead twigs acervuli appear as black dots.Light green spots appear which later turns brown.
- The pathogen also infects the stem-end of immature fruits causing fruit drop.
- In severe cases branches die back.

Etiology

Septate mycelia, asexual fruiting body-acervulus setae are present

Primary source of inoculum: Dormant mycelia

Secondary source of inoculum: Conidia produce by Acervulus

Epidemiology:

Warm weather, temperature 30-32^{o}C, RH 80-85%, Cloudy weather susceptible to host.

Management

- Collect the affected leaves and burn it.
- Avoid excess N application.
- Summer irrigation is best.
- Chemicals: Carbendazim-1.5gm/lt
- Benomyl-1gm/lt

2) BACTERIAL DISEASES

A) CITRUS CANKER/ BARK ERRUPTION:: *Xanthomonas campestris* pv.*citri*

Symptoms

- **Leaves:** Initially water soaked patches, these slowly turns to brown discoloration later produce corky raised spots then leads to yellow hallow.
- **Stem:** Same as leaves but no yellow hallow, bark eruption takes place, from cracks we can see bacteria ooze during warm rainy season.
- **Fruits:** brownish carky out growth and cracks formation and later crater like appearance is the common symptom. Marketing quality reduces, fruit size reduces.
- During preservation it lead to rotting.

Etiology

- Canker-infected leaves, twigs serve as the source of inoculum to spread the disease from season to season.
- However, the cankered leaves drop off early and bacteria perish rapidly in the soil.

Primary source of inoculum: Affected plant, soil

Secondary source of inoculum: Bacterial cells spread through Irrigation water, Agricultural operations, pruning shears.

Epidemiology:

Prevalence of 20^{o}-35^{o}C temperature, high humidity and the presence of moisture on the host surface.

Life cycle:

- The bacterium enters the host through stomata or wounds.
- It multiplies in the intercellular space, dissolves the middle lamella and establishes in the cortex region.
- Canker pustules develop an exude bacteria in the form of gummy substance.
- They are freely disseminated, chiefly by wind and Considerable extent by rains.
- Citrus leaf-miner helps dissemination and infection of citrus canker.
- Leaves affected by miner and canker get distorted and drop off early.
- The injury to the leaf epidermis made by the borrowings of leaf-miner serve as an easy opening to the canker bacterium and the canker lesion appear throught in the zig zag manner.

Management:

- Quarantine: If area is disease free, restrict the entry of planting material from infected to healthy area.

- Cultural: affected leaves, stem, fruit cut and burn, cut end portion of stem, paste with Bordeaux paste.
- Hot water treatment root stocks 50oC for 10-15 min.
- Biological: *Pseudomonas fluorescens*
- Chemicals:1% Bordeaux mixture
    - 0.3%Copper Oxychloride
    - 500 ppm Streptocycline.

VIRUS DISEASES

CITRUS TRISTEZA/QUICK DECLINE

Symptoms

- Leaf: Chlorosis is the common symptom, leaf size reduction, leaves drop off and defoliated twigs die back.
- Stem: Bark eruption and pittings on stem (v shaped dipression on the stem and stem twisting occurs.)
- Fruits: In the affected fruits thicknesss of the rind is increased, mesocarp decreases.
- Root stocks are susceptible, phloem necrosis is the common symptom, root discoloration and root decay takes place it leads to sudden leaf fall.

Primary Source of Inoculum: Affected plants, affected cuscuta

Secondary Source of Inoculum: Vectors (aphids) (*Toxoptera citricida)*, mechanically sap/ grafting/budding

Management

- Use the seedlings obtained from seeds for transplanting.
- Use a rough lemon root stock and other scion, protecting plants from phloem necrosis.
- As the disease severity increases cut and burn the affected parts.
- Phased manner replanting with resistant plants.
- Hot water treatment of rootstocks at 45^0 C for 10-25 min.

- Removal of cuscuta and spraying of systemic insecticide, Dimethoate 2ml/lt controls the aphid vector population.
- Apply recommended dose of N P K and FYM.
- Heat treatment.
- Cross Protection: Use the pre-immunized seedlings with mild strain of the virus to manage the disease and to avoid the losses.

VIROID DISEASES

Citrus Exocartis

Symptoms

This disease is pertaining to bark, later stage bark discoloration and removal takes place, yellowing leaf, leaf falling, plant may die on longer time.

Etiology

Mechanically spread through leaf to leaf rubbing, wounds, insect attack, affected secature

PSI: *Cuscuta reflexa*

SSI: Grafting and budding.

Management

- Seedlings are obtained by nucellar seeds.
- Irrigation management.
- Nutrient management.
- Avoid N application.
- Application of K.

PHYTOPLASMA DISEASE

CITRUS GREEENING

Symptoms

- Stunting of leaves, sparse foliation quick die back.
- Inter nodal length decreases, finally it looks like Witches broom.
- Poor crop of predominantly green and worthless fruits and only a portion of tree is affected. Foliar chlorosis occurs such plants resemble zinc deficiency.
- Primary source of inoculum: Affected plants, through planting material
- Secondary source of inoculum: Vector borne, phytoplasma-leaf hopper

Epidemiology:

Warm weather, temperature 30-32^{o}C , RH 80-85%, Susceptible to host.

Management:

- Select disease free planting material
- Host eradication in the field, Phytoplasma affected plants, uproot & burn.
- N, P & K Management- 2 dose recommended application, Increase in K application.
- Vector control- Systemic insectisicide, Metasystax 2 ml/lt aerial spray
- Antibiotic- Streptomycin 0.5gm/lt, aerial spray.

NEMATODE DISEASEs

- Nematodes are tiny creatures which live in soil, or in the tissues of living plants and animals.
- The juveniles (larvae) are tube-shaped, and look like tiny worms.
- Adults may be round or lemon-shaped.
- Adult females of some species, including the citrus nematode, are sedentary.

- They live all the time within a collection of plant cells which have been modified into a feeding and breeding site.
- Most nematodes are so small (less than 2 mm) that they cannot be seen except with a powerful microscope. Nematodes may be very numerous.
- A single handful of ordinary soil may contain thousands of them. Since they are in effect invisible, they are usually treated as a plant disease rather than as a plant pest.
- Most nematodes which infest plants live in the soil and attack the roots.
- They pierce the walls of the root cells with a hollow tube (stylet) and withdraw the contents of the cell.
- They may move into the cell, or move between cells.

Slow Decline

Caused by the citrus nematode *Tylenchulus semipenetrans*

Distribution

The citrus nematode is a world-wide pest of citrus trees.

Symptom

- A tree infected with citrus nematodes may survive for many years after it has been infected.
- The main effect of nematode infestation is "slow decline".
- Symptoms include the dieback of small branches, while leaves may turn yellow and fruit are small in size.
- There are reduced numbers of feeder roots.
- While citrus nematodes are too small to see, the roots they attack may have a gritty, knobbly appearance because of the egg masses which cling to them.
- A definite diagnosis must be made in a laboratory with a good microscope.
- Growers can expect some citrus nematodes to be present in most orchard soils.
- They do not become a problem unless populations are very high (i.e. more than 10,000 larvae per 500g of soil).

- Growers who are planting new orchards must be very careful not to introduce nematodes accidentally, in the soil around the roots of seedlings.
- If a large number of nematodes are already present in the soil, the best protection is to use resistant rootstock such as trifoliate orange or Troyer citrange.

Life Cycle

The typical life cycle for this nematode is: Egg, 4 larval satges and Adult female

Citrus Root Knot Nematode: *Meloidogyne incognita*

Symptoms:

- Aerial symptoms: yellowing of leaves and reduced plant growth and eventually reduction in yield.
- Below ground symptoms: Formation of galls on roots.
- The nematode is sedentary endoparasite, feeds on the affected part and complete its life cycle on the same gall.

Primary source of inoculum: Infected soil, host

Secondary source of inoculum: Spread through planting material, agriculture operation

Epidemiology:

Optimum soil moisture-50-60%, Sandy loam soils, Neutral PH, Susceptible host

Management:

- Summer ploughing reduces the inoculum load in the soil
- Application of carbofuran 10-15gm with 5-10 kg FYM.
- Application of VAM(Vesicular arbescular mycorrhiza)
- Application of Neem cake 5 kg/ plant.
- Soil type: Clay loam soil reduces nematode multiplication.
- Drip irrigation avoids movement of nematode from plant to plant.
- Use of resistance varieties.

POST HARVEST DISEASES:

Green / Blue mold rot: *Penicillium digitatum* and *P. italicum*

Green/Blue Mold: *Penicillium digitatum.*

Green/Blue mold are common post harvest diseases of all citrus growing areas of the country, particularly those with a cooler climate or those which use cold storage for citrus fruit.

Symptoms

- The first symptom is a tiny soft, watery spot 5-10 mm in diameter.
- The earliest symptom is a soft water soaked areas on the peel of the fruit and soon becoming covered with white mould in both the cases. Coloured spores formed at the centre of the lesions. In green mould rot, whitish margin is generally not more than 2 mm diameter. These two mould appear frequently together during transport and storage. But green mould is generally dominate as it grows rapidly at moderate temperature. Insect injury especially with Mediterranean fruit fly when the fruits are still on the trees which pre-harvest infection which are undetectable and also wounds caused during harvesting and handling are the predisposing factors.
- The decayed fruit becomes soft and shrinks in size. If the atmosphere is humid, the infected fruit also becomes attacked by other molds and bacteria, and soon collapses into a rotted mass.

Epidemiology:

- Green mold tends to develop most rapidly at temperatures near 24^0C.
- Growth is much slower if the temperature is above 30^0C.
- It is particularly common on fruit harvested in the middle of the season.

Mode of spread

- The fungus survives in the orchard from season to season mainly in the form of conidia. Infection is from airborne spores, which enter the peel of the fruit in places where there are small injuries or blemishes.

- It can also invade fruit which have been damaged on the tree by chilling injury. Infected fruit in storage do not infect the fruit packed around them.
- However, infected fruit may give off abundant green fungus spores which soil the skin of adjacent fruit.
- Since it attacks only injured fruit, the best way to prevent green mold is to handle the fruit carefully during and after harvest.

Alternaria rot: *Alternaria alternata* and *A. Citri.*

The first symptoms of the disease is seen on the fruits as watery rot. But before this, internal symptoms wre taken place. The internal symptoms varies with the species of crop In lemon, the pulp becomes greyis brown, soft and slimy. In oranges, grapefruits and mandarins, the affected interal tissue is black giving rise to a common name as Black rot or Black centre rot. In Mandarins, lesions often develop on the side of the fruit and the infected peel appears brown and hence the name, Brown spot of mandarins. In certain other cases, the symptoms consist of corky eruptions and pits.

Black mold or Aspergillus rot: (*Aspergillus niger)*

The rot may be mostly internal. Masses of black powdery spores are apparent only when the fruits are cut open. But, a very soft sunkened water soaked spots may develop on the peel, later giving rise to black spores resembling "soot". The decay is accompanied by odour of fermentation. Infection is observed while the fruits are still on the tree but, they look sound externally.

Black spot: *Phyllosticta citricarpa*

Various types of symptoms can be seen in this disease. Early infection may result in the appearance like "Melanose". Infection of immature fruits may also leads to "hard spot" or "limited spots" with a hallow centre. "Freckled sot" or "speckled blotch" is seen in fruits nearing maturity and develops further during storage. "Virulent spot" is observed late in the season when temperature is high and is characterized by irregular reddish sunken lesions.

Brown rot: *Phytophthora* spp.

Greyish brown spots are seen on the fruits. Infected fruits emit a characteristic pungent odour Under humid conditions, fine white spore bearing mould develops on the peel and spread to neighbouring fruits. Rotting is very rapid at 25^{o}C.

Sour rot: *Geotrichum candidum*

Water soaked spots on the fruits are the first symptoms of the disease but not discoloured. The surface of the lesion becomes covered with slimy off white spores and fruit tissue beneath is

Grey mold rot: *Botrytis cinerea*

Rotting may begin at the stem end or on the side of the fruit. The lesion is mid brown at first and firm and later darkens and become soft. "Nest" of decay develop and a mass of grey brown spores are formed under humid conditions.

Melanose : *Phomopsis citri* (= *Diaporthe citri*)

Small raised, reddish brown to black pustules are present on the peel making it rough to touch. The small spots are randomly distributed and exhibit a "Tear Stain" pattern. (Melanose is non=progressive skin blemish). As the fruit develops, the fungus dies back.

Black pit: *Pseudomonas sytingae* pv. *syringae*

The first symptoms are light brown spots on the skin of the fruits, later becoming dark brown and eventually black with markedly sunkened. There may be concentric rings of brown and on close examination, a small wound in the centre of each spot can be seen. Under moist conditions, grayish yellow droplets exude from the lesions but the tissue below the spot remains firm.

Precautions to avoid the post harvest diseases:

1. Wash the harvested fruits in heated disinfectants and rinse them.
2. Drying, grading, dying, waxing and packaging should be done without making injury or damage.
3. Remove decay or suspected fruits.

4. A range of chemicals should be used to avoid various kinds of pathogen (Topsin, Benlate, Diphenyl etc.)
5. Provide optimum storage conditions ie., around 10^{o}C.
6. Ethylene sensitive commodities should nbot be stored near to citrus.
7. Moisture loss of fruits can be reduced by waxing or by sealing with high density polythene film.

GRAPES (*Vitis vinifera*.) Vitaceae

Grapes is one of the world's major fruit crops and its association with man was believed to be older than that of rice or wheat. Grapes are now considered as a most remunerative crop along with nutritive value. The grapes are grown for various purposes in the production of **raisin,** wine, juice, canning and table purposes. The world's production of grapes exceeds that of any other fruit crop. Roughly, the grapes occupy nearly 11million hectares producing 75 million tonnes annually. Spain, Italy and France dominated the grape production with over half of the total world's supply. In India, grapes are grown under tropical as well as subtropical climate. The commercial cultivation of grapes has begun only during the last four decades and Maharashtra, Karnataka, Andhra Pradesh and Tamil Nadu are the states growing grapes in India.

Diseases

Grapes are susceptible to a number of diseases, some of which are very serious and cause great damage to the crop. In India, summer rains and high temperature help in the spread of diseases. The diseases which commonly occur in the vineyards on worldwide basis including India are anthracnose, powdery mildew, downy mildew and black rot.

GRAPE-DISEASE

Powdery mildew - *Uncinula necator*

Downy mildew - *Plasmopara viticola*

Anthracnose - *Elsinoe ampelina (=Gloeosporium amphelphagum)*

Black rot - *Guignardia bidwellii*

Bacterial canker - *Xanthomonas campestris* pv. *viticola*

Minor diseases

Brown leaf spot - *Cercospora viticola*

Rust - *Phakopsora vitis*

Coniothyrium blight - *Coniothyrum diplodiella*

Alternaria blight - *Alternaria vitis*

Drechslera leaf spot - *Drechslera rostrata*

Fruit rots

Pestalotiopsis fruit rot - *Pestalotiopsis menezesiana*

Grey mould rot - *Botrytis cinerea*

Blue/Green mould rot- *Penicillium digitatum*

Soft rot - *Phomopsis viticola*

Stalk end rot - *Aspergillus niger*

Penicillium rot - *Penicillium canescens*

Rhizopus rot - *Rhizopus nigricans*

Cladosporium rot - *Cladosporium herbarum*

Bitter rot - *Greenaria fuliginea*

Bacterial leaf spot - *Pseudomonas viticola*

Fan leaf - Grapevine fan leaf virus

Little leaf - MLO's (PPLO)

FUNGAL DISEASES

Powdery Mildew:

Powdery mildew is an endemic disease wherever the grapes are grown in the world. The disease has been reported from the American continent, Europe, Africa, Australia and Asia. In India, the disease is most common in Maharashtra, Gujarat, Andhra Pradesh, Karnataka and Tamil Nadu.

Economic Importance

The disease causes extensive damage in whole of Europe and Western USA, sometimes destroying the crop completely. French grapevine industry also suffered huge losses due to the epidemics of this disease during 1850-55.The disease not only reduces the yield and lower the fruit quality but wine prepared from infected fruits often develops off-flavor (Ough and Berg, 1979).

Symptoms

- The fungus attacks all the green parts of the plant at all stages of plant growth.
- The fungus produces white to grayish powdery patches on the affected plant parts including fruits but young leaves are most susceptible and develop small whitish patches both on upper as well as lower surface.
- These patches grow in size and coalesce to cover large areas on the leaf lamina and gets twisted. Malformation and discoloration of the affected leaves are also common symptom, resulting in distortion.
- Similarly, powdery patches are also produced on the stem, tendril, flowers and young fruit branches.
- Diseased vines appear wilted and the stem portion turns brown.
- The infected blossom and berries turn dark in colour, irregular in shape and brittle. In advance stage of infection, berries may develop cracks and such berries do not develop and ripe.
- When blossom is affected, flowers may drop off. Affected berries become malformed and skin cracks and pulp may be exposed under such conditions

Causal organism

Powdery mildew of grapevines is caused by *Uncinula necator* (Schw.) Burr., (Syn. *Oidium tuckeri* Berk.) which is an obligate parasite.

It is classified as follows:

Kingdom – Fungi

Phylum - Ascomycota

Class - Filamentous Ascomycetes

Order - Erysiphales

Family - Erysiphaceae.

Genus - *Uncinula*

Species - *necator*

Etiology

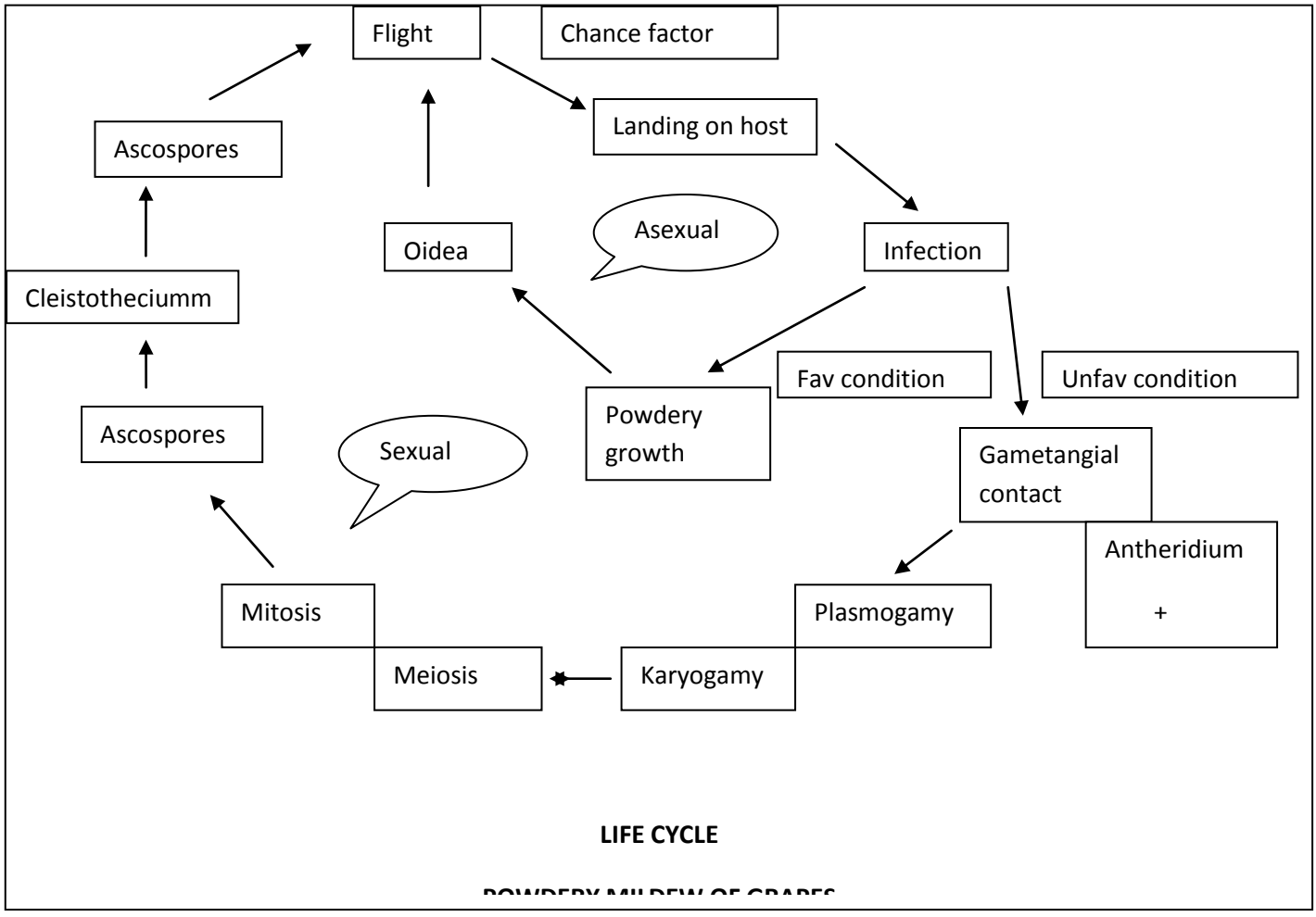
- Mycelia septate, external thin mycelia, haustoria sub epidermal, obligate parasite.
- Asexual spores are: barrel shaped, conidia borne on oidiophore in chains. Asexual stage of the pathogen is oidium.
- Sexual spores: Ascospores inside the Ascus in the ascocarp which is called as Cleistothecium.

Mode of Spread and Survival:

- It survives as dormant mycelia and as Cleistothecia on the shoots and buds from season to season.
- The disease spreads by the air- borne conidia/oidia.

Epidemiology

- The disease occurs in severe form from Oct- Nov in North India and Feb- June in South India.
- Disease is favoured by warm sultry weather and retarded by sunshine.
- Warm winter temperature from 20 to 33.5^{0}C has been found to be the cause for epidemic in Hyderabad.
- Disease development is adversely affected by rain.



LIFE CYCLE

POWDERY MILDEW OF GRAPES

Management

Cultural practices:

- The use of training systems which allow proper air circulation through the canopy and prevent excess shading helps in reducing the disease.
- Orchard sanitation is also important in reducing the disease pressure during the growing season.

Chemical control:

Fungicides like Sulphur, Dinocap, Benomyl, Triadimefon, Penconazole, Mycobutanil and Flusilazole are used commercially although not as extensively as sulphur, to control the disease.

- The use of fungicides for control of powdery mildew should begin during early stages of vine development. Spray schedules at an interval of 7-10 days are usually required for effective control by sulphur.
- Dinocap is to be given at an interval of 10-14 days while; sterol biosynthesis inhibiting fungicides are commonly used at 14-21 days schedule.
- For effective control, the fungicide spray should start just after bud burst.
- The fungicides should be sprayed alternatively and the same fungicide should not be sprayed continuously.

DOWNY MILDEW

Downy mildew is most destructive fungal disease of grapevine and occurs in most grape growing regions of the world. Before 1870 the disease was endemic to USA. It was first reported in Europe in 1878, within short period of time, the disease spread like wild fire in France and posed a threat to the vine industry .It was during this time that Prof. P.M.A. Millardett discovered the Bordeaux Mixture against downy mildew. He observed that the vines near to road side, sprayed with lime and copper sulphate mixture to avoid pilferage by street goers, were quite healthy as compared to the vines in the interior of vineyards (Millardet, 1885). Introduction of downy mildew to various countries was probably by way of infected nursery/propagating stocks.

Economic Importance

The disease results in cluster destruction and loss of vine foliage or photosynthetic area. Almost entire crop fails whenever the conditions are conducive for disease development. Under epidemic situations, vines may be defoliated, which results in nakedness of canes and exposes fruit to sunburn. In the next season, vine vigour and crop potential may be reduced.

Symptoms

- Symptoms of the disease appear on all aerial parts of the plant.
- The disease is usually first observed as small translucent, pale yellow spots with indefinite borders on the upper surface of leaves.
- Whitish downy growth on the lower surface of the leaves comprises of tufts of mycelia, sporangiphores and sporangia of the fungus. On the corresponding upper surface, small round to angular light green/chlorotic patches is the characteristic symptoms.
- On the under surface of leaves and directly under the spots, a downy growth of the fungus appears. The tissue in the spot is traversed by reddish lines.
- Later, the infected areas are killed and turn brown .The growth on the lower surface becomes dirty grey.
- Tender vines are also affected. Infected leaves turn yellow, brown and wither. Flowers die and drop off. Fruits become grayish, skin become hardened and shrivels resulting in mummified berries.
- The necrotic lesions are irregular in outline and they enlarge and coalesce to form larger necrotic areas on the leaves, frequently resulting in defoliation.
- Diseased shoots remain stunted. Infected leaves, shoots and tendrils are covered with whitish growth of the fungus.
- Flowers and berries are also affected. Flowers may blight or rot.
- During blossom or early fruiting stages, entire clusters or part of them may be attacked and become quickly covered with the downy growth and die.
- If infection takes place after the berries are half-grown, the fungus grows mostly internal.
- The berries become leathery and wrinkle and develop a reddish marbling to brown coloration. The fruit shed if the attack is very severe.
- The juice quality of fruit is found to be reduced. Infection of green young shoots, tendrils, stems and fruit stalks results in stunting, distortion and thickening of the tissues. Infected tissues turn brown and die.

Causal Organism

Grape downy mildew is caused by an obligate fungus, *Plasmopara viticola* (Berk. & Curt.) de Bary and the classification of the fungus is,

Kingdom - Chromista

Division - Oomycota

Class - Oomycetes

Order - Peronosporales

Family - Peronosporaceae

Genus - Plasmopara

Species - viticola

Etiology:

- Mycelium is intercellular with spherical haustoria, coenocytic, thin walled and hyaline.
- Sporangiophores arise from hyphae in the sub-stomatal spaces and sometimes they emerge directly through the cuticle.
- On young berries of grapevine they emerge through the lenticels.
- Sporangiophore branching is almost at right angles to the main axis and at regular intervals. Secondary branches arise from lower branches.
- From the apex of each branch 2-3 sterigmata arise and bear sporangia singly.
- The sporangia are thin walled, oval or lemon-shaped.
- Asexual spores: Zoospores are pear shaped, biflagellate borne in sporangia

- Sexual spores: Oospores thick walled, diploid developed through gametangial contact (union of dissimilar gamets, Oogonium and Antheridium) and are also called as dormant spores.

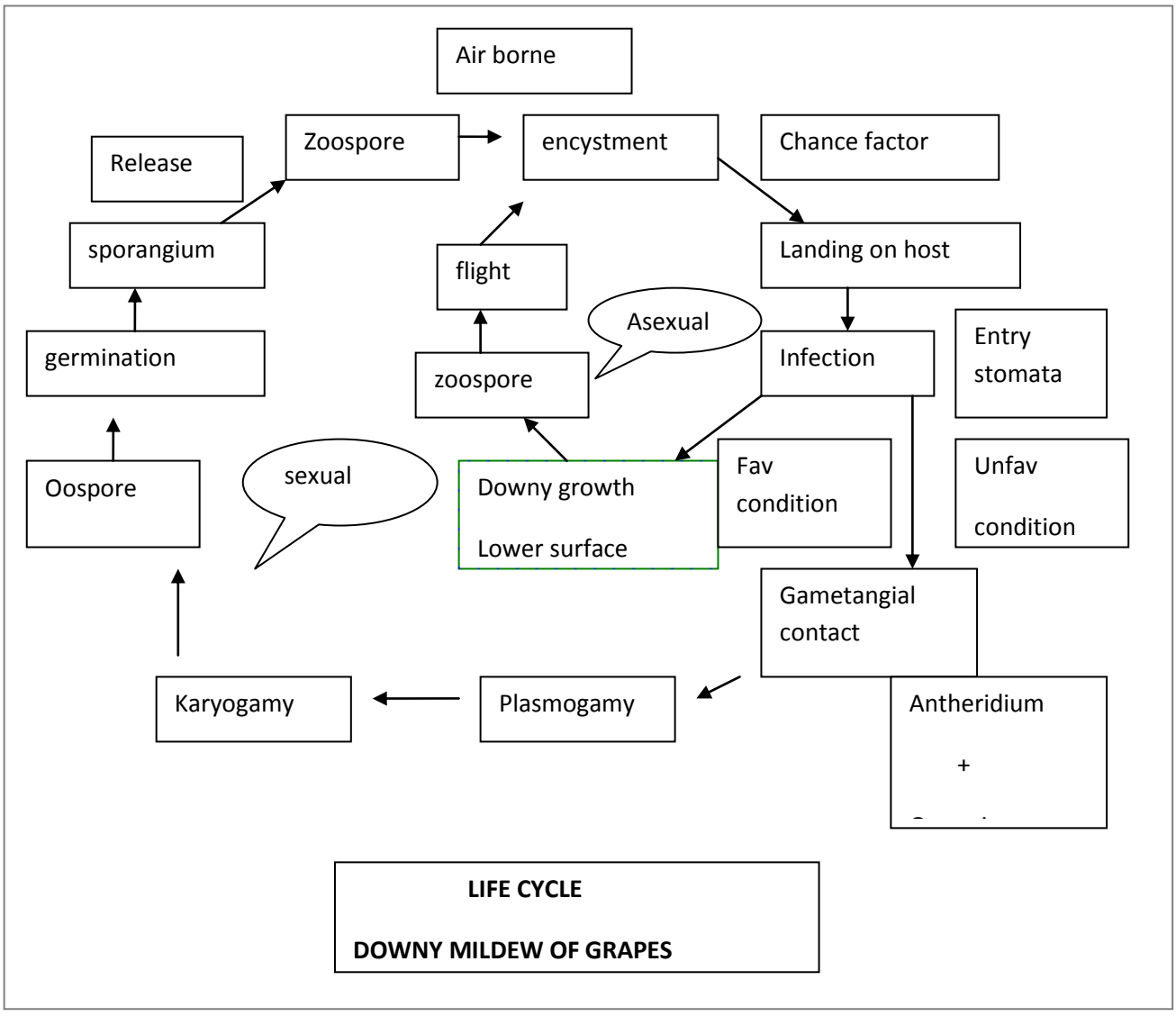
Mode of spread and survival

The pathogen survives on the infected leaves and vines as oospores and dormant mycelium.

The secondary spread is through wind- borne sporangia and zoospores which are found on the new flush.

Epidemiology

- The most favourable temperature for germination of sporangia is between 10-23^{0}C.
- Disease development is favoured during rainy season when there is heavy dew, relative humidity is above 80% and temperature is between 23 and 27^{0}C.



Management

Regulatory measures

- Restriction on the movement of planting material at regional, national or international level should be imposed, since the pathogen spreads through dormant cuttings (planting materials).

Cultural practices

- All infected plant material and pruned parts must be removed and burnt before bud sprouting, so as to reduce primary inoculum.
- Even during growing season plant debris must be avoided in and around the field.
- Careful attention should be paid to spacing of vines, row direction and placement of wind breaks, which will ensure maximum air drainage and minimum leaf wetness duration.
- To encourage air movement within the plant canopy, practices such as, removal of leaves around berry clusters, trellis designs and pruning systems which allow more air movement be followed during the early development of vines.
- Careful disbudding and training of veins should be practiced to maximize distance between soil and foliage.

Chemical control

- After pruning, the vines should be sprayed with Bordeaux Mixture 1.0% or Difolatan 0.2% or Copper oxychloride 0.3% or Chlorothalonil 0.2%.
- When the flushes are formed, spraying with Difolatan 0.2% or Chlorothalonil 0.2% or Metalaxyl 0.2% or Copper oxychloride (%) are effective.
- It may be repeated at weekly or fortnightly intervals depending up on severity and weather conditions.
- When the non-systemic fungicide is used during humid and rainy period spraying should be repeated for every two or three days.

Biological control:

- *Erwinia herbicola*, a saprophytic bacterium, used as liquid culture and sprayed on vines which inhibits *P. viticola* upto 75%.

ANTHRACNOSE / BIRDS EYE SPOT

Anthracnose is a widespread disease in all grape growing regions of the world. The disease is known in Europe since ancient times, however, in India, the disease was first recorded in 1903 near Poona and is now widely prevalent in Rajasthan, Uttar Pradesh, Punjab, Haryana, Andhra Pradesh, Karnataka and Tamil Nadu. Under north Indian conditions, the disease appears only during rainy season. In the southern part of the country, the berries escape infection because the crop matures before the onset of rains.

Symptoms

- The fungus attacks shoots, tendrils, petioles, leaves, veins and stems and also inflorescence and berries.
- Numerous spots occur on the young shoots. These spots may unite to girdle the stem and cause death of the tips and may also cause die-back symptoms.
- Spots appear on the new shoots and fruits also. Spots on petioles and leaves cause them to curl or become distorted.
- On berries, characteristic round, brown sunken spots resembling “Birds Eye” and hence the name of the disease.
- On the leaves it appears as small, irregular, dark brown spots. The central tissue turn grey and falls off. The disease appears as dark red spots on the berry.
- Later these spots are circular, sunken and ashy grey and in late stages these spots are surrounded by a dark margin which gives it the bird’s eye appearance.
- The spots are 7mm in dia but they may involve about half of the fruit.

Causal Organism

The anthracnose of grapes is caused by *Gloeosporium ampelophagum* (Pars.) Sacc. {*Elsinoe amphelina* (de bary) Shear –perfect stage}.

The fungus is classified as

Kingdom - Fungi

Division - Ascomycota

Class - Loculoascomycetes

Order - Dothideales

Family - Elsinoaceae

Genus - Elsinoe

Species - ampelina

Conidial stage is *Sphaceloma ampelina* de Bary . Conidia are formed in pink acervuli. The are hyaline, single celled, oblong or ovoid . Perithecia (Pseudothecia) are small and unconspicuous. Asci are globular and ascospores are hyaline, 3-celled.

Mode of spread and survival

The pathogen survives as dormant mycelium in the cankers on the stem and on the infected twigs. Secondary spread is through conidia which are carried by wind and rain water.

Epidemiology

The disease is severe during July- Aug and Nov- Dec months. Infection in new sprouts takes place during rainy season. Heavy rains after pruning leads to more incidence.

Management

Cultural practices:

- Training of vines should be such that water splashes should not reach the foliage, canes and branches during rainy season.

- Ground level canes and branches should be removed. All cankerous canes should be pruned and destroyed by burning.
- This will help in reducing the primary inoculum during the growing season.

Chemical control:

- Spray vineyards at the time of leaf emergence with Thiophanate methyl (0.1%), bitertanol (0.1%), benomyl (0.1%), carbendazim (0.1%), or Bordeaux mixture (1.0%).
- At least four sprays of fungicides should be given during rainy season at fortnightly intervals. Care should be taken not to spray the same fungicide regularly.

Varietal Resistance:

- The Muscadine grapes seems to be immune, Champane highly resistant, Concord moderately resistant and most varieties are highly susceptible.
- Variety Delight is tolerant whereas, Bharat Early and Hussaini are resistant

BUNCH ROT

Bunch rot, also known as grey mould rot or *Botrytis* rot and is prevalent throughout the world wherever the grapes are grown. The maximum damage of this disease is noticed in berries at the harvest time as well as during transport and storage.

Economic Importance

Infection on flowers and berries is most important from economic point of view as it lowers both quality and quantity of fruit. The flowers provide an excellent source of nutrition to the fungus. The berries are resistant to infection during development stage until maturity after which, these become increasingly susceptible. The famous noble rot represents a rare case of rotted food stuff becoming more valuable than healthy one. Under favourable dry conditions, following are heavy *Botrytis* attack, the mycelium colonizes the berry skin and kills epidermal cells thereby allowing abundant evaporation of water through cuticle. After drying, a raisin-like shrunken fruit is picked up selectively. The famous white Auslese- type wines, the most renowned originating from the Rhine Valley or Sauterne are made from such grapes (Nelson,1951; Jarvis, 1980).

Symptoms

- The disease symptoms appear on all plant parts i.e. leaves, shoots, flowers and berries. Both young and relatively older leaves are infected by the pathogen.
- The fungus produces irregular, necrotic spots in the centre of the leaves. Under certain conditions, marginal necrosis also occurs.
- Infected flowers normally do not develop any apparent symptoms but necrosis of stamens, the solitary ovary can often be seen covered with tufts of sporulating mycelia.
- The most prominent symptoms of the disease are found on the berries. Infected berries become dark coloured and show typical grayish, hairy mycelium all over their surface.
- Tufts of conidiophores and conidia protrude from stomata and peristomatal cracks on the skin of the berry. Under high disease pressure, all the berries in a bunch gets affected.

CAUSAL ORGANISM

The disease is caused by *Botrytis cinerea* Pers. ex. Fr.

The fungus is classified as,

Kingdom - Fungi

Division - Ascomycota

Class - Deuteromycetes < Anamorphs of apothecial Ascomycetes>

Order - Moniliales

Family - Moniliaceace

Genus - *Botrytis*

Species - *cinerea*

The fungus produces grey growth on the surface of the fruit but in high humidity, the mycelial growth may be cottony and white. The conidiophores are long, slender, erect, hyaline, unbranched or seldom branched. The epical cells enlarged or rounded bearing clusters of conidia on short sterigmata. Conidia are hyaline, ovate or elliptical to almost globose, one celled conidia appear grey in mass. Black irregular sclerotia are frequently produced.

Mode of spread and survival

- The fungus, *Botrytis cinerea* survives from season to season on the grapevines, rotted berries and stem clusters in the form of mycelium, conidia and sclerotia.
- The conidia of *B. cinerea* are dry and largely dispersed in air currents.

Epidemiology

- The optimum temperature for sclerotial germination followed by infection is between 20 and 25^0C and in relatively dry soil.
- Sclerotia are more likely to survive longer on canes and these are probably more important than those in soil as are source of primary inoculum.

Management

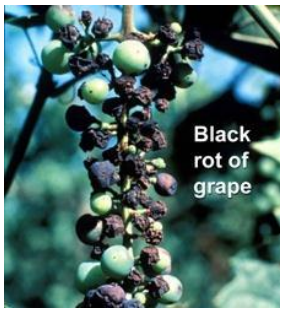
- Maintaining the sanitation in the vineyard is the most important cultural practice to keep the disease under check.
- Diseased vines, leaves and fruits must be picked up and destroyed.
- Removal of grape mummies acting as primary sources of infection from vines at the time of pruning and burning them.
- Fungicides like dicarboximide, procemidone, vinclozolin and iprodione are effective in disease control.
- Removal of leaves in the vicinity of flower clusters and bunches helps in reducing the disease severity.
- Some of promising new botrycides in grapes are triazole, folicur, sterol biosynthesis inhibitor (SBI).

BLACK ROT

The disease after its introduction in France during 1880's, it spread to all grape growing areas of Europe. In India, the disease has been observed in Madurai district. Black rot is more distructive in warm and humid areas than in the cooler and drier ones. The disease has been recently observed on certain purple varieties and it is less common on the seedless and Pachha draksha varieties.

Symptoms

- The disease on fruit begins to show as light, brownish, soft, circular spots which increase in size and the entire berry is discoloured.
- The decaying berries begin to shrivel within a week and are transformed into hard, black, shriveled mummies.
- On the leaf, circular red spots appear and later the margins become black. Minute black dots representing fruiting bodies of the fungus are arranged in a ring near the outer edge.



Causal Organism

Guignardia bidwelli (Ell.) Viala & Ravaz.

- The mycelium is hyaline when young and it becomes brown after full maturity.
- Perithecia are globose, ostiole not prominent. Asci are clavate, thick walled.
- Each Ascus contains 8 ascospores. Ascospores are bicelled but cells are unequal in size. Ascospores are hyaline, sub-ovoid or elliptical, slightly flattened on one side .

Mode of spread and survival

- Perithecia develop on mummified grape berries and the Ascospores are discharged when mummies are wet.
- Ascospores produce germ tube and penetrate directly through the cuticle.
- Primary infection occurs on young leaves and fruit pedicles.
- Pycnidia are rapidly produced. Pycnidiospores spread through meteoric water.
- They may survive the winter and germinate in the following season.

Epidemiology

Frequent rains and humid climate are conducive for disease development.

Management

- Diseased berries and leaves should be collected and destroyed.
- Spraying of Bordeaux Mixture 1.0% or Ferbam 0.2% or Captan 0.2%, Chlorothalonil 0.2% should be done when the new shoots are 15-25cm long and repeated before bloom, 10-15 days after bloom.

MINOR DISEASES

Brown Leaf Spot

Brown leaf spot is caused by *Cercospora viticola* (Ces.) Sacc (Perfect stage; *Mycosphaerella personata* Higgins), and classified as,

Kingdom - Fungi

Division - Deuteromycota

Class - Deuteromycetes

Order - Moniliales

Family - Dimatiaceae

Genus - Cercospora

Species – viticola.

- This is normally prevalent in neglected gardens, during July- Dec in the grapes growing areas.
- Dark brown, angular spots appear on leaves and young shoots. Sometimes young shoots dry up.
- The disease spreads through wind- borne conidia.
- High humidity favours the disease.
- Keeping the garden in healthy and robust (vigorous) conditions by proper manuring and cultural operations keeps away the disease.
- Mancozeb 0.25% or Bordeaux mixture 1.0% or benomyl 0.05% spray is quite effective.

- Varieties like Australia No.2, Champach and Champion are resistant.

RUST

Rust disease is incited by *Physopella vitis* Syd. & classification is as follows,

Kingdom - Fungi

Division - Basidiomycota

Class - Basidiomycetes

Order - Uredinales

Family - Melampsoraceae

Genus - *Physopella*

Species - *vitis*

- In Tamil Nadu, this disease has been reported from Salem, Dharmapuri, Nilgiris and Coimbatore districts.
- Generally the variety, Black Prince is affected. Besides it also attacks some wild species of *Vitis*.
- This disease is generally observed during the winter season.
- The fungus produces numerous orange coloured sori on the lower surface of the leaves. In severe cases of infection, the entire leaf surface is covered by the sori and are orange coloured and defoliation occurs.
- The uredospores are binucleate with hyaline or coloured walls. The uredospores are echinulated and are borne singly on pedicels .
- Teliospores are found in several layers. They are sessile and not echinulate. They are single celled with one germ pores. The wall is pigmented
- The fungus attacks only blue coloured grapes than green coloured grapes.
- The disease can be controlled by spraying Zineb 0.2% or spraying wettable sulphur 0.2% or dusting sulpur at 25 kg/ha.

CONIOTHYRIUM BLIGHT

The disease is caused by *Coniothyrium diplodiella* (Speg.) Petr. & Syd. [Perfect stage *Leptosphaeria coniothyrium* (Fel.) Sacc.].

- Isolated, reddish brown, irregular spots appear along the margins of the leaf. Affected leaf shows reddening from the margin towards the centre.
- Later, the lesions become cinnamon brown and bear pycnidia in dark encrustations.
- The leaves curl downward, wither and fall prematurely in dry weather.
- In damp weather conditions, they curl upwards and remain longer in the branches compared to healthy leaves.
- Dark brown, circular shrunken areas are seen on twigs, petioles and tendrils.
- The fungus produces pycnidia. Conidia are single celled and light amber- coloured when young and dark brown when old .

ALTERNARIA BLIGHT

The disease is caused by *Alternaria vitis* Cavara.

Characteristic symptom of the disease is the appearance of patches mostly along the margin of the leaves.

In the initial stage, minute, yellow spots appear on the upper surface of leaves. These spots later enlarge and form brownish spots with concentric rings in them.

In severe cases of attack, the leaves dry completely and defoliation occurs.

DRECHSLERA LEAF SPOT

Drechslera rostrata (Drechs.) Richardson & Fraser.

Produces leaf spot symptoms. Affected leaves show marginal lesions of light brown colour. They gradually change to reddish brown .

Infected portions become brittle and such portions fall off showing shot-holes.

FRUIT ROTS

PESTALOTIOPSIS FRUIT ROT: *Pestalotiopsis menezesiana* Bres. & Torr.

The infection starts just near the peduncle or tip of fruits and it spreads rapidly and covers the upper part of fruit .

Lesions on fruits become brownish black and leathery.

The fungus also attacks leaves and twigs.

BLUE MOULD ROT: *Penicillium digitatum* Sacc.

The rot affects the fruits before or after the harvest.

It is characterized by scanty growth of the pathogen which at first and turns bluish-green later.

The pathogen enters through wounds or cracks in the skin. In storage and transit the fungus decays the berries.

The affected tissues become soft and watery. They develop a mouldy flavour also.

In Vinifera grapes, fumigation with sulphur dioxide in storage reduce the rot.

PENICILLIUM ROT: *Penicillium canescens* Sopp.

Shallow, pinhead size, water-soaked lesions appear on the fruits. They become larger and deeper in advance stages of infection.

The decaying fruits emit fermented, mouldy smell.

Heavily infected fruits under humid conditions are partially or completely covered by mycelium, conidia and conidiophores.

The fungus produces conidia which are aseptate, small and globose.

SOFT ROT: *Phomopsis viticola* Sacc.

Berries develop small brown spots. Later they become round with distinct dark brown margins. Infected tissues becomes pulpy and white mycelial growth appears after 4 to 5 days.

The berries gets completely rotted within 10 to 12 days and emit a fermented odour.

Black pinhead-like fruiting bodies (pycnidia) develop over the entire surface of the fruit after 12 days .

Mycelium of the fungus is inter and intra-cellular in the host tissue. It is branched, septate and hyaline.

Two types of conidia are present – elliptical fusoid, acute at one or both ends, generally two guttulate and hemate or flexuous and filiform types.

Avoiding injuries to the ripe berries helps to reduce soft rot.

Bhokri(Nasik Green), a South Indian grape variety was found to be more resistant than Thompson Seedless and Kali Sahebi varieties.

STALK END ROT (Black mould rot): *Aspergillus niger* van Tiegh.

Affected berries show brown rot at stalk end. The rotting begins as small, circular to oval, water- soaked spot. It enlarges and turns brown.

White mycelial growth of the fungus develops and black conidial head of the fungus is seen. Infected tissues become soft and emit bad odour.

Diphenyl sprayed on cushions is effective at 1g per pack in protecting the fruits upto 15 days in storage as protectant and eradicant.

RHIZOPUS ROT: *Rhizopus nigricans* Ehrenb.

Round to irregular, light brown and water-soaked lesions appear on the fruits.

These lesions enlarge and engulf the entire fruit. When diseased fruits are stored in moist chambers, white sporangiophores with black sporangia are found on the surface.

Typical symptoms of soft watery rot are also observed. Diseased fruits become unattractive and unfit for consumption.

CLADOSPORIUM ROT: *Cladosporium herbarum* (Pers.) Sacc.

Black, firm and shallow decay is localized in one side of blossom end . The fruits become wrinkled on the affected side. A sparse growth of grey-green fungus may be seen on the fruits.

The infection occurs through uninjured skin or through wounds or cracks at the blossom end.

The rot can be reduced by sulphur fumigation and by cooling and storage of fruits at temperature ranges from 0.55 to 0.00C.

BITTER ROT: *Greenaria fuliginea* Scribner & Viala.

Ripe and unripe berries just near the peduncle are affected. It causes light brown to dark, fuliginous full of dense acervuli.

Brown, hard depressed patches on the berries which subsequently bear numerous black, dot-like fructifications.

Grapes harvested with small lesions develop typical rot symptoms and deteriorate in transit and storage.

BACTERIAL DISEASES

BACTERIAL CANKER

In India, the disease was noticed for the first time on *Vitis vinifera* cv. Anab-e-Shahi at Tirupati (Andhra Pradesh) in 1960.The disease appeared in an epiphytotic form during 1984 in Sangali and Solapur districts of Maharashtra on Thompson Seedles grapes. Now the disease has been noticed and prevalent in Karnataka, Maharashtra and Tamil Nadu.

Symptoms

- Small irregular water soaked spots on leaves, translucent to light and have a necrotic pinhead sized center.

- Numerous spots coalesce to form large patches.
- Severely infected leaves easily shed.
- On the stem disease starts as brown black spots around nodes. Advanced stage of nodal infection girdling and cracking of nodes is formed .
- Finally it leads to break down of plant.

Causal Organism: *Xanthomonas campestris* pv. v*iticola* (Nayudu) Dye.

- Bacterium is Gram negative, rod shaped with rounded ends, motile by single polar flagellum.

Bacterium classification is as follows,

Kingdom – Prokaryotae

Division - Gracillicute

Class - Protobacteria

Family - Pseudomonadaceae

Genus - *Xanthomonas*

Species – *campestris*

MODE OF SPREAD AND SURVIVAL

- The alternative hosts are neem, mango and *Phyllanthus maderaspatensis*
- The bacterium survives in the infected twigs, dry leaves upto 65 days.
- Secondary infection takes place through wind splashed rain.
- Disease spreads to distant places by diseased cuttings.

Epidemiology

- Temperature range of 25-30^{0}C is favourable for the disease development.
- Free water from dew, irrigation or rain on leaf are more important for pathogenesis.
- The disease frequency is positively correlated with number of rainy days.

MANAGEMENT

- Regular inspection of vineyard and destruction of infected plant materials.
- Use of disease free cuttings and late- October pruning are recommended to manage the disease.

- Spraying with Streptocycline 300ppm, starting from two leaf stage up to 70 days is also effective.

MINOR BACTERIAL DISEASE

BACTERIAL LEAF SPOT

This is caused by *Pseudomonas viticola* Patel *et al*.

Kingdom – Prokaryotae

Division - Gracillicute

Class - Protobacteria

Family - Pseudomonadaceae

Genus - *Pseudomonas*

Species - *viticola*

- The spots on the leaves are dark brown . Sometimes they coalesce to from larger spots.
- Vein infection is also common. Petioles and stems show elongated cankers.
- The infected leaves after drying are firmly attached to the stem. Affected dry leaves crumpled very easily.
- The bacterium is non- capsulated, gram negative and lopotrichous.
- Old, dried leaves attached to the grapevines and the stem cankers act as primary source of inoculum.
- The bacterium infects neem and *Phyllanthus maderaspatensis*.
- Rain disseminates the bacterium. The disease is severe during rainy season.

VIRAL DISEASES

FAN – LEAF

Causal organism: Grapevine fan leaf virus (GFLV).

(Syn. Grapevine infectious degeneration virus).

In India, fan-leaf was first reported in 1965.

Symptoms:

- Affected young leaves show variegated mottling.
- The malformed leaves have open petiolar sinuses. Widening of the petiolar sinuses and reduction of areas between the veins gives the impression of a half-closed fan.
- Affected leaves stand upright along the axis of young shoots and become cup-like.
- The dark green areas in the mottled leaf bulge upward and leaf surface become rough.
- The characteristic symptom of the disease is smalling of leaves.
- The affected leaves turn light yellow and show cupping.
- The distance between internodes is reduced and nodes and internodes become thin and weak. Growth became zig-zag at the nodes.
- Few lateral branches are produced and axillary branches proliferate to produce small, thin and weak, secondary branches.
- Infected plants do not produce flowers and fruits even at the age of three years.
- Plants become stunted and produce very few and weak rootlets.

Virus – virus particles are isometric, SS DNA virus and 25-30nm in diameter.

Physical properties of the virus:

- Thermal inactivation point is 60-65^0 C.
- Longevity in vitro is 15-30days at 20^{0}C
- Dilution end point is between 10^3 and 10^4.

Transmission

The vectors are nematodes, *Xiphinema index* and *X. italiae*.

The virus is mechanically transmissible to *Cucumis sativus, Chenopodium amaranticolor, Gomphrena globosa, Nicotiana tabacum* cv. 'White Burley', *Phaseolus vulgaris* cv. *prince.*

The disease has been transmitted by grafting or budding of the diseased scion onto the healthy rootstock of variety Emperor. It is not transmitted through pollen.

Management:

- Soil application with nematicide controls the nematode vectors and reduce the spread of the disease.

LITTLE LEAF

Causal organism: Phytoplasma like organism .

Symptom:

- The leaves on affected vines become extremely small and develop light yellow colour.
- Internodes and stems are reduced to a great extent and develop in zig-zag fashion.
- Axillary buds proliferate. No flower and fruit develops on affected vines.
- Roots become stunted and a few weak rootlets develop.

- Transmission: This disease is transmissible by grafting or budding.
- A temporary remission of disease symptom can be obtained by heat therapy (45-50^{0}C) and also when bud woods were treated with oxytetracycline hydrochloride 1,000 ppm.

I. Choose the correct answers from the options given below.0.5X10=5

1. The disease which posses coenocytic mycelia_____
   a. Powdery mildew, b. Downy mildew, c. Grape rust, d. Bird eye spot.
2. Powdery mildew of grape is caused by _____
   a. *Oidium viticola*, b. *Uncinula necator*, c. *Phyllactinea corylea*, d. *Sphaerotheca pannosa*.
3. Anamorphic name of Bird eye spot causal organism is _____
   a. *Elsinoe amphelina*, b. *Sphaceloma amphelina*, c. *Spiloceae amphelina*, d. both b & c.
4. _____ is responsible for hormone synthesis and disordered growth in crown gall of grape.
   a. Opines, b. T-DNA, c. Onc genes, d. Acetosyringone.
5. Bacterial canker of grapes is caused by _____ bacteria.
   a. Xanthomonas, b. Pseudomonas, c. Bacillus, d. Coccus.
6. Causal organism of grape canker produces _____ coloured colony in the media.
   a. brown, b. yellow, c. green, d. white.
7. Organism of grape yellows is _____ in shape.
   a. Bacilli, b. spirilli, c. cocci, d. none.
8. Biotic agent of Pierces of grapes is _____.
   a. Phytoplasma, b. Bacteria, c. Ricketsia, d. Viroid.
9. Systemic infection is found in _____.
   a. Fan leaf of grapes, b. Grape yellows, c. Pierces of grapes,
   d. all of these.
10. Fan leaf of grapes can be managed by _____.
    a. Fungicide, b. bactericide, c. nematicide, d. insecticide.

I. Answers.

1	2	3	4	5	6	7	8	9	10
b	b	b	c	a	b	d	c	d	c

II. Fill the gaps with suitable answers. 0.25X20 =5

1. _____ disease of grapes led to accidental development of fungicide _____, which is _____ in action, and the credit of this fungicide goes to _____.
2. Whitish downy and powdery growth of grapes comprises of _____ & _____ respectively.
3. Saturated humidity and dry humidity are adverse environmental conditions for _____& _____ diseases of grapes respectively.
4. Downy mildew & powdery mildew organisms of grapes are obligate _____&_____ parasites.
5. Age old resistant varieties of D.M. & P.M. of grapes are _____& _____ respectively.l
6. Causal organisms of grape rust and downy mildew are _____ *vitis* & _____*viticola* respectively.

7. Important viral disease of grape _____.
8. Two bacterial diseases of grapes _____& _____.
9. Two market diseases of grapes _____& _____.
10. Downy mildew and grape rust belongs to the kingdom _____ &_____ respectively.

II Answers

1	D.M, Bordeaux mixture, contact, P.A. Millardet.
2	Sporangiophore, sporangia & oidea.
3	P.M &D.M.
4	Endo & ecto.
5	Bangalore blue & Red sultana.
6	*Physopella* & *Plasmopara.*
7	Fan leaf of grapes.
8	Crown gall of grapes & Grapes canker.
9	Bird eye spot & Black rot.
10	Chromista & Mycota.

III. Match the following. 0.5X10=5

Sl.no.	A	Sl.no.	B
1	*Xiphenema index*	a	Grapes yellows
2	Bordeaux mixture	b	Powdery mildew of grapes
3	Bronzing	c	Bacterial canker
4	Hexaconazole	d	Grape rust
5	Fruit cracking	e	Pierces of grapes
6	Monotrichous bacteria	f	Bird eye spot
7	Plant hopper	g	Crown gall of grapes
8	Teliospores	h	Fan leaf of grapes
9	Acervulus	i	First fungiside

10	Peritrichus bacteria	j	Emulsified liquid

III Answers

1	2	3	4	5	6	7	8	9	10
h	i	e	j	b	c	a	d	f	g

IV. Say true or false, if false correct the statement 0.5X10=5

1. Powdery mildew of grapes was responsible for the wine industry collapse in France in 1982-84.
2. Sporangiophore branching of *Plasmopara viticola* is at acute angle.
3. Curved tip appendage with single ascus is found in Cleistothecium of grape powdery mildew.
4. Grape rust belongs to the order Uridinales and family Pucciniaceae.
5. Bird eye spot is a synonym of anthracnose in grapes.
6. *Guignardia bidwelli* causes one of the post harvest diseases in grape.
7. Benomyl is best chemical for post harvest diseases in fruits.
8. Gall formation in grapes takes place at soil level.
9. Ricketsia is a fastidious vascular bacteria.
10. Powdery mildew, Downy mildew causal organisms of grape can be cultured in laboratory.

IV Answers

1	2	3	4	5	6	7	8	9	10
F, D.M, 1882-84	F, Right angle	F, More than 1 ascus.	F, Melamsoraceae	T	T	T	F, 2 feet above the soil	T	F, Obligate parasite.

By, ASHWINI, R.
H.K.704.
IV. B.Sc.(Hort.), II Semester.
8 -11-2010.
Question paper on grapes
for 20 marks.

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POMEGRANATE

Introduction:

Pomegranate (*Punica granatum)* is one of the favorite table fruit of tropical & sub tropical regions. it is native of Iran and it belongs to family punicaceae. Pomegranate is extensively cultivated in Mediterranean countries like Spain, Morocco, Egypt, Iran, Afghanistan & Baluchistan.

Ripe pomegranate fruits are consumed fresh. Juice extracted from fruits makes an excellent drink. Apart from this, an attractive jelly anar-rub and syrup can also be manufactured from ripe fruits.

IMPORTANT DISEASES OF POMEGRANATE:

1. Cercospora leaf spot	-	*Cercospora punicae*
2. Bacterial blight	-	*Xanthomas axonopodis* pv. *punicae*
3. Leaf spots	-	*Colletotrichum gloeosporioides*
	-	*Sphaceloma punicae*
	-	*Fusarium fusaroidies*
	-	*Phomopsis aucubicola*
	-	*Drechslera rostara*

Minor diseases

1. Canker	-	*Ceuthospora phyllosticta*
2. Leaf and fruit spot	-	*Coelophoma empetri*
3. Flower and fruit spot	-	*Phytophthora nicotianae*
4. Fruit Spots	-	*Beltaraniella humicolla*
	-	*Pestalotiopsis versicolor*
5. Fruit rots		
*a.*Cladosporium fruit rot	-	*Cladosporium oxysporum*
b. Aspergillus fruit rots	-	*Aspergillus spp.*
c.Mild soft rot	-	*Penicillium chysogenum*

d. Soft rots	-	*Rhizopus arrhizus & R. stolonifier*
e. Dry rot	-	*Syncephalastrum racemsum*
f. Fusarium rot	-	*Fusarium equiseti*
g. Phomopsis rot	-	*Phomopsis sp.*
6. Root knot nematode	-	*Meloidogyne incognata*

Cercospora leaf spot - (*Cercospora punicae)*

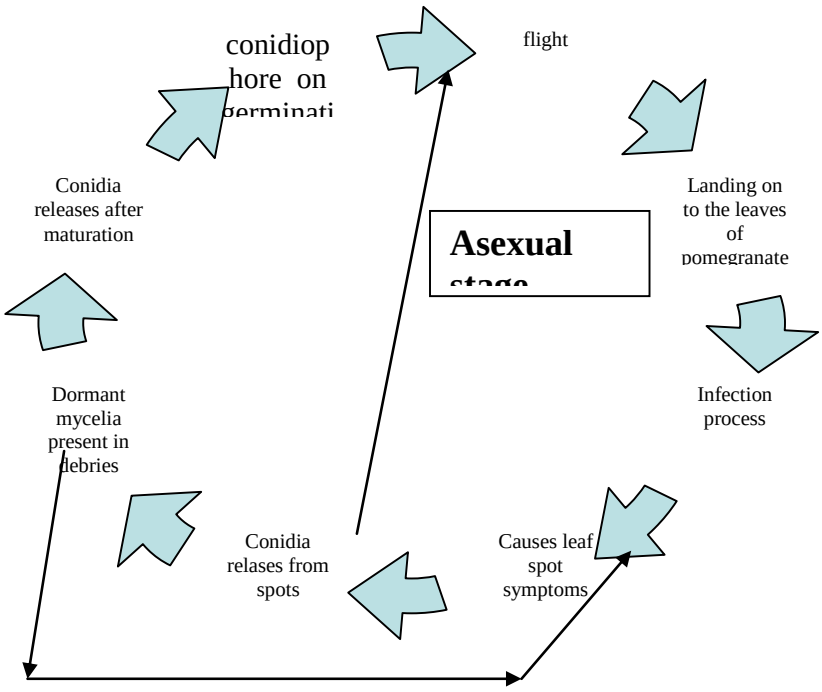
Symptoms:-

- Light brown zonate spots appear on the leaves and fruits.
- Black and elliptic spots appear on the twigs.
- The affected areas in the twigs become flattened and depressed with raised edges.
- Such infected twigs dry up. In severe cases the whole plant dies.

Causal organism:-

This disease coused by fungus Cercospora punicae ***(P.Henn)***. Conidiophores are olivaceous brown, short fasciculate, sparingly septate. Conidia are hyaline to pale olivaceous cylindrical, sub fisoid to sub clavate, septate .

Life cycle:



Mode of survival and Spread:

The pathogen survives in affected plant parts as dormant mycelia and spreads through airborne conidia produced in acervullus.

Epidemiology:

The disease is severe during August to November. When there is high humidity and the temperature between 20 and 27o C

Management:

Cultural practice:

- Clean cultivation, i.e. sanitation, includes removal of weeds.
- On fallen leaves or affected plant parts, spray nitrogen solution or bleaching powder to enhance degradation.
- Prune all affected branches then burn affected branches and pruned material and pruned area should be smeared with Bordeaux paste or coc paste.

Chemical:

- Spray thiophanate methyl 0.1% or mancozeb 0.2% or cardendazim 0.1%.

2. **Bacterial blight:** (*Xanthomas axonopodis* pv. *punicae)*

Symptoms:

- Small irregular, water soaked spots appear on the leaves.
- Spots vary from two to five mm in dia with necrotic centre of pin-head size.
- Spots are translucent, later turn light brown to dark brown and are surrounded by prominent water-soaked margins. Spots coalesce to form large patches.
- Severely infected leaves fall off.
- The bacterium attacks stems, branches and fruits also.
- On the stem, the disease starts as brown to black spots around the nodes it leads to girdling and cracking of nodes. Finally the branches break down.
- Brown to black spots on fruits is raised and oily in appearance.

Causal organism:

- *Xanthomonas axonopodis* pv.*punicae* [= *Xanthomonas campestris* pv.*punicae*].
- It is Gram-negative rod, motile with single polar flagellum. It is non acid fast and aerobic.

Mode of spread and survival:

- The bacterium survives on the tree.
- The pathogen survives for 120 days on he fallen leaves during the season.
- The primary infection is through infected cuttings.
- The disease spreads through wind splashed rains.

Epidemiology:

High temperature and low humidity favor the disease. Temperature of 30 to 34o C, relative humidity of 80 to 85% is favorable for multiplication of pathogen.

Management:

- Clean cultivation and strict sanitation in the orchard help to reduce the disease incidence.
- Collect and burn the fallen leaves
- Spraying of 1 per cent urea solution to fallen leaves enhances the degradation
- Bleaching on to the fallen leaves reduces the inoculum
- Spraying the Bordeaux mixture 1.0% controls the disease.
- Spray 0.05% streptocycline to control the disease
- Also can use copper oxy chloride spray at 0.3% concentration.
- Pruning at correct stage would reduce the disease(Bahar pruning)
- Ganesh as moderately resistant variety for bacterial blight disease

Leaf spots: (*Colletotrichum gloeosporioides)*

Symptoms:

- The disease appears as small, regular to regular to irregular dull violet or black spots on the leaves.
- These spots are surrounded by yellow margins.
- The infected leaves turn yellow and drop off.

Mode of survival and Spread:

- The pathogen survives in affected plant parts as dormant mycelia
- Spreads through airborne conidia produced in acervullus.
- Mode of entry through stomata

Epidemiology:

- The disease is severe during August to November.
- When there is high humidity and the temperature between 20 and 27o C

Management:

- Clean cultivation.
- On fallen leaves or affected plant parts, spray nitrogen solution or bleaching powder to enhance degradation.
- Prune all affected branches then burn affected branches and pruned material and pruned area should be smeared with Bordeaux paste or coc paste.
- Spray thiophanate methyl 0.1% or mancozeb 0.25% or cardendazim 0.1%

***Sphaceloma punicae* (Bitancourt and Jenkins)**

Symptom:

- The disease attacks leaves, shoots, calyx and fruits.
- Rusty spots appear on leaves. Infected leaves turn yellow and die, Rusty colored pustules appear on fruits.

- Drizzling rains and abundant dew favor disease development and spread.

Mode of survival and Spread:

The pathogen survives in affected plant parts and spreads through airborne conidia

Epidemiology:

The disease is severe during August to November. When there is high humidity and the temperature between 20 and 27^0 C

Management:

- Clean cultivation.
- On fallen leaves or affected plant parts, spray nitrogen solution or bleaching powder to enhance degradation.
- Prune all affected branches then burn affected branches and pruned material and pruned area should be smeared with Bordeaux paste or coc paste.
- Spray thiophonate methyl 0.1% or mancozeb 0.2% or carbendazim 0.1%.

Fusarium wilt: ***Fusarium fusarioides*** **(Farg &Cif)**

Symptom:

The disease appears as minute specks towards the leaf margin.

The spots are brown, circular to irregular in shape. Later the spots coalesce and form big dark brown necrotic blotch.

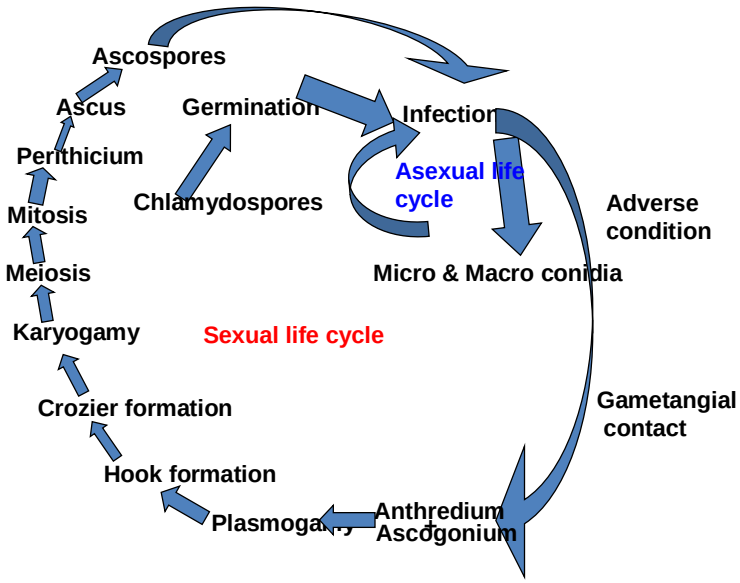
Mode of survival and Spread:

The pathogen survives in affected plant parts and spreads through airborne conidia

Epidemiology:

The disease is severe during August to November. When there is high humidity and the temperature between 20 and 27o C

Life cycle:



LIFE CYCLE OF FUSARIUM sps.

Management:

- Clean cultivation, i.e. sanitation, includes removal of weeds. On fallen leaves or affected plant parts, spray nitrogen solution or bleaching powder to enhance degradation.
- Prune all affected branches then burn affected branches and pruned material and pruned area should be smeared with Bordeaux paste or coc paste.
- Spray thiophonate methyl 0.1% or mancozeb 0.2% or cardendazim 0.1%.

Minor diseases

1. **Canker (*Ceuthospora phyllosticta)***

Symptom:

- Elliptic black spots are formed on the twigs.
- Affected areas become flattened and depressed wit raised edge.

- Later the bark dries and cracks and the wood below show abnormal dark brown black discoloration.
- Twigs beyond the cankerous spots dry off and in severe cases the affected tree dies.

Mode of spread and survival:-

Pathogen survives on can survive on the cankerous growth of the leaves, stem or fruit. At the time of warm rainy season bacteria ooze out from cankers, and then spread through splash borne and air borne. itenter through stomata and wounds on the plants.

Life cycle:

The bacterial spores present in the cankers ooze out when the conditions are congenial to them. then become splash borne or air borne and goes on moving, when they come in contact with the host plant surface they enter into the host through stomata or through wounds, multiplies inside the plant, causes infection, shows symptoms like cankerous growth on the surface and continues its life cycle.

2. **Leaf and fruit spot: *Coelophoma empetri* (Rostrup)**

Symptom:

- On leaves the spots are circular, reddish, and brown to dark brown.
- They coalesce to form bigger sized lesions which are negotic and dark brown.
- Later infected leaves turn pale yellow and drop brown.
- On fruits numerous minute circular tan brown spots which turn brown to black later.
- They coalesce to form irregular depressed and hard necrotic lesions.
- Lesions are restricted to epidermis baring black spherical pycnidia.

3. **Flower and fruit spot: *Phytophthora nicotianae***

Symptom:

- Spots on flower leads to premature shedding.

- Lesions are also found on fruits.
- Twigs in the trees are also infected.

Mode of survival and Spread:

Oospores are spherical. Sporangia are broadly turbinate with spherical basal portions and apical part prolonged into a break, papillate

Life cycle:-

- Oospores are thick walled, sexual diploids spores, present in the affected debris
- When conditions are congenial they germinates as a sporangium and releases zoospores
- Zoospores flight then encystment (Short period resting phase) takes place where and loose their flagellum.
- Soon after landing on to the host surface, encysted zoospore germinate to produce germ tube and enters through stomata.
- The mycelia multiplies by producing intracellular haustoria and absorbing nutrients and causes infection by producing sporangium and life cycle continues.
- If conditions are adverse it undergo sexual reproduction in that gematangial contact type of reproduction between oogonium and Antheridium take place.
- Plasmogamy, Karyogamy and oospores formation and the life cycle continues.

Management:

- Clean cultivation.
- On fallen leaves or affected plant parts, spray nitrogen solution or bleaching powder to enhance degradation.
- Prune all affected branches then burn affected branches and pruned material and pruned area should be smeared with Bordeaux paste or COC paste.
- Spray thiophonate methyl 0.1% or mancozeb 0.2% or cardendazim 0.1%

4. Fruit Spots

a. *Beltaraniella humicola*:

Symptoms:

- Black circular spots gradually enlarge and coalesce to form big spots leading to necrosis.
- The margin of spots varies from reddish to brown in color.
- Infection is restricted to the rind of fruit and undesirable of the pulp.

Mode of survival and Spread:

The pathogen survives in affected plant parts as dormant mycelia and spreads through airborne conidia

Epidemiology:

The disease is severe during August to November. When there is high humidity and the temperature between 20 and 27o C

Management:

- Clean cultivation.
- On fallen leaves or affected plant parts, spray nitrogen solution or bleaching powder to enhance degradation.
- Prune all affected branches then burn affected branches and pruned material and pruned area should be smeared with Bordeaux paste or coc paste.
- Spray thiophanate methyl 0.1% or mancozeb 0.25% or carbendazim 0.1%.

b. *Pestalotiopsis versicolor* (Speg.):

symptoms:

- The disease manifests its symptom as minute, brown to rust colored spots on the fruits.
- The spots coalesce with the disease advance and causes necrotic patches.

- The central portion of the lesion is depressed inward with raised margin and severe infection tear open the rind.
- In several cases infection penetrates deep into the fruits and causes discoloration of seeds.

Mode of survival and Spread:

The pathogen survives in affected plant parts as dormant mycelia and spreads through airborne conidia

Epidemiology:

The disease is severe during August to November. When there is high humidity and the temperature between 20 and 27o C

Management:

- Clean cultivation.
- On fallen leaves or affected plant parts, spray nitrogen solution or bleaching powder to enhance degradation.
- Prune all affected branches then burn affected branches and pruned material and pruned area should be smeared with Bordeaux paste or coc paste.
- Spray thiophanate methyl 0.1% or mancozeb 0.25% or carbendazim 0.1%.

5. **Fruit rots:**

a. **Cladosporium fruit rot:** ***Cladosporium oxysporum***

The diseased fruits develop orange-red to dull-brown circular spots and become olive-brown. In advanced stage, the entire fruit rots. Hyphae of the fungus are separate. Light olive-green, 2.5 to 30 µm in width. Conidiophores are light brown and simple. Conidia are light brown to olive green, 1-celled, fusoid and 1 to 20 x 3.5 to 4.5 µm.

b. **Aspergillus fruit rots:** ***Aspergillus flavus*** **(Link)**

It causes brownish discoloration, which gradually becomes blackish and slimy. Later it gets slightly depressed and is covered by green conidial heads of the fungus. The diseases cause soft rot fruits and emits fermented odour.

c. **Mild soft rot:** ***Penicillium chrysogenum*** **(Thom)**

Soft, Watery spots of two to four cm dia appear on the fruits. They increase in size and coalesce together. The spots are found covered with white mycelium and bluish green spores.

d. **Soft rots:** ***Rhizopus arrhizus & R. stolonifer (Fisher)***

Small spots appear on fruits. They increase in size and coalesce. Infection is restricted to rind. But the entire internal content decays into a pulpy mass. Under dry conditions cracking originated from the point of infection. Packing straw should be treated with sulphur dioxide. Treatment of fruits with linseed oil and mustard oil or castor oil protects them from rot.

e. **Dry rot:** ***Syncephalastrum racemosum (Cohn)***

Small isolated dark patches are formed on the surface of the fruits the patches are dry and covered with the mycelium and spores of the fungus. Inner pulp rots.

f. **Fusarium rot:** ***Fusarium equisetti (Corda)***

Circular and depressed lesions appear on the fruits. Lesions are surrounded by concentric wrinkles. The lesions increase in size and cover almost the entire fruit.

j. **Phomopsis rot:** ***Phomopsis*** **sp.**

The disease starts from calyx end and gradually spreads over the entire fruit. Pycnidia appear on affected areas. One spray with copper oxychloride checks the spread. Copper oxychloride 0.5 spray three times at 10 days interval controls the disease.

Management of fruit rots:

Harvest the produce during cool hours.

- During grading Wounded affected, irregular sized fruits or bunches discord.
- Use aerated boxes and smooth bedding filling material

- Preserve the produce before transit in completely controlled atmosphere condition
- Remove all affected part around grading packing areas
- Sterilize/decontaminate the storage bins with 0.5% formaldehyde or 70% ethyl alcohol.
- Chemical treatment with Benomyl 1g/lit, dip the fruits.
- Wax coating.
- Dip the fruits in wax solution.
- Dip the fruits in oils: Neem, Castor oil
- Dip the fruit in trichoderma solution.

6. Root knot nematode:-(*Meloidogyne incognita*)

Symptoms:

- Gradual yellowing of plant, stunting, root discoloration, formation of knots on the roots, root decay, finally plant collapse.

Mode of survival and spread:

- Survives in affected soil &affected plant and spread through irrigation water.

Epidemiology:

- Soil moisture, neutral pH, sandy loam soil, susceptible host.

Management:

- Use healthy certified plants.
- Use disease free area for new plantation.
- Pull out the affected plants &burn.
- Avoid excess N application: increase K application induces resistant to the plants.
- Apply Carbofuron 10-15g with 5-10 Kg of FYM to the root zone.
- Apply neem cake 5Kg/plant. Flooding of plot creates anaerobic condition. Apply VAM.

Model question paper of Pomegranate

I. Choose the correct answer.

1. Leafspot in pomegranate is caused due to-------
a*). phomopsis aucubicola b) drechslera rostrata* c) both d) none

2. Bacterial blight by—
a) Gram positive b) gram negative c) both d) none

3. Chladosporum conidiophores are----
a) Green colour b) dark brown c) light brown d) color varies

4. Epidemiology of bacterial blight is---
a) high temperature b) low humidity c) both d) none

5. Bacterial blight controlled by-----
a) Streptocyclin b) bordeux mixture 1% c) both d) none

II. Fill in the blanks.

1. dry rot and soft rot in pomegranate is caused due to------*&*-------*(syncephalastrum racemosum &rhizopus stolonifer)*
2. Bacterial blight on the pericarp with -----/----- shaped cracks.(L&Y)
3. Epidemiological factor for *xanthomonas axonopodis pv. Punicae*-----&------.(high temperature and low humidity)
4. Heart rot in punica granatum caused by ------&-----.(*Aspergillus niger & Alternaria spp.)*
5. Cercospora leaf spot can be controlled by -----@-------%. (mancozeb@0.2%)

III. Match the following.

1. leaf spot of pomegranate	starts from calyx end (3)
2. Bacteria	wind born (4)
3. *Phomopsis spp.*	*Fusarium fusaroides* (1)
4. leaf spot	rain splash (2)
5. *Sphaceloma punicae*	rust colored spots (5)

IV. True or False.

1.*Phytophthora nicotiana* leads to premature shedding of flowers.(T)
2. Blight shows mis shapen marking on fruit skin. (F) (L&Y)
3. Rusty pustules appear on leaf caused by *Sphaceloma punicae*. (T)
4. Cercospora shows red spots.(F) (brown)
5. Punica blight by *Xanthomonas axonopodis*.(T)

STRAWBERRY (*Fragaria chiloensis*)

Introduction

Family: Rosaceae

Origin : Northern America

- Strawberries are the favored fruit of many nations of the world.
- This fruit may be found in the markets from the tropics to the polar zones in both hemispheres.
- The strawberry plant, after producing the fruit ends out a number of runners along which new plants arise at intervals.
- A single mother plant in a vigorous condition may produce from 25 to 5new plants.
- Mother plants will form new crowns and roots produce berries for a number of years, but these are usually inferior to the younger plants formed from the runners.

Diseases of strawberry:

Powdery mildew

Symptoms

- Whitish powdery growth on upper surface of the leaf even young stem defoliation fruit cracking take place also fruit size reduction reduced fruit yield.
- Occasionally a powdery or surface mildew cause s some damage to plants.
- Casual Organism: *Sphaerotheca fragariae.*

Etiology

- Mycelium is white, septate, ectophytic and sends globose haustoria into the epidermal cells of the host. Conidiophores are short and erect.
- Conidia are one celled, oblong, and minutely verrucose with many large fat globules.
- Cleistothecia are formed towards the end of the season on the leaves, petals, stems and thorns. Cleistothecia are with simple myceloid appendages.
- Each ascus contains 8 ascospores.

Mode of spread and survival

The fungus over winters mycelium in dormant buds and shoots which are not entirely killed.

Either conidia or ascospores serve as primary inoculum. Secondary spread is through wind borne conidia. (Cleistothecia of the fungus)

Epidemiology

- Infection occurs when the air is saturated with moisture and the temperature is about 200c.
- Optimum conidial germination occurs at 97 to 9per cent relative humidity and at temperature ranging between 17 to240c.
- Spore production is maximum at 24 to 280c.

Disease cycle

- Affected leaves, buds and twigs having clestothecia, in favourable conditions it produce ascus (sexual fruiting body) in that ascospores are present.
- Ascus liberates ascospores and they flight, landing on to the host surface and cause infection leeds to powdery mildew. White powdery growth comprising of oidea.
- Oidea releases barrel shaped conidia and cause infection and continues asexually life cycle.
- Adverse climatic conditions the fungus switched on to sexual stage by production of Antheridium and Ascagonium.
- Gametangial contact type of reproductiononce Ascogonium and Antheridium come in contact together, plasmogamy, karyogamy, meiosis followed bymitosis and ascospore formation take place.

Management:

- The diseased and fallen leaves should be collected and burnt.
- Four sprayings at 1days interval with wet table Sulphur 0.3 per cent or Dinocap 0.07 per cent or Carbendazim 0.1 per cent controls the disease effectively.
- Spraying with Phalton 0.3 per cent + Carbendzim 0.1% also controls the disease. Spraying with benomyl 0.1 per cent or triademefon (bayleton) 0.1 per cent at 3days interval controls the disease.
- Some of the resistant varieties are aawliver, abhisarika, Adolf morstman, African star, Barbara etc.

- Excess fertilization especially with nitrogenous fertilizers and crowding of plants should be avoided.

LEAF SPOT

Symptoms

- Leaf spot is most frequently evident on the blades of the leaflets, but may appear on the petioles, fruit, and fruit stems.
- The lesions may be seen first on the upper surface as small, deep-purple, somewhat indefinite areas.
- As the spot enlarges, the central area becomes brown, but soon turns to a definite white spot in older leaves or to a light brown in young tender leaves.
- An indefinite dark purple zone surrounds the central light area, giving the whole a birds-eyes effect.
- When the infections are bunched on the leaf, the purplish area may become confluent and extend around a number of the white spots, and if the infection is near the edge of the leaflet, the purpling often extends to the border.
- One the undersurface the symptoms are much the same as on the upper, but the coloring is less intense.
- Here the prominent veins which are touched by any of the spots take on a reddish-purple color which extends some distance beyond the infected spots.

Casual Organism *Mycosphaerella fragariae.*

Management:

- Curing of planting material
- Caprtonbal 13kg/ha soil application
- Copper Oxychloride 0.3% or Carbendazim 0.1%

Strawberry Leaf Scorch

Symptoms

- Leaf scorch lesions may appear not only on the leaf blades but also on the petioles, fruit pedicels, and on the sepals of the calyx.
- In a very early stage leaf scorch lesions resemble those produced by the leaf spot organism in that small dark purple spots appear scattered over the upper surface of the leaflets.
- It is not difficult to distinguish the two after the spots have developed.
- In the mature condition the leaf scorch spots are large and irregular in outline and never show the white central area characteristic of the leaf spot disease.
- On the contrary, the black fruiting bodies which develop in the central area give the leaf scorch disease a tar spot appearance.

Causal Organism : *Leptothyrium fragariae*

Disease Cycle.

- Strawberry leaves often survive the winter, and diseased leaves may be found in the early spring bearing both the perfect and imperfect stages of the leaf scorch organism.
- Ascospores are more important than the conidia in primary infection, since they are discharged in great numbers during the early spring months when the new leaves are developing.
- Under suitable moisture conditions the ascospores germinate within 24 hours and infection takes place by direct penetration of the epidermal cells, in contrast to the stomatal infection of Mycosphaerella fragariae.

Management:

- Use Healthy planting material
- Avoid creation of un necessary wounds
- Application of fertilizer should be delayed at least 1days
- spraying with Copper oxychloride 0.3 per cent or defolaton 0.2 per cent or Chlorothalonil 0.2 per cent
- Use of resistant varieties

Leaf Blight

Symptoms

- The disease is most conspicuous on the leaves, although at times it appears on the calyx.
- Usually the spots on the single leaflet are limited to one to five or six.
- When first observed, the young spots are uniformly reddish purple and almost circular in outline. If they are near one of the main veins, the spots are elliptical.
- Later three zones may be normal green of the leaf, a light brown zone about 5 mm width, and, finally, a dark brown central area 2 to 3 mm in diameter.
- The white central area characteristic of leaf spot is never present.
- If the spots occur on a prominent vein, and especially if on the midrib, the typical V-shaped lesion is formed, with the purpling of the tissue extending fanlike to the border of the leaflet.

Caual organism: *Dendrophoma obscurans*

Management:

To spray the 1% of mercuric acetate.

Cortical Root Rot (Black Root) of Strawberry

Symptoms:

- A plantation affected by root rot presents an uneven patchy appearance due to dwarfing of the diseased plants and to gaps caused by the complete death of the severely affected plants.
- It is generally agreed that certain definite concerned.
- Under certain environmental conditions some of these organisms are considered much more virulent than others.

Management:

- Biological controlTrichoderma viride
- ChemicalCarbendazim 0.1% apray.

Grey Mold of Strawberry

Symptoms

- The disease, while regarded as a fruit rot, often starts early in the season as a blossom blight.
- In the cluster of blossoms on the main fruit stalk, one or more will show a blasted condition, usually with the disease extending part way down the pedicel.
- Later, as the berries enlarge, the disease may be observed on the tips of the calyx lobes, often confined to one or two of the lobes.
- Infection on the berries may appear at any point.
- Often the first rot on half-grown fruit appears at the base of the fruit and originates from the infected calyx.

Causal Organism*: Botrytis Cinerea.*

Management

- Picking and destroying old blooms and over wintered canes help in reducing the disease.
- Avoiding excess irrigation helps to check the disease.
- Fungicidal spray with triphenyl tin acetate (Brestan) 0.05 per cent is effective in its control.
- The disease is effectively controlled by spraying with ferbam 0.2 per cent or capton or benomyl 0.1 per cent or mancozeb 0.2 per cent

Angular Leaf Spot (Bacterial Blight)

Angular leaf spot or bacterial blight of strawberries is caused by the bacterium Xanthomonas fragariae. The disease was first reported in Minnesota in 1960, and It appears to be spreading rapidly to many strawberry-growing areas of the world with the importation of planting material.

Symptoms

- Typical symptoms of angular leaf spot appear initially as minute, water-soaked lesions on

the lower leaf surface (Figure).

- These lesions enlarge to become angular spots, usually delineated by small veins.
- An important distinguishing characteristic of this disease is that lesions are translucent when viewed with transmitted light, but dark green when viewed with reflected light (Figure).
- Under moist conditions, lesions often have a viscous bacterial exudate on the lower leaf surface. When it dries, the exudate forms a whitish, scaly film.
- This exudate or film is an additional characteristic that is useful in the identification of angular leaf spot.
- Lesions may coalesce to cover large portions of the leaf.
- Eventually, lesions become visible on the upper leaf surface as irregular, reddish-brown spots, which are necrotic and opaque to transmitted light.
- A chlorotic halo may surround the lesion.
- At this stage, symptoms may be difficult to distinguish from those of common leaf spot and leaf scorch.
- Heavily infected leaves may die, especially if major veins are infected.
- Occasionally, under natural conditions, infection follows the major veins, resulting in veinal water-soaking that may or may not spread to the interveinal regions.
- Infection by *X. fragariae* may become systemic.
- The pathogen can infect all plant parts except fruits and roots and, in some cases, even the fruits have been infected, apparently only in the tissue adjacent to an infected calyx (fruit cap).
- Calyx infection can be serious. Infected tissues turn black resulting in unattractive fruit (Figure 10).

Disease Development

- Inoculum for the primary infection of new growth in the spring comes from infected dead leaves where the pathogen over wintered.
- *X. fragariae* may survive for extended periods in dry leaves or in infected leaves buried in the soil. Spread is primarily from infected leaf debris or infected crowns.

- Bacteria that exude from lesions under high-moisture conditions may provide secondary inoculum.
- Bacteria may be disseminated to uninfected plants or leaves by splashing water, such as rain or overhead irrigation.
- *X. fragariae* gains entrance into host tissue either passively through wounds or actively as motile cells that swim into natural plant openings by means of drops of dew, gutation fluid, rain, or irrigation water.

Epidemiology

- Moderate to cool daytime temperatures around 20C,
- low nighttime temperature (near or just below freezing) and
- High relative humidity (92- 97%).
- Long periods of precipitation,
- Sprinkler irrigation to protect plants from freezing, or heavy dews in the spring also favor the disease.
- Young leaf tissue or leaves on healthy, vigorous plants are more likely to become infected than those on diseased or environmentally stressed plants.

Management

- Identification of the disease at the early stage and removal of runners reduces the disease
- Picking and destroying old blooms and over wintered canes help in reducing the disease.
- Avoiding excess irrigation helps to check the disease.
- Fungicidal spray copper oxy chloride 0.2% is effective in its control.
- The disease is effectively controlled by spraying with streptocycline 0.05%.

Minor Diseases of the Strawberry

- Stem-end Rot and Leaf Blotch.
- Verticillium Wilt of Strawberries.
- Leathery Rot of Strawberries

- Rhizoctonia Brown Rot of Strawberries.

POST HARVEST DISEASES OF STRAWBERRY

- Botrytis rot: *Botrytis cineria*
- Colletotrichum rot: *Colletotrichum spp*
- Phytophthera rot: *Phytophthora spp*

Management:

- Poly mulching avoid the fruit touches to the soil
- Avoid the over mulching
- Harvest in the fruits in cool hours and drying in shade condition
- Strawberry packing using the dry material preserve it in controlled environmental condition (-4c)
- Before the 15 days harvest spray the benomyl 1g/ lit

REFERENCE DISEASES OF HORTICULTURAL CROPS

- Dr. Arjunan
- G. Karthikeyan
- Dr. Dinakaran
- Dr. T. Raguchander
- PLANT PATHOLOGY
- GEORGE N. AGRIOS

Pl. Path 303 (2+1)Diseases of Fruit, Plantation, Medicinal and aromatic crops

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Jack

Introduction

Jackfruit (*Artocarpus heterophyllus*) is consumed as fruit as well as vegetable. The trees are supposed to be hardy but even then the following diseases become a limiting factor in its cultivation. Jack fruit is a minor and less exploited crop which is rarely grown as monocrop. Usually it is grown as mixed crop.

Jack fruit is said to be rich source of carbohydrate and even some vitamins like VitaA.

The plant genus *Artocarpus* comprises roughly 50 species of tropical trees native to the Pacific and South and Southeast Asia, several of which produce edible Fruit. Jackfruit, *Artocarpus heterophyllus*,

Rhizopus rot is a common fungal disease of jackfruitb flowers and fruit. Rot is more likely to occur in high-rainfall areas or during and after stormy periods. When warm, humid, wet weather coincides with the flowering and fruiting season, rhizopus rot can cause total loss of fruit in jackfruit trees.

Major Diseases

1. Die back; (*Botryodiplodia theobromae*)
2. Fruit rots
    a. *Rhizopus artocarpus*
    b. *Rhizopus nigriocans*
    C. *Phytopthora palmivora*

Minor Diseases

a. Leaf spot- *Phyllosticta artocarina*
b. Pink disease- *Botryobasidium salmonicolor* & *Corticium Salmonicolor*

Major Diseases

1. Die back (*Botryodiplodia theobromae*)

SYMPTOMS

- The most of the becomes evident by discoloration & darkening of the bark some distance from the tip.
- The dark area advances & young green twigs start withering first at the base & then extending out words along the veins of leaf edges.
- The affected leaves turn brown & their margins roll upwards at this stage.
- The twig or branches dies shrivels & falls there may be exudation of gum from affected branches such branches are often affected by shoot borers infected twigs show internal discoloration.
- At this stage, the twigs or branches die, shrivel and fall, and there may be an exudation of gum from affected branches. Such branches have also been found to be affected by shoot borers and shot hole borers. when split open.
- In early stages, epidermal and sub-epidermal cells of twigs are often slightly shrivelled On such twigs, erumpent aceruvuli of *Colletotrichum gloeosporioides* are also observed.

CAUSAL ORGANISM: *Botryodiplodia theobromae*

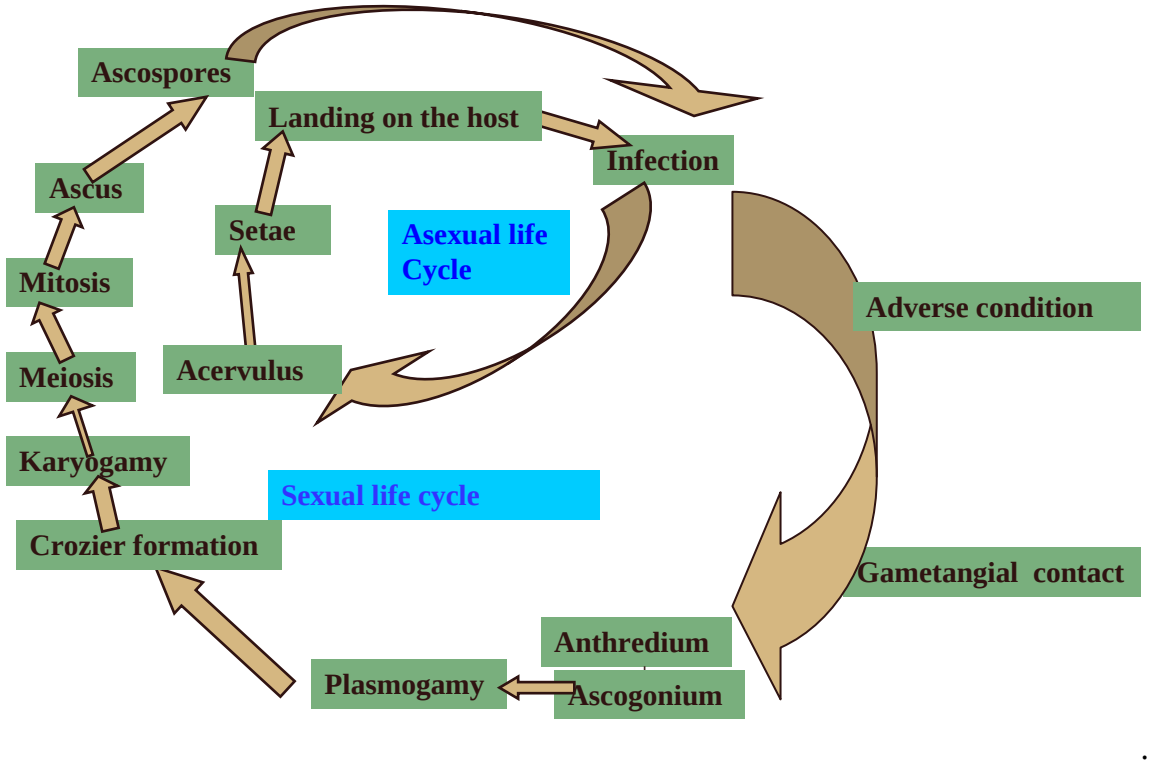
ETIOLOGY:

- Pycnidia are asexual fruiting body, up to 5mm in diameter. Conidia are asexual spores, thin walled at first and become thick walled, septate mycelia is present.
- Primary source of inoculum: Dormant mycelia
- Secondary source of inoculum: Soil and airborne conidia.

EPIDEMOLOGY

Temperature at 25^0 -30^0. low relative humidity (80- 85%), susceptible host.

DISEASE CYCLE:



Management:

- Pruning of infected twigs followed by spraying of carbendazim 0.1% or thiophonate methyl 0.2 % or chlorothaloni 0.2% is recommended.
- Controlling shoot borer, & shot hole borers by suitable insecticides is also important in reducing die back disease

2. Fruit rots

a. *Rhizopus artocarpi*

SYMPTOMS:

- The young fruits & inference are badly attacked by the fungus & only a small percentage of the fruit reach maturity female inflorescence & matured fruits are not usually attacked.
- The disease is a soft rot a large no. of the affected fruits fall off early.
- In the first stage of attack the fungus appears as a grayish growth with abundant mycelia which gradually becomes dense forming a black growth.

- The fungus gradually advances until the whole fruit or the entire inflorescence rots & falls off.

Causal organism:Three species of plant-pathogenic fungi of the genus *Rhizopus* can cause this disease in the tropics: *Rhizopus oryzae*, *Rhizopus artocarpus*, and *Rhizopus stolonifer*. No jackfruit varieties are reported to have significant resistance to the disease.

EPIDEMIOLOGY:

- Warm, humid, rainy conditions favor the development of rhizopus rot. Wind, rain, and insects dislodge and spread the tiny fungal spores.
- When deposited on moist fruit surfaces, the spores germinate and infective mycelia grow into the tissues.
- The infection produces a layer of black spores on the fruit surface to start secondary cycles of infection and disease. Although wounds can predispose the fruit to infection, unwounded flowers and
- young fruit are also susceptible.
- *Rhizopus* can survive on decaying plant litter or in the soil to initiate new infections.

Management

- Prune the tree to encourage good ventilation and to reduce relative humidity in the canopy.
- Remove and destroy diseased fruit from trees and the ground. Clean up decaying organic debris within and around the tree.
- Ensure that water does not pond around the tree's root zone. Control weeds around young trees.
- Intercrop jackfruit with trees that are not susceptible to infection by Rhizopus. Keep ripe fruit from contact with the soil or decayingorganic material.
- Avoid wounding the fruit. Wash fruit after harvest in clean water and dry thoroughly before packing or transporting.
- Do not pack fruit with symptoms, destroy them.
- Avoid storing fruit after harvest in hot, poorly ventilated containers.

Chemical Control:

- Spraying of the young fruits with capton 0.2% or Bordeaux mixture 1.0% or copper oxy chloride .025%.
- An interval of three weeks during the months of Jan – Feb & March is effective in controlling the disease.

***Phytophthora* rot:** *Phytopthora palmivora*

Symptoms:

- Infection takes place through whole or wounded skin in rough skinned verities & through wounds in smooth skinned verities.
- Water socked lesions occur 48-78 hours after inoculation. They enlarge to form light brown spots with sporulating hyphae near the edge affected fruits develop soft rot.
- The damage caused to the bark of crown roots and or bark of the trunk is called Phytophthora gummosis collar rot or foot rot.

Causal Organism: *Phytopthora palmivora*

Epidemiology

- Sporangial production rain water was the best and P. *palmivora* thrives best at 25-28°C. A soil pH of 5.4-7.5 favours the disease

Management: Spraying with Benomyl 1g/lt completely control the rotting

MINOR DISEASE

A. Leaf spot- (*Phyllosticta artocarina*)

Symptoms:

It produces white spots with broad dark margins on leaves. It can be controlled by spraying Bordeaux mixture 1.0%. *Pestalotiopsis clastica* also causes leaf spots *colletotrichom gloeosporioides*. It is characterized by dark brick red spots on both the leaf surfaces in mature spots the centres become grayish with erupted dark acervulus, The margins of the spots turn dark brown.

Management:

The disease is effectively controlled by spraying Carbendazim 0.1% or Thiophanate methyl 0.2% or Difolatan 0.2%.

B. Pink disease- (*Botryobasidium salmonicolaor* & *Corticium Salmonicolor*)

Symptoms

- It is widespread in tropical and subtropical areas.
- The disease appears as a pinkish powdery coating on the stem.
- Pink colour represents profuse conidial production of fungus.
- Young woody branches of the affected tree lose their leaves & show die back pink encrustation is seen on the lower shaded side, and show die-back.

Management:

The affected branches should be pruned and the cut end should be pasted with Bordeaux paste or Copper Oxychloride

APPLE (*Malus domestica*)

Family: Rosaceae

Origin: Caucsus mountains of south west Asia

Introduction

Apples are most delicious fruit for its crispness long storage life, Apple is the king of temperate zone, they are good for human health. Apples are high in vit c fiber low in calories, pectin .They are rich source of mineral nutrients. They contains rich amount of iron &acts as a blood purifier. Apples acts as a natural tooth brushers. Himachal Pradesh is consider as the apple bowl of India

Diseases of Apple

Apple scab: *Venturia inaequalis*

Powdery mildew: *Podosphaera leuchotricha*

Cedar rust : *Gymnosporangium juniperi verginiane*

Fire blight: *Erwinia amylovora*

Crown gall: *Agrobacterium tumefaciens*

Black Rot :*Botryosphaeria obtuse*

Sooty blotch: *Leptodontium elatius*

Flyspeck :*Zygophiala jamaicensis*

Phytopthora Crown Rot, Collar Rot, and Root: *Phytopthora spp.*

Apple Scab

Disease causing organism*: Venturia inaequalis* (Cooke) Wint.

Symptoms:

- Infections are most obvious on the leaves and fruit.
- When the infection first occurs on leaves, it is visible as a lighter shade of green when compared to the rest of the leaf surface.
- The inner portion of the lesion may become gray - brown as the fungus and the leaf tissue in that area die.
- Under severe conditions, the whole leaf can take on a velvet appearance, a phenomenon

known as scab this condition can lead to premature defoliation.

- Foliar lesions which are formed in the autumn (late season scab) may appear on either surface of the leaf as a small, round, tan or black spot that closely resembles other fungal lesions which can affect apple leaves.
- Early infection of the fruit often results in large lesions which deform the fruit, and may cause it to drop off.

Disease cycle

- The fungus primarily over winters on infected leaves on the orchard floor.
- Ascospores are released in the spring at about bud break, and disseminated by wind during rainy periods.
- Moisture required in order for the spores to germinate.
- The time it takes for infection to occur is a function of the number of hours of leaf wetness and the temperature Several secondary cycles of infection, arising from spores produced in primary lesions, may occur during the growing season.
- During the primary stage of disease development, when ascospores are released from leaves on the orchard floor, begin the degree day model in order to determine ascospore maturity.
- Orchards should be scouted on a weekly basis during the primary stage.
- Approximately seventeen days after predicted depletion of ascospores a final monitoring should be conducted for primary scab lesions.
- Management of scab for the remainder of the season should be based on the incidence of primary scab lesions.
- Late season determination of inoculum levels in the orchard may be done after harvest.

Dissemination:

Ascospores are disseminated by wind during rainy periods in the spring, and conidia are disseminated by wind and rain once infection is established on the tree

Primary source of inoculum: affected fallen leaves

Secondary source of inoculum: airborne conidia

Cultural practices:

When establishing a new orchard, plant cultivars which are resistant to the disease.

Applications of 5% urea to leaf litter may be applied in the fall in order to hasten leaf decomposition and therefore reduce primary inoculum.

FIRE BLIGHT

Fire blight is a destructive bacterial disease of apples and pears that kills blossoms, shoots, limbs, and, sometimes, entire trees.

Symptoms: Blossom blight symptoms most often appear within one to two weeks after bloom and usually involve the entire blossom cluster, which wilts and dies, turning brown on apple and quite black on pear. When weather is favorable for pathogen development, globules of bacterial ooze can be seen on the blossoms. The spur bearing the blossom cluster also dies and the infection may spread into and kill portions of the supporting limb. The tips of young infected shoots wilt, forming a very typical shepherd's crook symptom. Older shoots that become infected after they develop about 2leaves may not show this curling symptom at the tip. As the infection spreads down the shoot axis, the leaves first show dark streaks in the mid veins, then wilt and turn brown, remaining tightly attached to the shoot throughout the season. As with blossom infections, the pathogen often invades and kills a portion of the limb supporting the infected shoot. The first symptom on water sprouts and shoots that are invaded systemically from nearby active cankers is the development of a yellow to orange discoloration of the shoot tip before wilting occurs. In addition, the petioles and mid veins of the basal leaves on such sprouts usually become necrotic before those at the shoot tip.

Depending on the cultivar and its stage of development at the time infection occurs, a single blossom or shoot infection can result in the death of an entire limb, and where the central leader or trunk of the tree is invaded, a major portion of the tree can be killed in just one season. In general, infections of any type that occur between petal fall and terminal bud set usually lead to the greatest limb and tree loss. In addition, heavily structured trees tend to suffer less severe limb loss than those trained to weaker systems for high productivity.

Primary source of inoculum Over wintering cankers harboring the fire blight pathogen are often clearly visible on trunks and large limbs as slightly to deeply depressed areas of discolored bark, which are sometimes cracked about the margins.

Secondary source of inoculum: Baceterial droplets on blossom

Disease cycle:

- The bacteria over winter in bark tissues along the edges of cankers caused by infection in previous years.
- The bacteria multiplies in the spring, the cankers exude a characteristic ooze, and the bacteria are disseminated by rain and insects to vulnerable tissues - especially open blossoms, tender vegetative shoot tips, and young leaves.
- The bacteria penetrate the tree at natural openings or wounds. Secondary infection arises from fresh infections.

Disease causing organism: *Erwinia amylovora* (Burrill) Winslow

Dissemination:

Disseminated by bees and other pollinating insects and by rain

Primary source of inoculum: Affected cankers

Secondary source of inoculum: splash born bacterial cells

- Monitoring in orchard blocks where the disease occurred during the previous season.
- Observe blighted limbs and shoots for removal during normal pruning operation.
- There may be a need to remove whole trees on some occasions.
- A very important aspect of fire blight management involves monitoring the weather for the specific conditions that govern the build-up of inoculum in the orchard, the blossom infection process and the appearance of symptoms.

Fire Blight Management - Cultural Control

Dormant Season:

- Fire blight over wintering cankers have either smooth or cracked margins. Both types of cankers should be removed.
- The smooth margined cankers are harder to see, but they are also more likely to be active than rough margined cankers.
- Active cankers may enlarge in the spring causing further structural damage. They also provide inoculum for new infections.

- One or more separate operations to prune out cankers are recommended.
- Since cankers may be hard to locate, it is always best to go over the orchard several times. Cankers are most visible on bright, sunny days.
- Make cuts 15-3cm below the canker margins.
- It is not considered necessary to sterilize pruning tools during the dormant season.
- Do, however, disinfect your tools if spring pruning is extended into late spring when temperatures have warmed up and/or the budburst stage has arrived.
- These conditions may also reactivate the infectious bacteria in cankers.

In fact, an additional inspection for cankers around the budburst stage may reveal cankers that were missed earlier.

Growing Season:

- Remove current season infections as soon as they are noticed.
- Prune out infected branches at least 30-4cm below the visibly diseased part. This is necessary as bacteria are usually present beyond the discoloured area.
- Dip tools in a disinfectant between each cut.
- Flag trees that have been pruned, and watch for further symptoms or the development of cankers.
- Prunings should be removed and burned immediately.
- Scout for new fire blight strikes every 3 or 4 days. Frequent scouting will aid removal of new infections before they have a chance to invade the structural wood.
- Where infections occur on shoots attached to scaffold limbs or the trunk, it is not always possible to cut back 3cm without sacrificing the limb or even the tree.
- An option on large trees is to scrape out dis coloured inner bark using a hatchet or knife, down to clean wood, and disinfect the cut surface.
- Summer pruning (other than removal of strikes) should be avoided during a serious outbreak, due to the danger of spreading the disease.
- If there is any fire blight in the area, disinfect your tools while summer pruning.

Disinfectants:

- Good disinfectants for tools include household bleach, Lysol Concentrated Disinfectant,

and Pine Sol, as well as commercial disinfectants such as Chemprocide. Mix according to label instructions.-

- Bleach can be diluted up to 1:5 with water, and needs to be mixed fresh every day.
- Tools can either be dipped into, or sprayed with the disinfectant solution.
- If you use bleach, be aware that it will corrode metal tools and damage your clothing. Ideally, tools should be disinfected after every cut. Dilute disinfectant can also be sprayed on the bark after cutting out an infected branch.
- Don't over fertilize the trees. Excess nitrogen causes vigorous shoot growth, which is more susceptible. Nutrient application should be balanced, preferably based on soil and leaf analysis. Application of fertilizer should also be timed to avoid a late flush of growth, because late season infections are more likely to produce cankers that allow the bacteria to over winter.
- Do not run overhead sprinklers while blossom is present on the tree and weather is favorable for fire blight infection. Overhead irrigation may increase fire blight by splashing bacteria around from tree to tree, and by increasing moisture and humidity levels in the canopy. Cutting back on irrigation may also help to slow down over-vigorous trees.
- Control insects with sucking mouthparts such as aphids, leafhoppers and pear psylla. These insects can spread fire blight.

Chemical Control:

- Antibiotic streptomycin, fixed copper compounds (copper oxychloride), and copper sulfate (Bordeaux), as well as the biopesticides BlightBan and Bloomtime.
- These are protectants and therefore must be applied before infection occurs. They will not cure diseased tissue

Insect control:-

The role of insects in the transmission of fire blight bacteria is under investigation.- It is likely that insects that cause wounds (leafhoppers, plant bugs, pear psylla) can create places for bacteria to enter the tree, and some summer infections (shoot blight) are probably facilitated by insects.-

Resistant cultivars:-

Red Delicious, Liberty, Enterprise and Freedom

Powdery Mildew

Symptoms:

Evidence of powdery mildew infection may appears on primaryleaves, buds, shoots, blossoms, and fruit. Symptoms of infections on the leaves most often are seen as whitish, felt-like patches of fungal mycelium and spores. These symptoms most commonly appear first on the lower surface of the leaves. Lesions may also appear on the upper surface as chlorotic spots, or cover the entire leaf with powdery, white spores and mycelium. Curling and crinkling of the leaves can occur as a result of infections along the leaf margin. Leaves affected severely by the disease may fall off Buds which are infected with powdery mildew can become more susceptible to winter injury. Fruit infections on certain cultivars result in a netlike russeting.

Disease causing organism: *Podosphaera leucotricha* (Ell. and Eva.) Salmon

Disease Cycle

The fungus over winters in the dormant buds that had been infected in the preceding growing season. Buds which have been infected are more susceptible to winter damage. Below temperatures of 12 F the survival rate of the over wintering buds is generally less than 5%. The over wintering fungus within the bud produces spores that initiate the primary infections of the disease cycle in the spring. Unlike the apple scab fungus, the spores of powdery mildew do not require a film of water in order to germinate The resulting infections of the young leaves and blossoms then provide inoculum for secondary cycles of the diseases.

Dissemination

In the spring, spores are produced by the powdery mildew fungus which has over wintered in the buds, and are carried by winds to vulnerable (young) tissues.

PSI; dormant mycelia

SSI; barrel shaped conidea

MANAGEMENT

- Key times for management From tight cluster until terminal growth stops, particularly the period after petal fall when vegetative growth is rapid. Begin to look for signs of infection when leaves emerge from the bud.
- Management OptionsDepending on the susceptibility of the cultivar and the impact of cold weather temperatures on over wintering inoculum survival, chemical control may be needed.
- Cultural ControlsPlant cultivars which are less susceptible to the disease. Reduce humidity in the tree canopy by pruning to increase air, light, and spray penetration.
- ChemicalBavistin 0.5gm per lit

CEDAR APPLE RUST

Symptoms: Infections first appear on apple as bright yellow-orange foliar lesions on the upper surface of leaves, petioles, and young fruit. Lesions may be bordered by a red band or a chlorotic halo. Fruit lesions which occur on fruit are superficial and extend not more than 1/16 inch into the flesh. They occur most often on the calyx end of the fruit. On cedar the fungus produces brown to reddish brown leaf galls.

Disease causing agent: *Gymnosporangium juniperi virginianae.*

Dissemination: Spores produced on eastern red cedar are discharged following rain, and disseminated by wind currents to apple hosts. Spores produced on apple may also be carried by wind to cedars

Primary source of inoculumtelial galls on cedar plant

Secondary source of inoculumairborne basidio spores

Disease Cycle: Unlike some other diseases, cedar apple rust requires two hosts in order to complete its lifecycle. On eastern red cedar, the fungus causes galls to form. Spring rains cause the red cedar galls to exude horn-like structures called telia, which become swollen and jelly-like, and which dry back to dark brown threads when the rains cease. Swelling and drying of the telia occurs repeatedly throughout the spring. The telia produce teliopores, which germinate during rain to produce basidiospores. The basidiospores may be carried by the wind for more

than 1 mile to vulnerable apple tissue. The spores which land on young apple tissue then germinate if there is a film of water upon the leaves for a sufficient period of time. One to two weeks after infection the lesions on the upper sides of the leaves (or fruit) produce watery orange drops, and then produce small orange-brown dots (pycnia) containing pycniospores. Two weeks after the formation of the pycniospores, aecia bearing aeciospores appear on the lower surface of the leaves (or on fruit). These are released during dry weather during July and August. These are then disseminated by the wind and those that land on eastern red cedar infect them, and form mature galls after two years of infection.

Management

- Key times for managementSpores are released from cedar during rainy periods from the last week in April until mid-June, with the peak release from pink until full bloom. Lesions are first visible on the upper sides of the leaves in spring to early summer.
- Management OptionsThe grower should be most concerned aut cedar apple rust if the cultivars grown in the orchard are susceptible to the disease, if there are eastern red cedars in the vicinity, and if there are numerous rainy periods during the spring.
- Cultural Management OptionsSources of infection may be reduced by cutting down nearby eastern red cedar, but it is difficult to entirely eliminate sources of infection due to the distance spores are able to be carried by the wind. Some apple cultivars are resistant to cedar apple rust, and may be grown without fungicide sprays to control it.
- Certain scab fungicides may also control cedar apple rust mancozeb 2 ml per lit

Black Rot

Disease causing organism: *Botryospaeria obtusa* (Schwein)Shoemaker

Dissemination: Spores are disseminated by wind and rain

Symptoms :Signs of leaf infection usually appear 1-3 weeks after petal fall and become visible as small purple flecks that enlarge to form circular lesions. The margins of the lesions remain purple while the centers become tan to brown (this disease is often called frogeye leaf spotdue to these symptoms).

BlackRot fruit Symptoms on the fruit first appear as red flecks that will turn purple and be bordered by a red ring. As the lesions enlarge, they form a series of rings alternating from black

to brown. The lesions of the fruit will remain firm. Also, symptoms include cankers on limbs that begin as reddish brown areas which are slightly sunken.
Cankers on limbs may remain small or enlarge to become several feet long.

Disease cycle: The fungus over winters in cankers, dead bark, twigs, and in and mummified apples on the tree. Spores are released during rainy periods. Infection occurs through stomata, cracks, and wounds.

Management

- Key times for managementA critical time for management of leaf infections is between tight cluster and pink. Fruit infection can begin as sepal infection early in the season and new infection can occur throughout the growing season.
- Management OptionsA major decrease in incidence of this disease can be attained though cultural means. Control is usually attained through a combination of cultural and chemical methods.
- Cultural ControlsPiles of pruning should be removed from the orchard and burned, or they may be left on the orchard floor and chopped with a flail mower. Remove HYPERLINK
  http://orchard.uvm.edu/uvmapple/pest/BacktoBasics/Diseases/Black%20Rot.html
  FELSandmummymummified apples, dead wood, and shoots infected with black rot in order to remove sources of inoculum.
- Chemical :carbendazim 2 g/lit

SOOTY BLOTCH

Disease causing organisms: A complex of fungi which includes *Leptodontium elatius* (G. and *Geastrumia polystigmatus* Batista)

Symptoms: Colonies of the fungi on the fruit resemble images sooty or cloudy olive green blotches on the surface of the fruit. The fungus grows superficially on the surface of the fruit and may be easily wiped away.

Dissemination: Sooty blotch spores are released during rainy periods and are disseminated by wind.

Disease Cycle: The fungi over winter on infested apple twigs and on numerous forest trees. During rains in the spring and early summer the spores are dispersed, with secondary spread occurring throughout the season. Fruit infection can occur as early as 2-3 weeks after petal fall. Infections are most likely to occur during periods of frequent rain and high humidity. Symptoms of infection may not be apparent until some time (typically 2to 25 days) after the initial establishment of infection.

Management

- Key times for managementThe key time for management begins 1-2 weeks after petal fall and continues until 2-3 weeks before harvest. Temperatures between 6and 70C
- Cultural practicesRemove reservoir hosts from the orchard and from the perimeter of the orchard. Sooty blotchthe humid conditions present in poorly pruned trees and in damp, slow-drying areas of the orchard. Winter and summer prune in order to increase air, light, and spray penetration. Thinning fruit to separate fruit clusters facilitates the drying of the fruit after rainy periods.
- Chemical; 1percent Bordeaux

FLYSPECK

Disease causing organism: *Zygophiala jamaicensis* E. Mason

Dissemination: Spores which produce primary infection are disseminated by wind during rainy periods from over wintering sites. Spores which produce secondary infections may be wind or water borne.

Symptoms: Flyspeck appears on the fruit in well-defined groups of shiny, black dots which grow on the surface of the fruit. Areas of these dots are usually less than an inch in diameter. Fungi grow superficially on the fruit and may be wiped from the surface easily.

Disease cycle: The fungus over winters on infested apple twigs and on reservoir hosts such as brambles. Spores are then released during rainy periods just before bloom to 1-2 months after

bloom, and are carried by wind to the host in order to create the primary infection. The spores then germinate and create superficial fungal growth. Colonies become visible and spores are produced in approximately three weeks. Secondary infection develops on the twigs and on the apple fruit. The spores which create secondary infection are also airborne and are released after sunrise.

Management

- Key times for managementA key time for apple infection accumulated from 1days past petal fall. Periods of frequent occurs after 27hours of leaf wetness have rainfall during above normal summer temperatures are particularly favorable to an outbreak of this disease. Management OptionsA major decrease in incidence of this disease can be attained through cultural practices.
- Cultural Management OptionsPruning for air and light penetration and thinning of fruit clusters can reduce incidence of this disease. Mowing nearby ditches and banks to decrease the amount of nearby reservoir hosts may also be helpful.
- Chemical; bavistin 2gm /lit

Phytopthora Crown Rot, Collar Rot, and Root Rot

(Collar rot affects the scion portion of the tree, crown rot affects the rootstock portion of the tree. Root rot affects the root system away from the crown region.)

Disease causing organisms: fungi in the genus *Phytopthora*

Dissemination: Soil born fungal pathogen. Pathogen survives in soil for several years as spores, especially in old orchard soils. May also be brought into the orchard on infected nursery stock.

Symptoms:

Cankers may be seen at or below the ground line, and may extend from the original site of infection into the root system and up the trunk to the bud union and above the bud union if the scion is also susceptible. Infected bark is brown and often slimy when wet. When the bark is pulled away, the cambium and phloem will be an orange, reddish brown color. The cankers caused by the fungus girdle the tree, resulting in poor vegetative growth and chlorotic foliage that may turn purple in the autumn. A severely infected tree may die. Trees may be killed in one growing season or may linger for a number of growing seasons.

Disease cycle

The fungus survives in the soil as thick-walled spores (oospores) that are resistant to drought and relatively resistant to chemical treatment. The fungus may also be brought in on infected nursery stock and in contaminated irrigation water. Mobile spores (zoospores) originating from the oospores move to the tree and colonize the apple bark tissue. The fungus may build up to high levels in the soil in a short period under favorable conditions - i.e. during wet, cool periods after harvest and in spring.

Monitoring and Management

- The best time to manage Phytopthora diseases is during the initial stages of orchard establishment, when selecting the orchard site, planting, site preparation and rootstock selection. Management OptionsWhile there are some fungicides registered for control of Phytopthora, management is best achieved through cultural methods.
- Cultural ControlsPrimary control of Phytopthora diseases is culture. When planting a new orchard, select the site and rootstocks carefully. Be sure the orchard site has adequate drainage throughout the year. When irrigating the orchard, do not saturate the soil for prolonged period is. Use rootstocks resistant to infection by the disease. Scion cultivars may also be chosen for resistance.
- ChemicalMancozeb 2g/lit

I. Choose the correct answers from the following:

1. The disease which had endangered the very existence of delicious apples;
   A. Powdery mildew
   B. Apple scab
   C. Fruit spots
   D. Root rot
2. The breeding of scab resistant varieties of apple was undertaken;
   a. IARI
   b. ICAR
   c. RFRS Mashobra
   d. RFRS Bikaner

3. The root rot of apple is caused by;
   A. *Dematophora necatrix*
   B. *Podospharea leucotricha*
   C. *Corticium salmoniicolor*
   D. *Botryosphaeria obtuse*
4. Silvering of foliage appears soon after petal fall is the typical symptoms of
   A. Nail head canker
   B. Leaf canker
   C. Pink disease
   D. Fruit spots
5. Hairy root is due to;
   A. *Agrobacterium tumefaciens*
   B. *Dematophora necatrix*
   C. *Podospharea leucotricha*
   D. *Corticium salmoniicolor*

II. Fill up the blanks

1. Apple proliferation is _____ disease.
2. _____ is antagonistic to Agrobacterium tumefaciens
3. Apple scab is first noticed on _____ variety of apple trees in _____valley.
4. Fire blight of apple is caused by _____ bacteria &the bio agent used to control the same is _____.
5. The alternate main host for the Gymnosporangium juniper virginianaeare _____&_____ respectively.
6. Amphelomyces quisqualis is effective against the _____.
7. _____ stage is absent inthe apple rust caused by Gymnosporangium juniper virginianae

III. Say True or False for the following.

1. The PSI for apple scab is zoospores of pseudothecium.
2. The apple rust is a heterocious also monocyclic disease.
3. Apple crown rot. Root rot, Collar rot are the complete loss disease caused by a single organism Dematophora necatrix.

4. Apple Dapple /Apple scar skin is a viriod disease.
5. The two crab apples Malus floribunda Malus toringoidesare have resistance against the root rot.
6. Bitter rot, Sour rot, Brown rot are not post harvest diseases.

IV. Match the following

Powdery mildew	Botryosphaeria obtusa
Black rot	Gloeodes pomigena
Sooty blotch	Glomerella cingulata
White rot	Botrytis cinerea
Soft rot	Botryosphaeria dothidea
Grey mould rot	Peniciliumexpansum
Bitter rot	Podospharea leucotricha

ANSWERS of the FAQ's

I choose the correct answers from the following:

(b)

(c)

(a)

(b)

(a)

II. Fill up the blanks

Phytoplasma

Agrobacterium radiobacter strain K-84

Ambri, shopian area (kashmir)

G ve , Erwinia herbicola

Apple cedar plants

Podospharea leucotricha

Uredial

III. Say True or False for the following.

False

False

True

True

True

False

IV. Match the following

Powdery mildew	Podospharea leucotricha
Black rot	Botryosphaeria obtusa
Sooty blotch	Gloeodes pomigena
White rot	Botryosphaeria dothidea
Soft rot	Peniciliumexpansum
Grey mould rot	Botrytis cinerea
Bitter rot	Glomerella cingulata

REFFERENCE;Diseases of fruit crops

Author;V KGuptha&k Sathish shar

PEACH

Botanical name: *Prunus persica*

Family: Rosaceae

Origin: china

Uses:

- It is rich in sucrose, fructose, & glucose.
- It is rich source of protein with all amino acid.
- It also contains- carotene, thiamine, riboflavin, niacin, iron, & zinc.
- Peach are grown for both desert & processing purpose.
- It is also used for making wine, fruit juice is common drink.
- The cake after extraction of oil can also be used for various purpose.

List of diseases

1. Leaf curl –*Taphrina deformans*
2. Rust – *Puccinia pruni* – spinosae
3. California peach blight- *Stigmina carpophila*
4. Scab – *Venturia carpophila*

Minor diseases

1. Powdery mildew –*Sphaerotheca pannosa* var. *persicae*
2. Frosty mildews – *Cercosporella persicae*
3. Target leaf spot – *Phyllosticta persicae*
4. Bacterial leaf spot: *Pseudomonas syringae* pv. *persicae*
5. Gummosis: Prunus dwarf virus
6. Mosaic virus
7. Necrotic Leaf spot: virus
8. Peach- X : Phytoplasma like organism
9. Peach yellows : Phytoplasma like organism

DISEASES OF PEACH

Major Diseases

1. PEACH LEAF CURL: *Taphrina deformans*

In India this disease is prevalent in Himachal Pradesh, Jammu& Kashmir.

SYMPTOMS:

- The disease first appears in the early spring as the leaves begin to unfold
- The leaf blade thickens and midrib turns yellow &curl
- Finally leaf turn to reddish purple tint
- The reddish velvety surface of lamina is soon covered with a whitish grey bloom of the fungus on the upper surface
- Both the leaves & petiole may curl
- Affected leaves die & drop immaturely
- Twigs become pale green to yellow, swollen, stunted & exude gummy material
- Flowers and fruits are also infected & drop prematurely

Peach leaf curl- *Taphrina deformans*

ETIOLOGY:

- Mycelia are intercellular and it does not produce specific ascocarp.
- Asci are produced (Open ascus) individually and measure 25to 40 into 8 to11 micro meter.
- Each ascus bears eight ascospores with a diameter of 3 to 7 micro meter.

Epidemiology:

The disease is prevalent in areas where cool mist spring weather prevails and the dry hot weather hastens defoliation

Primary source of inoculum: Dormant mycelia in the affected stem

Secondary source of inoculum: Air borne conidia

MANAGEMENT:

- Removal & burning of infected shoots reduce the spread of the disease
- A dormant spray with Bordeaux mixture (1%) with an adhesive & a winter spray with Bordeaux mixture 1% before bud burst controls the disease

2. RUST: *Puccinia pruni-spinosae*

SYMPTOMS:

- Pale yellow spots appear on both the surfaces of the leaves.
- Later the spots become bright yellow.
- On the under surface numerous brown dusty pustules are seen.
- Pustules covered on the under surface of the leaves.
- Defoliation of leaf occurs.
- The fruit is rarely attacked.

Primary source of inoculum: Air borne teliospore (teliospores germinate producing basidiospores becoming wind bonre)

Secondary source of inoculum: Uredospores

Etiology: the fungus persists as perennial mycelium, in the under ground stems of anemone.

The ascidia produced on this plant during spring infect peach leaves.

MANAGEMENT:

- Cut & burn the affected leaves or plant part.
- Spray with zineb 0.2% or dusting with sulphur.

3. CALIFORNIA PEACH BLIGHT /shot hole / pustular spot: *Stigmina carpophila*

Symptoms:

- The pathogen attacks twigs, blossoms, leaves, fruits & unopened buds.
- Small, circular deep purple spot appear on the fruit.
- The spots become raised & rough.
- Dark brown, scattered lesions enlarge rapidly on the leaves.
- The diseased buds become darken color.
- Small, purplish, raised spots appear on twigs & they expand in to necrotic cankers.

Epidemiology:

Rise in day temperature & prolonged winter rains are conducive for the epiphytotic proportions of the disease.

Primary source of inoculum: dormant mycelium survive on the affected plant part.

Secondary source of inoculum: rain splash air borne conidia

.

MANAGEMENT:

- Cut and burn the affected plant part.
- Spray capton 0.2% or captafol 0.2% to control the disease.

4. SCAB /freckle /black spot: *Venturia carpophila*

Symptoms:

- The disease occurs on fruit, twigs & leaves.
- Circular & dark –olivasious lesions appear on fruits.
- In sever infection the individual spots merge & form a uniform, dark olivaceous, velvety blotch.
- A thicky or corky layer of cells is produced below surface the scabbed region.
- The fruit becomes abnormal in shape & cracks.
- On the twigs, light brown oval lesions are formed which enlarge & turn dark brown.
- Dark brown, long& narrow lesions are noticed on the midrib.

Etiology:

Dormant mycelia, septate mycelia.

Primary source of inoculum: dormant mycelia in fallen leaves.

Secondary source of inoculum: spilocea type of conidia (air borne)

Infection takes place in between the cuticle & epidermis.

Epidemiology:

- 9 hour of leaf wetness period, 17-180c temperature, susceptible host.
- In fallen leaves if 200-300 pseudothecia present & leaf wetness is 9 hour, single pseudothecia produces 800-900 ascospores.

Management:

- Cut & burn affected plant part.
- Low- lying fields should be avoided for cultivation.
- Tree should be properly pruned to permit free air circulation.
- Timely application of the standard fungicide sprays controls the scab.
- Spraying of 5% urea solution to the fallen leaves.
- Incorporate fallen leaves to the soil.
- Chemical spray with scheduling times like :are

    a) silver tip to green tip- mancozeb 4g/liter

    b) Pink bud stage-carbendazin @ 1g/ liter.

    C) Fruit stage-(pea nut stage) – capton 3g/ liter

    d) 40 days before harvest –hexaconozole 1.5g /liter.

- Biological agent's like- *Althelia* species, *Chaetonium globosum*.

MINOR DISEASESL:

POWDERY MILDEW: *Sphaerotheca pannosa* var. *persicae.*

SYMPTOMS:

- Whitish powdery growth of fungus on leaves young shoots & fruits.

- The young leaves are coated with a thick layer of mycelium &they become narrow & curled.
- Terminal portion of the shoot covered by white powdery layer.
- White powdery growth later turns to pinkish & finally dark brown.
- Epicarp of fruit becomes leathery & hard.

Primary source of inoculum: dormant mycelia
Secondary source of inoculum: air borne conidia.

Management:

- Use of resistance variety.
- Cut& burn the affected plant part.
- Spraying with sulphur compounds.

6. FROSTY MILDEW: *Cercosporella persicae.*

Symptoms:

It produces pale green areas on the upper leaf surface and creamy white fungal growth on lower surface.

Primary source of inoculum: affected plant parts.

Secondary source of inoculum: air borne conidia.

MANAGEMENT:

- Cut &burn the affected plant parts.
- Application of wettable sulfur @ 3gram per liter.

7. BACTERIAL LEAF SPOT: *Pseudomonas morus-prunorum*.

SYMPTOMS:

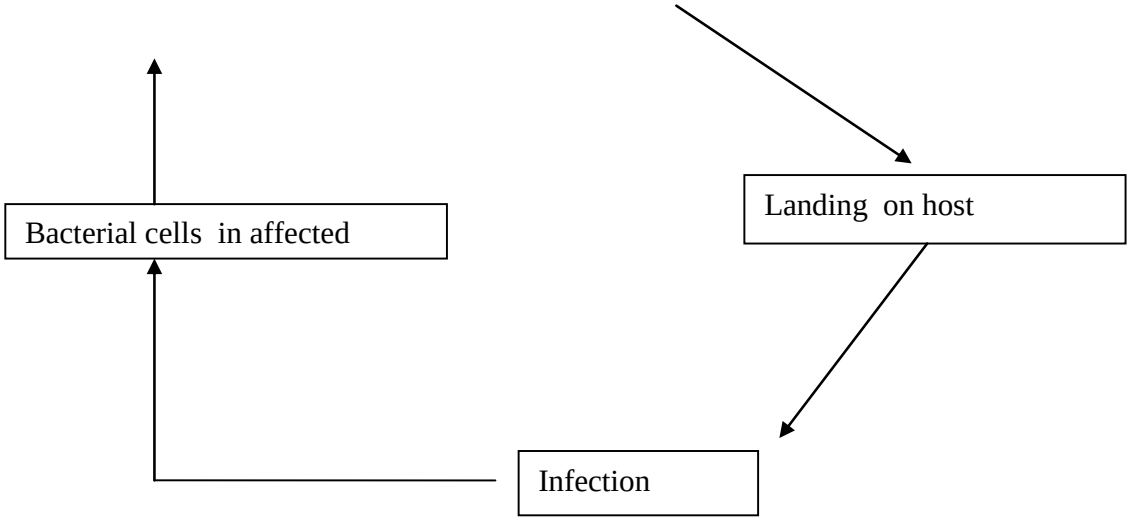
- Small circular green spots occur on the leaves.
- Later spots become angular, deep purple to black.
- The spotted area falls and shot holes are formed.
- Sever infection leads to defoliation which devitalizes the tree.
- Circular spots are noticed on fruits. They are water-soaked initially and become black.
- Due to intense spotting on the fruits, pitting or cracking occurs in the vicinity of spots.
- Twigs canker results in the death of branch.

MANAGEMENT:

- Cut & burn the affected plant parts.
- Spraying with zinc sulphate-lime solution is affective.
-

LIFE CYCLE:

Soil,air splash borne bacterial cells.



8. BACTERIAL CANKER / GUMMOSIS: *Pseudomonas syringae* pv. *syringae* vanHall.

SYMPTOMS

- The disease attacks trunk, limbs, shoots, fruit spurs, blossom, dormant buds, leave & fruits.
- The bark & outer sap wood show circular to elongated, water –soaked lesions.
- Bark becomes brown& gummy.
- The girdled branches die.
- Blossom blight takes place& purple lesions appear on leaves.

Primary source of inoculum: affected plant

Secondary source of inoculum: air borne bacterial cell.

MANAGEMENT:

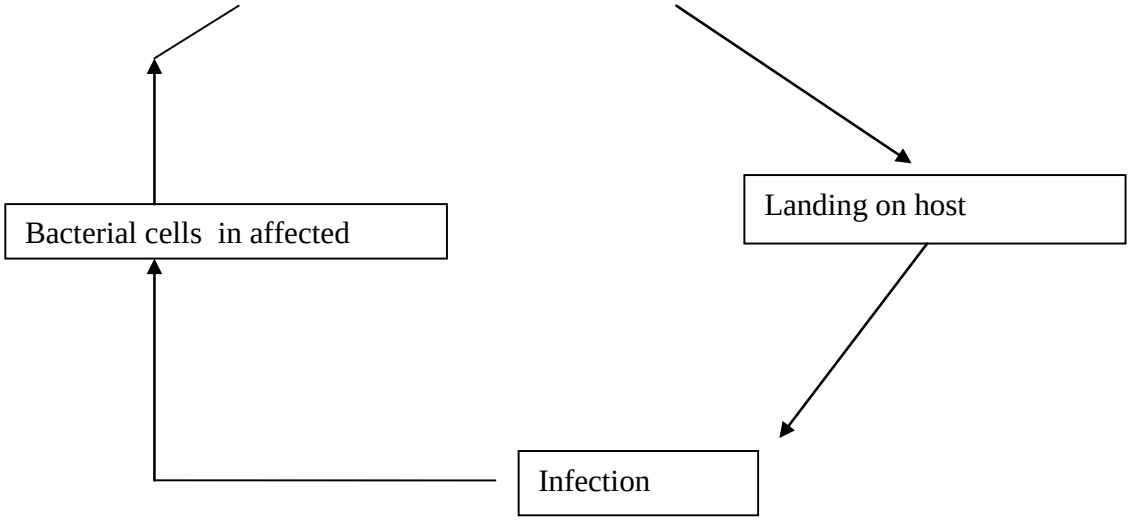
Cut &burn the affected plant part.

Aerial spray of streptocyclin 0.5g/ liter.

Resistant varieties -barbank, black champa, elephant heart & maripo

Life cycle:

Soil, air splash borne bacterial cells



9. PEACH MOSAIC: VIRUS.

SYMPTOMS:

- Leaves emerging during spring & summer show light green mosaic & ring spot mottle.
- They become small & deformed.
- Stunting growth of the plant and short inter nodes.
- Yellow mottling are seen on new growth flushes during spring.

VECTOR-ERIOPHYID MITE.

MODE OF SPREAD:

It transmits through grafting and also by Eriophyid mites.

MANAGEMENT:

- Use of disease free planting material.
- Exposing the planting material to 37^{o}C for 15- 39 days.
- Apricot seedling can be used as a resistant root stock.
- Removal of host plant.
- Spraying with acaricide against mite pests will reduce the spread of the disease.

10. NECROTIC LEAF SPOT: VIRUS

SYMPTOMS:

Initially ring- spots on the leaves which later become necrotic.

Necrotic tissues later fall down and leave holes in the leaves.

MODE OF SPREAD: It transmits through grafting.

MANAGEMENT:

- Use of disease free planting material.
- Exposing the planting material to 37 degree centigrade for 15- 39 days.
- Apricot seedling can be used as a resistant root stock.
- Removal of host plant

11. PEACH "X": PHYTOPLASMA –LIKE ORGANISM.

SYMPTOMS:

The trees show varying degree of anthocyanosis, twig and shoot die-back and general decline.

Affected leaves roll upward on affected branches.

Falling of leaves prematurely.

Fruits are small, malformed and abort without proper ripening.

MODE OF SPREAD: It transmits through grafting and leaf hopper.

VECTOR: leaf hopper and it also transmit by dodder (*Cuscuta reflexa*)

MANAGEMENT:

Use of disease free planting material.

Exposing the planting material to 37^{o}C for 15- 39 days.

Apricot seedling can be used as a resistant root stock.

Removal of host plant

12. PEACH YELLOWS / PAJA ROSETTE: PHYTOPLASMA –LIKE ORGANISM

SYMPTOMS:

- Trees show numerous upright branches growing from the main stem.
- The branches are numerous and the tree looks bush.
- The leaves are small but the basal 1 or 2 leaves are abnormally long.
- Most of the leaves show light green to yellow mottling and have irregular margins and clearing of veins.
- The trees are stunted and inter nodes are short and looks bushy.

- Premature unfolding of leaf bud is common.
- The leaves on affected trees continue to grow even after the fall of normal leaves.
- The larger leaves on affected trees are also mottled.
- Later, symptoms of wilting and die back appear, resulting in the death of plant.

I. MULTIPLE CHOICE QUESTIONS

1. California peach blight is also called as

a. Shot hole
b. Pustular spot
c. Both a & b
d. None of these

2. Causal organism of peach rust is

a. Puccinia pruni
b. Tranzschelia pruni
c. Both a & b
d. None of these

3. *Peach scab is caused by*

a. Venturia carpophila
b. Venturia pirina
c. Both a & b
d. None of these

4. Peach yellows is caused by

a. Virus
b. Fungi
c. Mycoplasma
d. None of these

5. **Necrotic leaf spot is caused by**

a. Virus
b. Fungi
c. Mycoplasma
d. None of these

II. **MATCH THE FOLLOWING**

A	B
1. Bacterial leaf spot	a. virus
2. Necrotic leaf spot	b. Mycoplasma
3. Bacterial canker	c. *Phyllosticta persicae*
4. Peach X	d. *Pseudomonas mors-prunorum*
5. Target leaf spot	e. *Pseudomonas syringe pv. persicae*

III. **TRUE OR FALSE**

a. leaf curl in peach is caused by fungi ( )
b. peach scab is also called as freckle or black spot ( )
c. causal organism of frosty mildew is *Cercosporella persicae* ( )
d. peach rust, removal of alternative host and spraying with zineb @ 0.20% is effective ( )
e. causal organism of powdery mildew in peach is *Erysiphae* spp ( )

a. **FILL IN THE BLANKS** causal organism of California peach blight is ----------
b. causal organism of peach leaf curl is ----------
c. bacterial canker attacks ---------- plant parts
d. causal organism of powdery mildew in peach is----------

e. ---------- is the causal agent for target leaf spot in peach.

Key answers

I. 1-c, 2-c, 3-a, 4-c & 5-a
II. 1-d, 2-c, 3-e, 4-b & 5-a
III. 1-T, 2-T, 3-T, 4-T & 5-F
IV. 1. *stigmiacarpophila*
2. Taphrina defromans
3 . All
4. *Sphaerotheca punnosa* var. *persicae*
5. *Phyllosticta persicae*

REFERANSE BOOK:

Introductory fruit crop:

PLUM

DISEASES, SYMPTOMS, ETIOLOGY, EPIDEMOLOGY, AND MANAGEMENT OF PLUM FRUIT CROP.

INTRODUCTION:

`**Plum (*Prunus spp*.)** is a delicious stone fruit of temperate regions, which ranks next to **Peach** in importance and production. The pleasantly blended pulp and juice of this fruit is liked by most people. Because of large varietal diversity, it can be grown in both temperate and subtropical areas. In India, plum cultivation was started by the **Europeans** in 1870 in kull valley and shimla hills, and then subsequently spread to other temperate regions of the country.

The cultivated plums belong to two species viz**. *Prunus domestica*** (European plum) and ***P. salicina*** (Japanese plum).

Botanical classification:

Kingdom:	Plantae
Division:	Magnoliophyta
Class:	Magnoliopsida
Order:	Rosales
Family:	Rosaceae
Subfamily:	Maloideae
Genus:	*Prunus*
Subgenus:	***Prunus***

IMPORTANCE & USES:

Plum fruit tastes sweet and the skin may be particularly tart. It is juicy and can be eaten fresh or used in jam-making or other recipes. Plum juice can be fermented into plum wine; when distilled, this produces a brandy known in Eastern Europe as Slivovitz, Rakia, Tzuica or Palinka. Dried plums are also known simply as prunes, as if 'prune' signified merely a dried plum - however, prunes are a distinct type of plum, and may have predated the fruits that we know more commonly as plums. Prunes are also sweet and juicy and contain several antioxidants. Plums and prunes are known for their laxative

effect. This effect has been attributed to various compounds present in the fruits, such as dietary fiber, sorbitol, and isatin. Prunes and prune juice are often used to help regulate the functioning of the digestive system.

Dried, salted plums are used as a snack, sometimes known as *salaito* or *salao*. Various flavors of dried plum are available at Chinese grocers and specialty stores worldwide. They tend to be much drier than the standard prune. Cream, Ginsing, Spicy, and Salty are among the common varieties. Licorice is generally used to intensify the flavor of these plums and is used to make salty plum drinks and toppings for Shaved Ice or *baobing*.Prune kernel oil is made from the fleshy inner part of the pit of the plum.

The plum is infested by the following diseases;

Diseases		causal organism
1. Plum pocket	-	*Taphrina maculans*.
2. Wilt	-	*Verticillium albo-atrum* (Reinke & Berth)
3. Leaf curl	-	*Taphrina deformans* (Berk & Tul)
4. Bacterial canker	-	*Pseudomonas syringae* pv.*syringae* (van Hall).
5. Bacterial leaf spot	-	*Xanthomonas syringae*
6. Line pattern	-	Plum American line pattern virus.
7. Plum mosaic	-	Plum line pattern virus & ring spot virus(Kennedy et al)
8. Creamy-white spot	-	Creamy white spot virus.

1. PLUM POCKET*: Taphrina maculans*

SYMPTOMS:

- The symptoms are more prominent on fruits and less prominent on leaves and stem.
- the affected fruits having whitish circular spots on the fruits are completely covered
- Infected fruits doubling their size.
- Affected fruits fail to produce seeds and are hollow then later stages falls off from the branches.
- On the leaves in rare cases whitish coat will form & leaf falling takes place.

PSI-dormant mycelia.

SSI-Air born conidia

EPIDEMOLOGY;

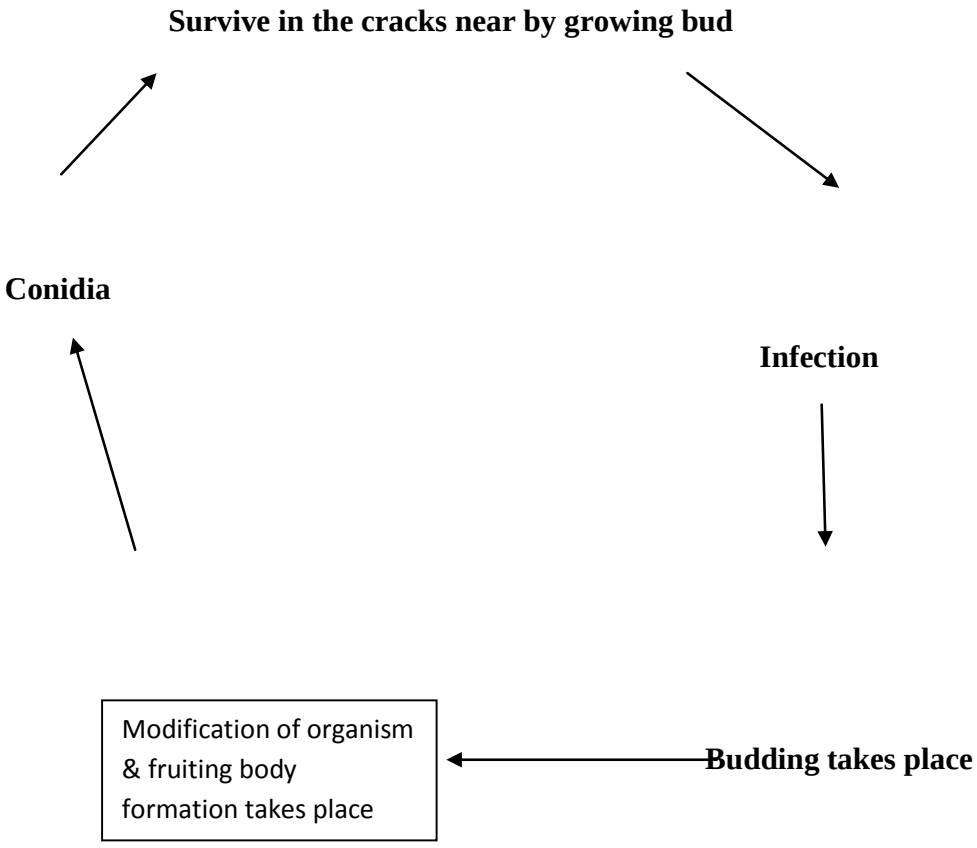
- The disease is prevalent in areas where cool mist spring weather prevails and the dry hot weather hastens defoliation.

MANAGEMENT;

1. Removal &burning of infected shoots reduce the spread of the disease.
2. Before bud sprout spray sulphur or copper fungicide.
3. Incorporate the fallen leaves & spray 5% urea on fallen leaves.

ZZ

LIFE CYCLE:



- The organism produces open ascus no ascocarp. Ascospores may be 4-5.
- After release ascospores budding takes place then it will detach & produces conidia.

- These conidia survive in the cracks near by growing bud & life cycle continues.

2. WILT*: Verticillium albo-atrum*. (Reinke & Berth)

SYMPTOMS:

- The affected limbs get defoliated in early summer.
- The first declining symptoms are seen on the lower branches.
- Roots of infected plants turn brown & die.
- No partial wilt but lower leaves yellowing.
- Occurs at flowering &fruiting stage.
- Complete loss. Loss depending on seveitrty.
- V – Shaped yellowing of leaf margin.

ETILOGY:

Septate mycelia, V – shaped conidiophores, on which single celled conidia is formed.

PSI: dormant mycelia

SSI: conidia (unicellular)

EPIDEMOLOGY:

Warm weather loving alkaline **PH** &more sever in black clay soil, temperature-28-29^0, and RH-80-85%. Low soil moisture, affected soil, nematode infected soil.

MANAGEMENT:

- Cut& burn the affected plant part.
- Treat the seeds with carbendizine.
- Carbendizine 1.5 gm/liter soil drenching.
- Neutralized PH by gypsum application.
- Uproot the initially affected plants& burn.
- High application of K & low N application
- Application of Bavistin at the rate of 1.5 g / liter soil drenching & Trichoderma viridae reduce the disease.

3. LEAF CURL: *Taphrina deformans* (Berk & Tul)

SYMPTOMS:

- The disease first appears in the early spring as the leaves begin to unfold.
- The leaf blade thickens& midrib turns yellow &curl.
- Finally leaf turns to reddish purple tint.

- The reddish velvety surface of lamina is soon covered with a whitish grey bloom of the fungus on the upper surface.
- Both the leaves & petiole may curl.
- Affected leaves die & drop immaturely.
- Twigs become pale green to yellow, swollen, stunted & exude gummy material.
- Flowers & fruits are also infected & drop prematurely.

ETIOLOGY:

- Mycelia are intercellular & it does not produce ascocarp.
- Asci are produced individually & measure 25to 40 into 8 to11 micro meter.
- Each ascus bears eight ascospores with a diameter of 3 to 7micro meter.

EPIDEMOLOGY:

The disease is prevalent in areas where cool mist spring weather prevails & the dry hot weather hastens defoliation.

PSI: dormant mycelia in affected stem.

SSI: air borne conidia.

MANAGEMENT:

- Removal & burning of infected shoots reduce the spread of the disease.
- A dormant spray with Bordeaux mixture (6:10:100) with an adhesive & a winter spray with Bordeaux mixture 1.2% before bud burst control the disease.

LIFE CYCLE:

The fungus is spread by wind and rain and attacks the leaves as they break bud and fruit as it begins to develop during cool, wet weather. A single layer of spore-producing tissue develops on the infected plant part, giving the blistered area a white or translucent appearance when fresh. Spores are released from this tissue from late spring to midsummer, and will remain on twigs and bud scales until the following spring.

4. BACTERIAL CANKER / GUMMOSIS*: Pseudomonas syringae pv.syringae* (van Hall).

SYMPTOMS

- The disease attacks trunk, limbs, shoots, fruit spurs, blossom, dormant buds, leave & fruits.
- The bark & outer sap wood show circular to elongated, water –soaked lesions.
- Bark becomes brown& gummy.
- The girdled branches die.
- Blossom blight takes place& purple lesions appear on leaves.

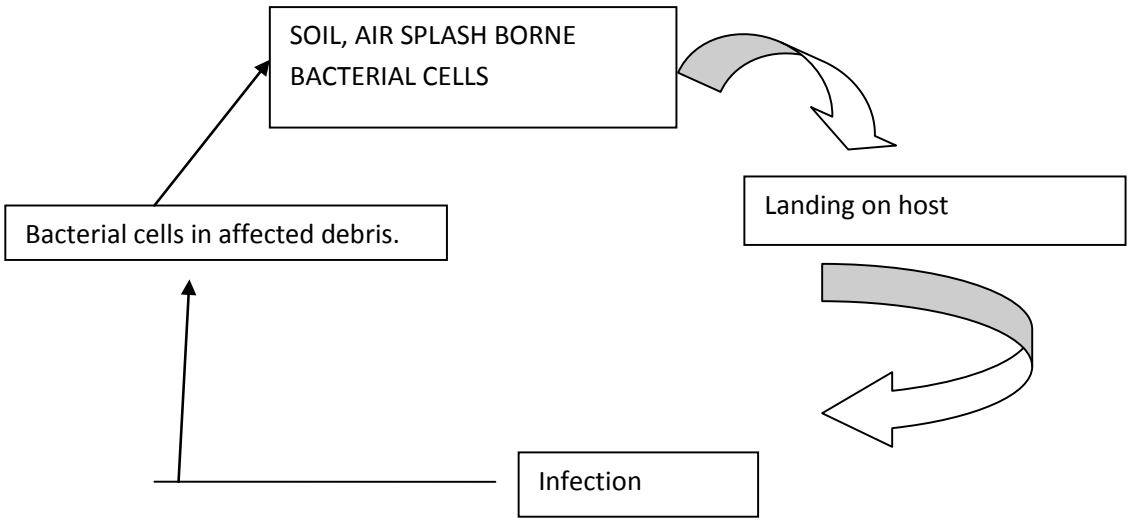
PSI: affected plant

SSI: air borne bacterial cell.

MANAGEMENT:

- Cut &burn the affected plant part.
- Aerial spray of streptocyclin 0.5g/ liter.
- Resistant varieties -barbank, black champa, elephant heart & mariposa.

LIFE CYCLE:



5. BACTERIAL LEAF SPOT*: Xanthomonas syringae pv.pruni vauterin.*

SYMPTOMS:

- It is most commonly observed in nursery stages.
- The disease appears on leaf surface are angular dark brown spots of 0.5to 3.0 mm diameter.
- The lesions are bordered by light yellowish green halo.
- In sever condition leaves turn yellow & drop.

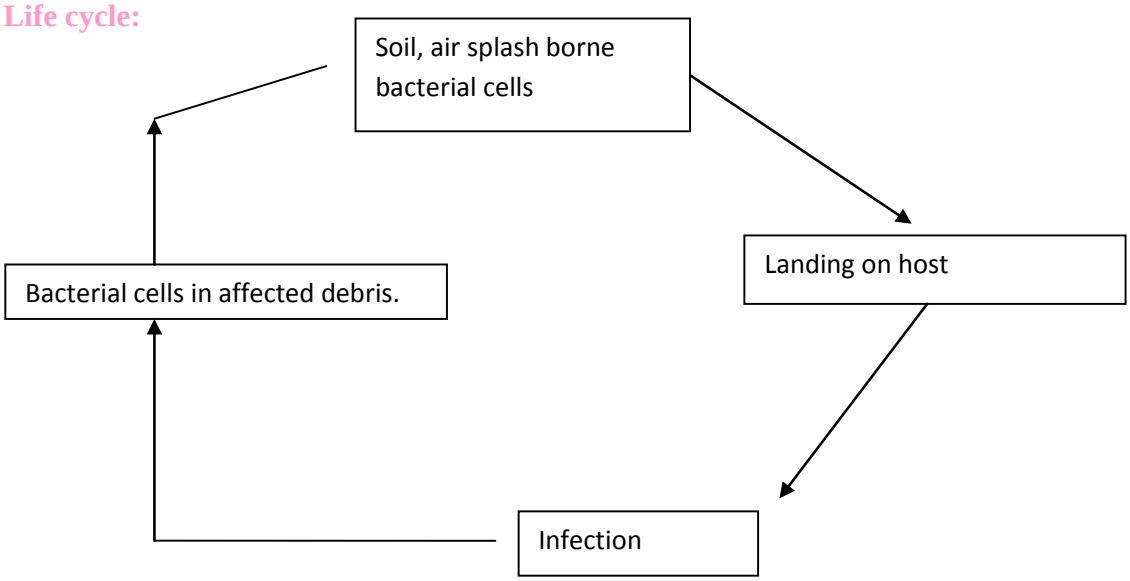
PSI: affected plant part

SSI: air borne bacterial cells.

MANAGEMENT:

- Cut &burn the affected plant part.
- Aerial spray of streptocyclin (0.5 g/liter).

Life cycle:



6. LINE PATTERN: Plum American line pattern virus.

SYMPTOMS:

- Yellow vein banding in part or whole of the leaf lamina.
- Chlorosis of the entire leaf with stunting of plant.
- Some times green stamen petiole show chlorosis.

- Old branches exhibit aerial rotting.
- Chlorotic spots on ripened fruits.

MODE OF SPREAD: through grafting, vector is aphid.

MANAGEMENT:

- Use disease free planting material.
- Exposing the planting material at 37 degree centigrade for 15-39 days.
- Apricot seedlings can be used as resistant root stock, against plum line pattern virus.

7. PLUM MOSAIC: Plum line pattern virus & ring spot virus.(Kennedy et – al)

SYMPTOMS:

- Leaves emerging during spring & summer show light green mosaic & ring spot mottle.
- They become small & deformed.

MODE OF SPREAD:

It transmit through grafting.

MANAGEMENT:

- Use of disease free planting material.
- Exposing the planting material to 37 degree centigrade for 15- 39 days.
- Apricot seedling can be used as a resistant root stock.
- Removal of host plant.

8. CREAMY-WHITE SPOT: CREAMY WHITE SPOT VIRUS

SYMPTOMS:

- Small, pale yellow to white spots on the leaves.
- These spots coalesce& form large white areas.
- This virus is restricted to plum only.

MODE OF SPRED:

Through grafting & aphids.

MANAGEMENT:

- Use of disease free planting material..
- Exposing the planting material to 37 degree centigrade for 15-39 days.
- Apricot seedlings are used as a resistant root stock.
- Removal of host plant.

9. BLACK KNOT: Scientific name: *Apdiosporina morbosum*, a fungus

Species affected: Plums and cherries
Where it occurs: throughout the state

Symptoms:

1. First year symptoms include light green swellings on twigs.
2. By the following spring these have enlarged and turned a velvety black.

Control Recommendations:

1. Remove all knots by April 1 and burn.
2. Limit pruning to late winter.
3. Treat branches with lime sulfur at green tip, full bloom and petal fall

CHOOSE THE CORRECT ANSWERS:

1. Peach leaf curl is caused by
   - **i.** Virus
   - **iii.Fungus.**
   - ii. Virus + vector
   - iv. Both (i)&(iii)
2. Creamy white spot is caused by
   - i. **Virus**
   - iii. Fungus
   - ii. Bacteria
   - iv. Nematode
3. Thermal inactivation point for the organism responsible for Line pattern Disease of Plum is
   - **i.** 90^0c
   - iii**. 66^0c**
   - ii. 93^0c
   - iv. 91.5^0c

4. Viral disease is more in …….. season.

   i. Early winter iii**. Summer**

   ii. Late winter iv. Spring season.

5. *Taphrina deformans* bears ……. Ascospores in a single asci of diameter 3-7 micro meter.

   i. 1 iii. 2

   ii. **8** iv. 4

I. FILL UP THE GIVEN BLANKS

1. Wilt of Plum is caused by ***Verticillium albo-atrum.***
2. Biotic factor responsible for Peach leaf curl is **Fungus**.
3. *Taphrina deformans* causes **Leaf curl** disease in Plum.
4. Invitro Longevity of Prunus Virus 10 is **0.2 days** (4 hrs in sap established with 2-Mercaptoe-thanol)
5. Bacterial leaf spot is caused by ***Xanthomonas arboricola.***

II. MATCH THE CORRECT PAIRS

A		**B**
1. Leaf curl	-	Aphids
2. Wilt	-	*Verticillim albo-atrum*. **(2)**
3. Bacterial gummosis/canker	-	Prunus virus-10**.(4)**
4. Line pattern	-	*Verticillium solani*.
5. Plum mosaic	-	Ring spot virus **(5)**
		Taphrina deformans. **(1)**
		Xanthomonas arboricola pv. pruni **(3)**

III. STATE WHETHER TRUE OR FALSE:

1. Bacterial leaf spot is caused by *Pseudomonas syrigae pv syringae* **(FALSE**)
2. *Verticillium albo-atrum* is a soil borne fungi**. (TRUE)**

3. Line pattern disease caused by virus can be transmissible by dodder, Cuscuta hyaline. **(TRUE)**
4. The disease Plum mosaic can be controlled by using Copper –oxy-chloride at 0.3%. **(FALSE)**
5. Virus disease can be transmissible by Grafting. **(TRUE)**

REFERENCE:

Diseases of Horticultural Crops

Dr. G. Arjunan karthikiyan

Dr.D. Dinakaran

Dr. T. Raghuchander

SAPOTA (Chikoo)

1. Leaf spot

Phaeopleospora indica , Pestalotiopsis versicolor

Phaeopleospora indica: Earlier circular spots which pinkish then gradually to brownish in colour and the centre of the spot sometimes whitish grey colour. And number of spots are more on leaves.

Pestalotiopsis versicolor: spots are circular and brownish and bigger. Later stages can see the black dots on centre of the spot. These black dots are the asexual fruiting body of the fungus (Acervulus).

In advanced stages leads to defoliation.

Management: Carbendazim 0.1% and Companion (Combi product) includes carbendazim and mancozeb 12% and 72% to avoid resistant development in pathogen,

2. Flat limb: *Botyodiploidia theobromae*

In young stems instead of normal growth flattening takes place. On this flatted stem can see the small sized leaves with small petioles.

This is a sporadic disease in plant 1 or 2 branch in whole plantation 1 or 2 plants are affected.

Management

Cut the affected stems and burn and cut portion paste with COC 0.3% to avoid dieback

3. Sooty mould: *Capnodium versicolor*

Symptoms:

- Disease severity increases in increased population of leaf hoppers, aphids and other insects. Black superficial growth on entire surface of leaves, fruits and twigs. Fungus is not a parasite. It grows on the excreta and honey secretions of insects.
- Under dry spell such affected leaves curl & shrivel. During flowering time the appearance of the disease results in reduced fruit set.
- Sooty mass is a superficial growth of the fungus and it multiplies on insect secretions. Impact of this disease on host is photosynthesis activity and yield decreases.

- Primary source of inoculum: Dormant mycelia
- Secondary source of inoculum: Air borne conidia: Spread: Insects, Aphids, wind
- Epidemiology: Temperature 28 -32^0 c, 85-90% RH, Warm Weather and susceptible host

Management

- Sprays of wettable sulphur 0.2% along with insecticide Dimethoate 1.5g/lit
- Spray of 1% starch solution makes flakes of the fungus and due to small wind falls of from the plant.

5. Red rust : *Cephaleuros versicolor*

The algal disease and it has been observed in India and else where. It is one of the minor disease of importance. Reduction in photosynthetic activity and defoliation as a result of algal attack lower vitality of the host plant.

Symptoms:

- The disease is characterized by initial green coloured, circular patches with marginal serrations.
- The upper surfaces of the spot consist of numerous, unbranched filaments, which project through cuticle.
- As and when disease advances the organism turns red rusty spots on the leaves and young twig.
- Spores mature, fall off and leave cream to white velvet texture on the surface of leaf.

Etiology: *Cephaleuros virescens* (Kunze).

- The algae after a period of vegetative growth develop its reproductive structure.
- Certain cells become sporangia. They are of 2 types.
- Those formed directly on the thallus are sessile and thick walled, 40-50micrometer in diameter with orange pigments.
- They are formed singly on the vegetative filaments. Some are produced above the surface on special sporangiophores consisting of thick, rigid, septate hairs with a length of 50micrometer, swollen into a vesicle at the tip. Each vesicle carries 3-6 sporangia on curved pedicels.
- When the sporangia are riped, the contents are converted in to zoospores and liberated through an opening in the wall.

- The zoospores are orange in color, ovoid and swim actively by means of cilia.

Epidemiology:

- The disease is more common on close plantation.
- The zoospores cause initial infection.
- High moist condition favours development of fruiting bodies of the algae.

Management: it is controlled by spraying with Bordeaux mixture 1% or Copper Oxychloride 0.3% or lime sulphur0.2%.

Model question paper of Sapota

I. Choose the correct answer.

1. Flat limb is caused by the disease------

a) base rot b) heart rot c)fasciation d)anthracnose

1. Heart rot disease is ------

a) loss of turgidity b)defoliation c)grey spots d)water soaked lesions

2. Fasciation is caused by------

a) Botrydiploidia theobromae b)Phytopthora parasitica

c) Capnodium spp. D) Colletotrichum spp.

4. Ceratocystis paradoxa is ------

a) Base rot b) heart rot c) sooty mould d) anthracnose

5. Anthracnose is-----

a) Black acervulii b) oospores c) zoospores d) none

II. Fill in the blanks.

1. Leaf spot is caused by_____ (*Phloeospora indica*)
2. Flat limb disease is also known as _____ (fasciation)
3. Base rot is caused by _____(*Ceratocystis paradoxa*)
4. Charcoal like powder is due to_____ (*Capnodium spp*.)
5. Sapota leafspot is managed by_____(Dithane M-45)

III. Match the following.

1. Sooty mould loss of turgidity (4)

2. Fasciation	water soaked lesion (5)
3. Anthracnose	hamper photosynthesis (1)
4. Heart rot	small sized fruits (2)
5. Base rot	acervulus (3)

IV. True or False.

1. *Phloeospora indica* causes leaf spot. (T)
2. Withering and discoloration of veins is due to base rot. (F) (heart rot)
3. Heart rot is caused by *Phytopthora parasitica*.(T)
4. Anthracnose is due to Capnodium spp. (F) (Colletotrichum spp.)
5. Base rot is managed by COC 3gm/lit. (T)

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Part-2

Diseases of Fruit, Plantation, Medicinal and Aromatic Crops

3. Diseases of Fruits, Plantation and Medicinal & Aromatic Crops (HPI 201) 3 (2+1)

Etiology, symptoms, mode of spread, epidemiology and integrated management of the diseases of fruits, plantation, medicinal and aromatic crops viz mango, banana, grape, citrus, guava, sapota, papaya, jack fruit, pineapple, pomegranate, ber, apple, pear, peach, plum, almond, walnut, strawberry, areca nut, coconut, oil palm, coffee, tea, cocoa, cashew, rubber, betel vine senna, neem, hemp, belladonna, pyrethrum, camphor, costus, crotalaria, datura, dioscorea, mint, opium, Solanum khasianum and Tephrosia. Important post-harvest diseases of fruit, plantation and medicinal and aromatic crops and their management.

***Practical**: Observations of disease symptoms, identification of casual organisms and host parasite relationship of important diseases. Examination of scrapings and cultures of important pathogens of fruits, plantation, medicinal and aromatic crops.*

Pear diseases

Introduction

Pear is one of the important fruit of temperate zone, this fruit is popular for its delicious taste. There are many diseases which badly affect this crop. Most severe of them are fire blight, powdery mil dew & crown gall of apple. Some of the major diseases are discussed here.

LIST OF PEAR DISEASES

Pear scab	*Venturia inaequalis*
Powdery mildew	*Podosphaera leucotricha*
Pacific Coast Pear Rust	*Gymnosporangium libocedri*
Fire blight	*Erwinia amylovora*
Crown gall	*Agrobacterium tumefaciens*
Fabraea Leaf Spot	Fabraea maculata
Pear decline	Phytoplasma disease

Phytophthora Crown Rot, Collar Rot, and Root: *Phytophthora* sp.

Powdery mildew

Casual organism- ***Podosphaera leucotricha***

Symptoms –

- On leaves- whitish powdery growth on upper & lower side comprising of oidea
- On stem- whitish powdery growth
- On fruits- whitish powdery growth but in dry condition

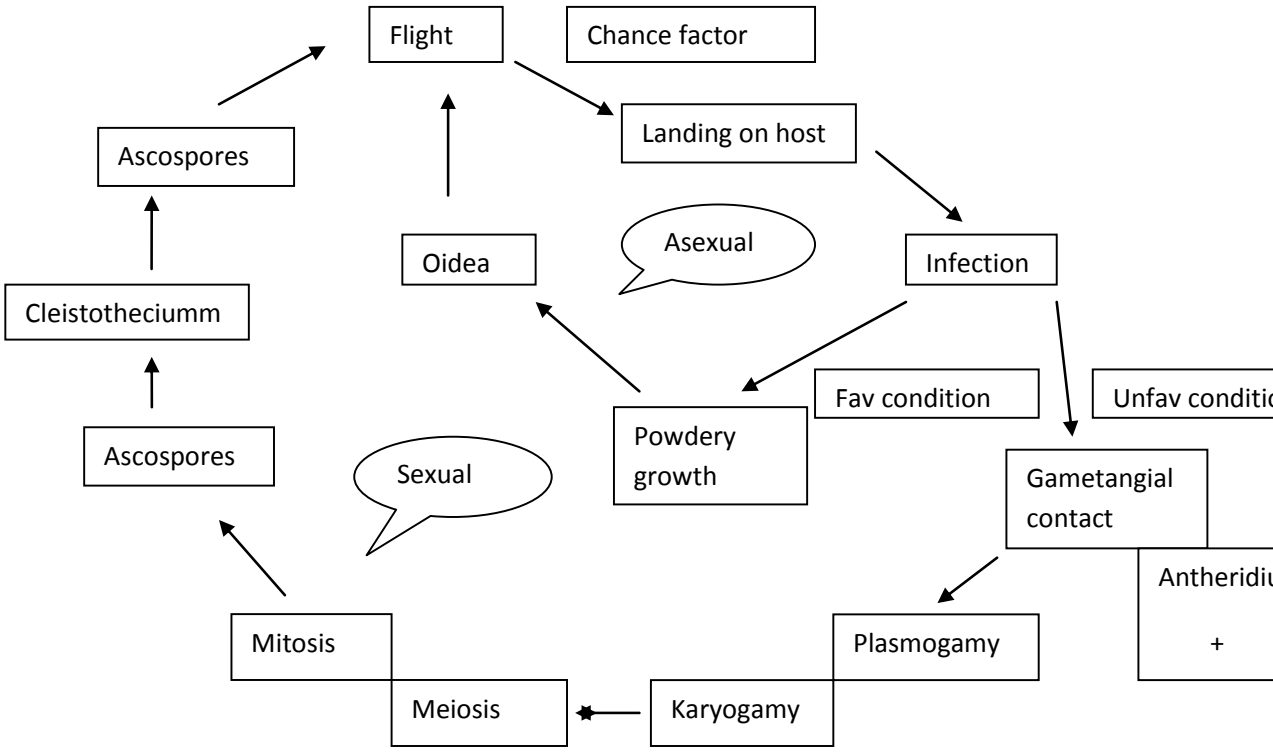
Etiology-

- Mycelia –septate, subepidermal houstiria
- Asexual spore-conidia
- Asexual fruiting body- oidium
- Sexual spore- ascospore
- Sexual fruiting body- cleistothecium
- Primary source of inoculum: dormant mycelia in infected dormant bud
- Secondary source of inoculum- barrel shaped conidia

Epidemiology-

- Warm weather condition
- Temperature- 28-32 ‘c
- Relative humadity- 80-90 %
- Intermittent rainfall

Life cycle-



- **Management-**

Cultural-

- pruning of canker affected part & paste CoC at cut end
- Spray 5% urea on fallen leave
- Optimum plant density
- Use of drip irrigation

Chemical-

- ❖ Calcium oxychloride 0.3%
- ❖ Bordeux mixture 1%
- ❖ Streptocyclin 0.05%

Biological-

- *Erwinia herbicola*
- *Psuedomonas fluorescens*

FIRE BLIGHT – *Erwinia amylovora*

Symptoms:

Affected parts appear to be scorched by fire. A watery ooze may be exuded from infected plant parts. The disease may kill entire trees. Fruit which are infected early remain small and appear shriveled, dark, and 'water soaked'. They will remain attached to the cluster.

Fruits affected later are less tasted

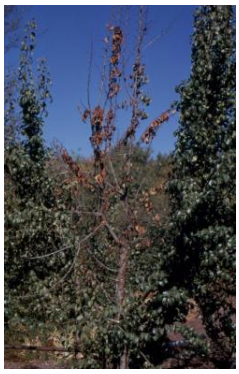
Disease cycle: The bacteria over winter in bark tissues along the edges of cankers caused by infection in previous years. The bacteria multiplies in the spring, the cankers exude a characteristic ooze, and the bacteria are disseminated by rain and insects to vulnerable tissues - especially open blossoms, tender vegetative shoot tips, and young leaves. The bacteria penetrate the tree at natural openings or wounds. Secondary infection arises from ooze from fresh infections.

Note the blackened flowers and vascular system (part of this terminal shoot has been cut in cross section).

Hold over canker on a pear branch. These can be difficult to see on smaller branches

Last year's shoot has died quickly and must be cut out soon before more of the branch dies.

Black lesions on the young fruit and bacteria oozing from the base of the spur.



An entire tree can die in a few weeks if management tactics are not in place.

Mature fruit with discolored infection center and bacterial ooze.

Disease causing organism: *Erwinia amylovora* (Burrill) Winslow

Dissemination:

Disseminated by bees and other pollinating insects and by rain

Primary source of inoculum: Bacterial cells present on affected cankers and on cracks and cravices.

Secondary source of inoculum: Rain splash borne bacterial cells

Monitoring and Management:

The need for chemical control depends on a combination of orchard risk factors and weather conditions. Infection is most likely to occur after 200 degree hours (base 65 F) have accumulated since the first blossom has opened in the orchard. Predictive models of likely infection periods (such as the Washington fire blight risk model and the Maryblyt model) can help growers to determine when such sprays may be needed

Management Options:

Control of fire blight is aimed at reducing the level of inoculum in the orchard, reducing the susceptibility of the trees through horticultural practices, and preventing infection at critical and times through the use of bactericides.

Cultural Practices:

Reduce primary inoculum by removing infected plant material when winter pruning. Inspect orchard weekly during the growing season remove infected plant material. When removing infected plant material, cut infected branches at least 12 - 18 inches below the lowest evidence of disease. When removing infected plant material during the growing season, prune only on sunny, hot days when rain is not predicted.

Control insect vectors in the orchard. When planting new orchards, avoid susceptible cultivars. Plant well-drained soil. Maintain proper orchard nutrition in order to discourage excessive tree vigor.

Chemical:

COC (0.3%) and STREPTOCYCLIN (0,05%)

Pacific Coast Pear Rust

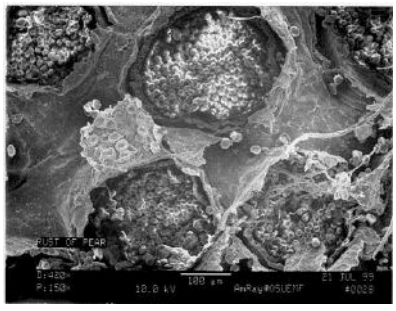
Casual organism-: *Gymnosporangium libocedri*

Symptoms:

Leaf: Spots fade and darken as the leaf matures or falls off the tree. Green shoots and leaves

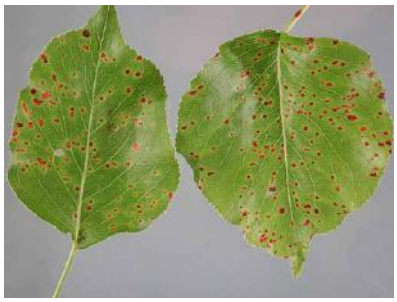
also are attacked but not as frequently.

Fruit: Pear fruit are malformed while young and drop from the tree. Bright yellowish to orangish spots with numerous cup-shape pustules (aecia) develop over the fruit surface. Oriental and European cultivars are susceptible. 'Winter Nelis' is severely affected, but 'Bartlett' is not..



This is a scanning electron micrograph of aecia and aeciaspores (150x

Note the reddish, yellow lesions on these young, misshapen fruit.



Numerous rust pustules (uredia) can be seen on these flowering pear leaves (*Pyrus calleryana*).

Dissemination : Spores produced on eastern red cedar are discharged following rain, and disseminated by wind currents to pear hosts. Spores produced on pear may also be carried by wind to cedars

Primary source of inoculum: telial galls on cedar plant becoming air borne basidiopsores.

Secondary source of inoculum: airborne basidiospores

Cultural control: Remove alternate hosts around the orchard.

The grower should be most concerned aut cedar pear rust if the cultivars grown in the orchard are susceptible to the disease, if there are eastern red cedars in the vicinity, and if there are numerous rainy periods during the spring.

Cultural Management Options: Sources of infection may be reduced by cutting down nearby eastern red cedar, but it is difficult to entirely eliminate sources of infection due to the distance spores are able to be carried by the wind. Some pear cultivars are resistant to cedar pear rust, and may be grown without fungicide sprays to control it.

Chemical: Certain scab fungicides may also control cedar pear rust mancozeb 2 ml per lit

Fabraea Leaf Spot

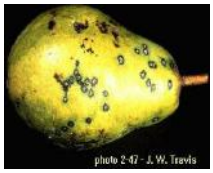
Casual organnnism; - *Fabraea maculata*

Symptoms:

Leaf :spot can be found on petioles, leaves, shoots and fruits. Initial lesions on leaves are tiny, round, purplish-black spots, which quickly enlarge to 1/8 to 1/4 inch in diameter and usually have a blackish-brown center (photo 2-46). Spots coalesce and severely infected leaves fall to the ground prematurely. A small black acervulus may develop in the center of each lesion, from which conidia ooze in a creamy, white mass in wet weather.

Fruit :lesions (photo 2-47) are larger than those on leaves and cause the fruit to crack and drop. Lesions on current season's shoots may be observed as small inconspicuous, purplish-black spots. Some lesions develop into superficial cankers, but most are walled-off during the next growing season, so that cankers rarely persist in two-year-old wood.

Disease Cycle: The four-celled conidia (Entomosporium maculatum), with a distinctive insect-like appearance, are spread mainly from overwintering leaf litter, and some from twig cankers, by splashing water from rains or overhead irrigation. Wetting periods for infection may vary from 8 to 12 hours at temperatures of 50 to 77 F (10-25 C). Lesions begin to appear about 7 days after the beginning of an infection period. The disease may advance rapidly in late summer as wind and rain distribute the conidia throughout the tree. Susceptibility of leaves and fruit to infection does not decrease with maturity. Nearly all pears of European descent are susceptible to this leaf spot.



Management:

This disease is controlled with applications of protectant fungicides.

Early-season spray programs for pear scab should also control early-season leaf spot infections. Where ascospores and conidia of the fungus occur after petal fall, summer fungicide treatments are needed

Phytopthora Crown Rot, Collar Rot and Root Rot

(Collar rot affects the scion portion of the tree, crown rot affects the rootstock portion of the tree. Root rot affects the root system away from the crown region.)

Disease causing organisms: *Phytopthora* spp.

Dissemination: Soil born fungal pathogen. Pathogen survives in soil for several years as spores, especially in old orchard soils. May also be brought into the orchard on infected nursery stock.

Symptoms:

Cankers may be seen at or below the ground line, and may extend from the original site of infection into the root system and up the trunk to the bud union and above the bud union if the scion is also susceptible. Infected bark is brown and often slimy when wet. When the bark is pulled away, the cambium and phloem will be an orange, reddish brown color. The cankers caused by the fungus girdle the tree, resulting in poor vegetative growth and chlorotic foliage that may turn purple in the autumn. A severely infected tree may die. Trees may be killed in one growing season or may linger for a number of growing seasons.


Disease cycle:

The fungus survives in the soil as thick-walled spores (oospores) that are resistant to drought and relatively resistant to chemical treatment. The fungus may also be brought in on infected nursery stock and in contaminated irrigation water. Mobile spores (zoospores) originating from the oospores move to the tree and colonize the pear bark tissue. The fungus may build

up to high levels in the soil in a short period under favorable conditions - i.e. during wet, cool periods after harvest and in spring.

Monitoring and Management:

Key times for management: The best time to manage Phytopthora diseases is during the initial stages of orchard establishment, when selecting the orchard site, planting, site preparation and rootstock selection. Management Options: While there are some fungicides registered for control of Phytopthora, management is best achieved through cultural methods.

Cultural Controls: Primary control of Phytopthora diseases is culture. When planting a new orchard, select the site and rootstocks carefully. Be sure the orchard site has adequate drainage throughout the year. When irrigating the orchard, do not saturate the soil for prolonged period is. Use rootstocks resistant to infection by the disease. Scion cultivars may also be chosen for resistance.

Chemical: Bordeaux mixture 1% or Copper oxychloride (.03%) or Mancozeb 0.25%

Pear –decline

Casual organism:- Phytoplasma like organism

Symptoms: Pear decline is characterized by two phases: quick decline and slow decline. Trees may wilt, scorch, and die in a few weeks or lose vigor over several seasons during which foliage gets

sparse with little or no terminal growth and leaf size is reduced.

An abnormal early red leaf coloration has been observed frequently on affected trees. Examining the graft union reveals a brown line on the cambial face of the phloem tissue. (Use a pocket knife to expose the cambium.)

Early or premature foliar discoloration is a general symptoms of this disease.

Cultural control:

1. Use resistant or tolerant rootstocks.
2. Use the best orchard management practices, including the best possible insect and disease control, irrigation, drainage, fertilization, and pruning.
3. Control pear psylla.
4. When grafting Asian pear trees over to European *(P. communis)* cultivars, graft below the union of the Asian pear with its rootstock to avoid creating a highly decline-susceptible tree.

Pear scab

Casual organism-: *Venturia pirina*,

Symptoms: In spring, sooty spots with a soft velvet look appear on young fruit, stems, calyx lobes, or flower petals.

fruit :Young infected fruit frequently drops or is misshapen. Scab spots expand with growth until halted by dry weather or sprays. Old fruit infections often crack open. Cracks are surrounded by russeted, corky tissue and then an olive-color ring of active fungus growth. If fruit is infected late in the season, about 2 weeks before harvest, pinpoint scab spots often show up in storage a month or more later.

On leaves: olive-black spots expand with leaf growth but often cause the leaf to twist abnormally. Infected twigs show small blisterlike infections the size of a pinhead and develop a corky layer. Many twig infections are sloughed off during the summer season.

Note the sunken, dark lesions on this fruit.

Scab can be clearly seen on the leaves and fruit.

Stem lesions are very troublesome as an overwintering site and need to be removed if observed.

Etiology

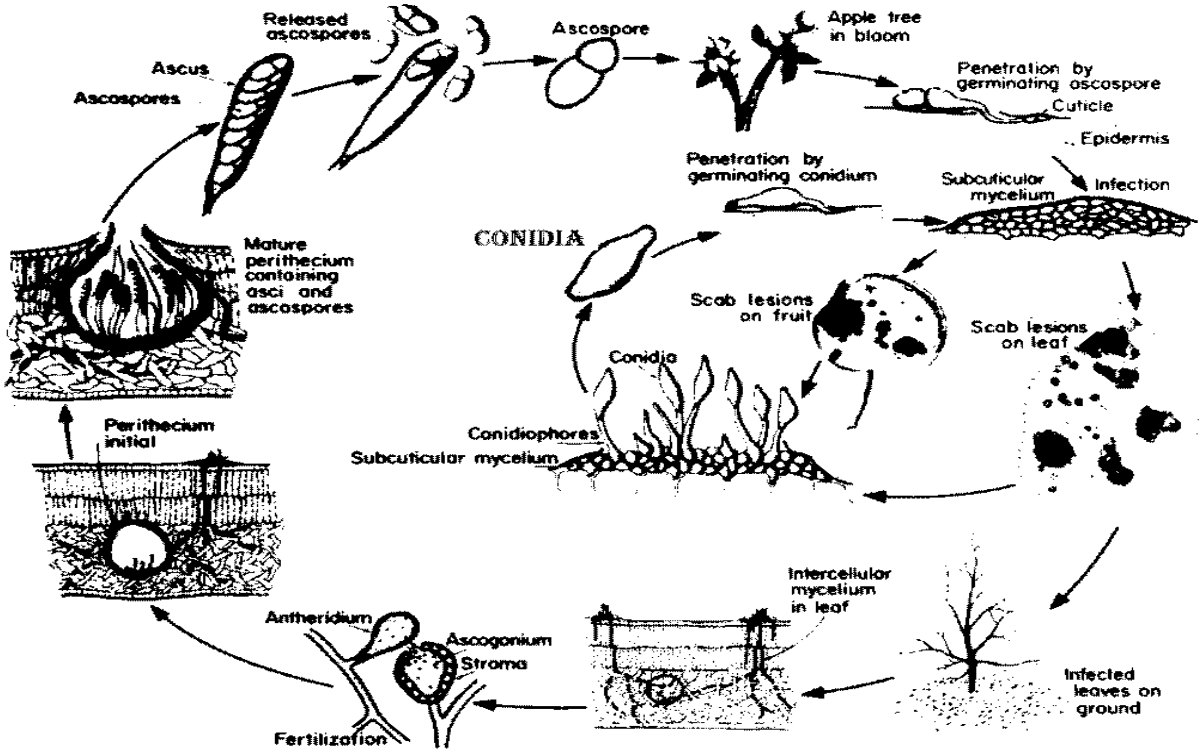
- mycelia –septate, subepidermal houstiria
- Asexual spore- spilocea type of conidia
- Asexual fruiting body-

- Sexual spore- ascospore
- Sexual fruiting body- psuedothecium

PSI; pathogen survive on affected fallen leaves

SSI; Airborne conidia

Life cycle



Cultural control:

1. Carefully discing to cover old leaves with soil, where practical, may help reduce spring infections.
2. Pruning out infected twigs also offers some benefit.
3. Applying dolomitic lime after leaf drop in fall to increase soil pH also helps reduce inoculum the next spring.

Chemical control: spray schedule-

Spray- silver tip to green stage mancozeb @ 2g/l or chlorothalonil @ 2g/l
Spray –pink to blooming stage carbendazim @ 1.5g/l
Spray- young fruit coc @ 3g/l
Spray – maturation stage mancozeb @ 2g/l
Spray –postharvest benomyl @ 1g/l

Biological control:

- **Tricoderma species**
- **Althelia species**
- **Chaetomium species**

Crown gall of pear-

caused by the *Agrobacteriun*

Symptoms

The disease first appears as small overgrowths or galls on the roots, crown, trunk, or canes. Galls usually develop on the crown or trunk of the plant near the soil line or underground on the roots. Above ground or aerial galls may form on canes of brambles and highly susceptible cultivars of pear. Although they can occur, aerial galls are not common on fruit trees.

Below ground symptoms:-
In early stages of development the galls appear as tumor-like swellings that are more or less spherical, white or flesh-colored, rough, spongy (soft), and wart-like. They usually form in late spring or early summer and can be formed each season. As galls age they become dark brown to black, hard, rough, and woody. Some disintegrate with time and others may remain for the life of the plant.

Above ground symptoms:-
The tops of infected plants may appear normal. If infection is severe, plants may be stunted, produce dry, poorly-developed fruit, or show various deficiency symptoms due to impaired uptake and transport of nutrients and water.

Causal Organism
The crown gall bacterium is soil-borne and persists for long periods of time in the soil in plant debris. It requires a fresh wound in order to infect and initiate gall formation.

Infection process:-

Wounds that commonly serve as infection sites are those made during pruning, machinery operations, freezing injury, growth cracks, soil insects, and any other factor that causes injury to plant tissues. Bacteria are abundant in the outer portions of primary galls, which is often sloughed off into the soil. In addition to primary galls, secondary galls may also form around other wounds and on other portions of the plant in the absence of the bacterium. The bacteria overwinter inside the plant (systemically) in galls, or in the soil. When they come in contact with wounded tissue of a susceptible host, they enter the plant and induce gall formation, thus completing the disease cycle. The bacteria are most commonly introduced into a planting site on or in planting material.

Control

1. Obtain clean (disease free) nursery stock from a reputable nursery and inspect the roots and crowns yourself to make sure they are free from galls. Avoid planting clean material in sites previously infested with the bacteria.

2. Avoid all unnecessary root, crown, and trunk wounding by careless cultivation and other machinery operation, and control soil insects. Any practice that reduces wounding is highly beneficial. Preventing winter injury (especially on pears) is also beneficial.

3. On pears, the double trunk system of training may be a useful system for minimizing losses due to crown gall. If one trunk is infected, it can be removed. The remaining trunk can be pruned leaving a full number of buds until the second trunk can be renewed. Galls on the upper parts of the trunk or on canes can be removed by pruning.

4. A relatively new biological control agent for crown gall is available for pear, pear, stone fruit, blueberry, brambles, and many ornamentals.

The agent is a nonpathog *Agrobacteriu or* stra K - 84 that protects the plants against rring strains c bacteria ir

Model questions

I. Choose the correct answer:

1. Pear powdery mildew is caused by an organism ---------

a) *Uncinulla necator b) Plasmapara viticola c) Oidium mangiferae d)Podosphaera leuchotricha*

2. Sexual fruiting body of *P.leuchotricha* is---------

a) Pseudothecium b) Perithicium c) Cleistothecium d) Apothecium

3. Organism which causes scab in both apple and pear is -------

a) *Spiloceae pomi b) Venturia ineaqualis* c)Only a d) both a&b

4. Fungal bioagent which parasatises on scab are-------

a)Athelia& chetonium sp. B)E. herbicola c)P. fluorescens d) Pencillium sp

5. Asexual stage of V. ineaqualis is ---------- type of conidia.

a) Whip like b) Muricate c) Spiloceae d) Verticillate

6. Fire blight *E. amylovora* was first identified by ----------

a) Millerdet b) John c) Michell d) T.J.Burrill

7. Crown gall is caused by ----------

a) *A. tumifaceans b) A. radiobacter c) A. solani d) A. melangainae*

8. Crown gall is caused due to ----------

a) Ti plasmid b) +ve chemotoxis c) increased growth hormones d) all of the above.

9. Slow decline is caused by----------

a) Fungi b) Bacteria c) Virus d) Phytoplasma

10. *Colletotrichum angulata* is a c. o for ----------

a) Soft rot b) Brown rot c) bitter rot d) Dry rot

II. Fill in the blanks

1. Asexual name of *Venturia ineaqualis* is ----------
2. C. o for collar rot disease ----------
3. White root rot is caused by ----------
4. Pink canker/ Die back is caused by ----------
5. Crown gall is caused by ----------
6. Pear scab is caused by ----------
7. Dry rot is a ---------- disease
8. Sooty blotch and fly speck is caused by ---------- and ----------

9. *Trichothecium roseum* is a ---------- mould

III.Match the following

1. Collar rot	1. *Botryobasidium salmonicolor*
2. Soft rot	2. *Gloeodes promigens*
3. Bitter rot	3.*Spilocea pomi*
4. Brown rot	4.*Alternaria moli*
5. Dry rot	5.*Pencillium expansum*
6. Scab	6.*Phytopthora cactorum*
7. Powdery mildew	7.*Colletotrichum angulatum*
8. Pink mould	8.*Sclerotinia fructiginea*
9. Sooty blotch	9.*Podosphaera leuchotricha*
10. Pink canker	10.*Trichothecium roseum*

IV. Say true or false:

1. *A. tumifaceans* is peritrichous bacteria having Ti plasmid.
2. +ve chemotoxis of bacteria is occurred due to acetosyringone reaction.
3. In crown gall root show hypotropic symptoms.
4. *A. radiobacter* strain K 26 is biological agent.
5. *E. amylovora* is a first plant parasitic bacteria.
6. Althelia is bacterial bioagent.
7. Reticulate networking with whitish powdery growth on fruit is by scab.
8. Asexual stage of *V. ineaqualis* is as spiloceae.
9. Quick decline is present in pear.
10. Die back/ pink canker is caused by *Botryobasidium salmonicolor*

ARECANUT (*Areca catechu* L.)

INTRODUTION:

Arecanut (*Areca catechu* Linn) family Palmae is a tropical palm grown in about 2,54,000ha with an annual production of 3, 33,000 tonnes. The palm is extensively cultivated in the states of Karnataka, Kerala, Tamil Nadu and parts of Maharashtra, West Bengal, Assam, Goa, Meghalaya and Andra Pradesh. The palm is affected by a number of diseases and disorders which affect the roots, stem, fronds, spear leaf, spadices and developing fruits. The palms from its seedling stage are influenced by many diseases. Few diseases can cause economic yield reduction or mortality of palm**.**

DISEASES OF ARECA NUT

Major diseases

1. Mahali disease -*Phytophthora meadii (=P. arecae)*
2. Bacterial leaf stripe: *Xanthomonas campestris* pv. *Arecae*
3. Anabe roga (disease): *Ganoderma lucidum*
4. Yellow leaf disease: Phytoplasma-like organism
5. Bud rot - *Phytophthora arecae*
6. Stem bleeding -*Thielaviopsis paradoxa*
7. Inflorescence die back –*Colletotrichum gleosporioides*

Minor diseases

a. Red rust -*Cephaleuros* sp.
b. Yellow leaf spot: Fungal complex
c. Root rot -*Fusarium* sp.
d. Leaf blight – *Phomopsis palmicola* var. *arecae*

1. MAHALI/KOLEROGA/FRUIT ROT/NUT ROT

In areas receiving heavy rain fall, mahali (heavy devastation) or koleroga (kole=rotting, roga =disease) is most dreaded disease. Butler in 1906 first recorded this

disease from Mysore. Lesli,C.Coleman (1910's) who worked extensively on this disease and developed management practices to manage the disease which are still working satisfactorily.

Symptoms:

- Characteristic symptoms include rotting and excessive shedding of immature nuts form the trees.
- The first sign of the disease is on the nuts, on which a water soaked lesions usually develop towards the base. Because of this watery rot, the disease is locally called as "Neerugole".
- Later leads to discoloration, discoloration starts browning then leads to deep browning, later dropping of nuts takes place..
- The fallen nuts show the felty, white mass of mycelium of the fungus which soon envelops the entire surface. Infected nuts loose their luster. This type of symptoms with boost like growth of the fungus , as also locally called as "Busurugole".
- The disease gradually spreads among the bunch ultimately covering the entire bunch wherein they rot and shed from the bunches.
- Fruit stalks and rachis of inflorescence are also affected. They are lighter in weight and deteriorate and are unsuitable for chewing.
- Very often, the top of the affected trees may also dry resulting in withering of leaves and bunches.

(Mahali/ bud rot disease of areca nut)

Infected palm showing characteristic symptoms of bud and crown rot diseases

(Kole roga of areca nut) **An affected nuts with white mycelial growth**

Causal organism – *Phytophthora meadii [=P. arecae* (Coleman) Peth. (Syn. *Phytophthora palmivora* var.arecae)].

Etiology:

- The mycelium is inter or intra cellular, coenocytic but forms septa in older stages.
- Haustoria are finger like, occasionally branched and sparsely produced.
- The sporangiophores are irregularly branched and the sporangia are pyriform to elliptical.
- Oospores are the sexual spores and are also act as dormant spores which survive for about 4-5 years.

Mode of spread and survival:

- Rain and wind plays an important role in the initiation and spread of the disease since low temperature and high humidity are favorable for the growth of the fungus.
- Intermittent rains with alternative sunshine are more conductive to a rapid spread of the disease.
- The close plantation of trees and plant grown in valleys gives ideal conditions for spread. Formation of oospores in the diseased nuts at the end of the season and dormant mycelia present in cracks and crevices of the tree helps the pathogen to perpetuate from season to season.

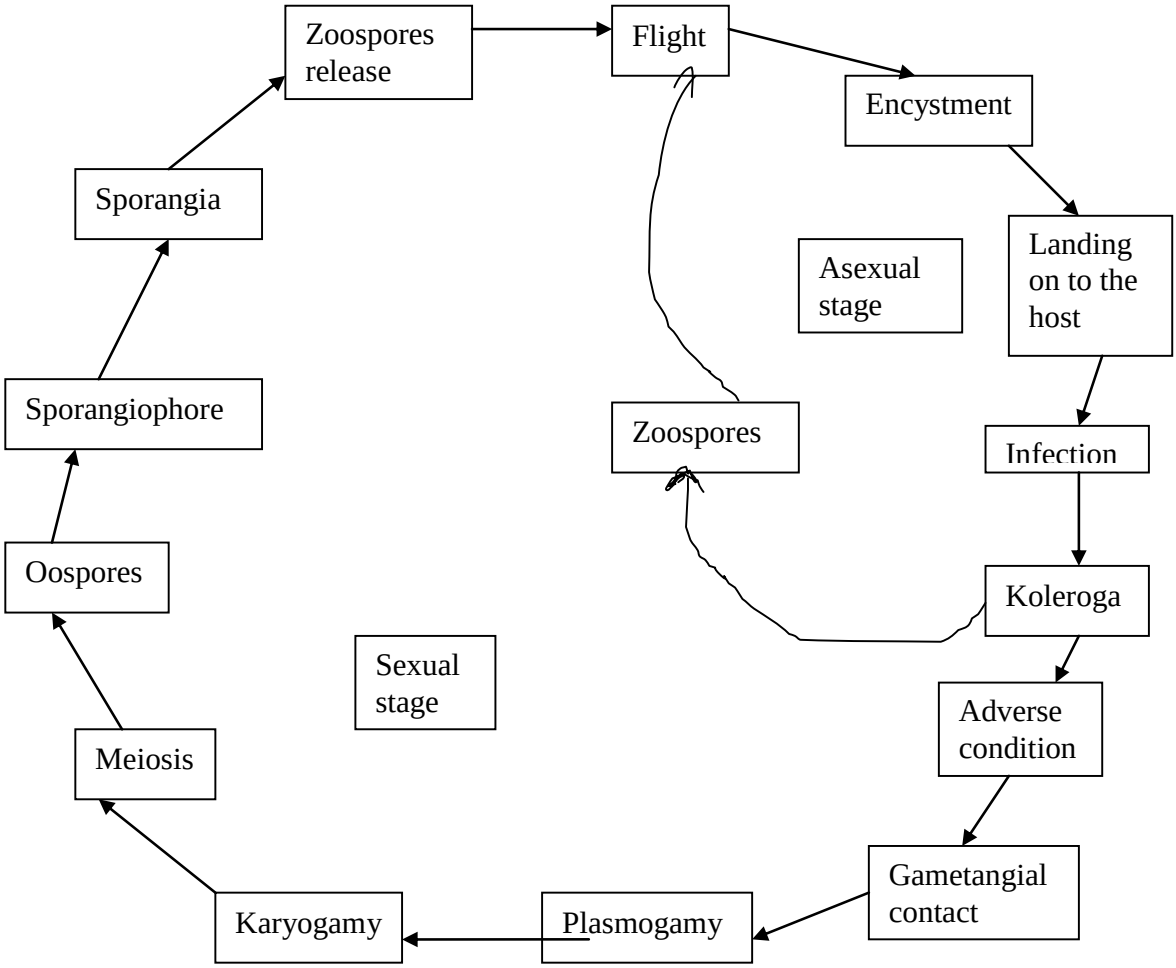
- The fungus also infects potato tubers, apple and cocoa fruits, fruits of citrus nobilis, *Artocarpus incisa* and *Agave wightii*.

Epidemiology:

- The optimum temperature for fungus is 18-22^{o}C
- Relative \Humidity of more 95% is congenial for the development of disease.
- Sporangia of the fungus have best caught in aeroscope slides at a height of 10-11m .
- The fungus infects the nuts readily but not after 6 months old. Heavy rainfall, wind, low temp ,alternate sunshine and rainfall favours the disease.

Management:

- Cleanliness and field sanitation including destruction of diseased tree tops and plant parts are foremost important in the management of the disease. Fallen infected nuts should be collected and burnt/destroyed.
- Spraying with Bordeaux mixture 1.0% is recommended. Vegetable oils from ground nut, sesame, coconut or sunflower added to Bordeaux mixture before spraying also protect the palm from this disease.
- Prophylactic spraying with Bordeaux mixture 1% once before the onset of south west monsoon and a second application 40-45 days later has been recommended with Metalaxyl MZ (0.2%).
- Cover the fresh bunches after first spray with polythene bags to avoid fresh/further infection.
- While spraying to the tree, the whole crown region should be covered.



Life cycle of Koleroga

2. BACTERIAL LEAF STRIPE

Rao and Mohan (1970) reported its occurrence from Tumkur areas of Karnataka state in an endemic form.

Symptoms:

- The initial symptoms include 1-4 mm diameter wide, dark green water soaked, translucent, linear lesions or stripes along side and parallel to the mid rib of the leaf let of its other main veins.
- The lesions may be developing at any point on the lamina, but more commonly from the base or towards the tip of the leaf let.

- The margin of the lesions is usually straight and well defined, but occasionally it may appear wavy.
- The lesions are covered with abundant bacterial exudates on the lower surface. The exudate is creamy white and slimy.
- On drying, it forms a waxy film or creamy white or yellowish flakes or fine granules or irregular yellowish masses.
- In the advanced stages, the lesions may measure 1cm or more wide and several centimeters long involving the midrib also.
- The affected midrib and veins of the leaflet get discolored and turn black.
- All the leaflets of leaf may be affected resulting in complete or partial blighting of the leaf and in severe cases the entire crown may be killed particularly in seedlings.

(Bacterial leaf stripe)

Infected leaf showing characteristic symptoms of black stripe on lower and upper surface.

Etiology:

Xanthomonas campestris pv. *arecae* (Rao and Mohan) Dye

- It is soil borne, rod shaped, gram negative bacteria, monotrichous, genetic material DNA , reproduced by binary fusion.

Epidemiology:

- Temperature 26 to 28^{0}C, Relative humidity 85-90%, intermittent rainfall, susceptible host favours the disease.

Mode of spread and survival:

- The bacterium infects arecanut and other ornamental palms.
- The disease remains aggressive during and after the rainy season and it is of little significance during the hot dry summer months.
- The incidence is high during the months of July October when the average monthly rainfall is 130mm or more with more than 10 rainy days per month. 3-5 year old palms are highly susceptible to the disease than the older palms.

Management:

Cultural control:

- Early identification and eradication.
- Use healthy planting materials.
- Antibiotics like tetracycline and its formulations are effective as prophylactic and curative treatments at 500 ppm concentration.
- Stem injection of antibiotics has longer residual effect than foliar spray. Streptocycline 0.05% or copper oxychloride 0.3% spray can also be given.

3. ANABE ROGA/ROOT ROT/ROOT WILT/TANJAVUR WILT/GANODERMA WILT:

Symptoms;

Above ground ;

- Yellowing and browning of outer whorl of leaves. As the disease advances the inner whorl also exhibit the same symptom.
- Leaves dries at later stage of the disease, droops and hang around the stem.
- The impact is the flowers, and nut size reduction and dropping.
- In severe or advanced stages, drooping of all the leaves and drop off by leaving only stem with out leaves. Discolouraiton of vascular bundles can be seen.

On trunk

- Later stages of the disease, stem bleeding and oozing of gum takes place upto the height of 5m.

Below ground level on roots

- The roots of the infected plant become brittle, discololur and dry.
- Sporophores and fruiting bodies can be seen on the stem portion at the collar region mostly after the death of the tree which gives the name "Anabe Roga (Mushroom like)".

Causal organism; *Ganoderma lucidum*

Etiology:

- The fungus is heterothallic and weak parasite.
- Vegetative spores are Chlamydospores.
- Conidia are round, thin walled. Sexual spores are basidiospores

Primary source of innoculum:

- Chlamydospore and dormant mycelia survive in soil, affected roots.

Secondary source of innoculum

- Air borne basidiospores.

Mode of spread and survival;

- It is a soil borne and survives as dormant mycelium, chlamydospores. Secondary spared through the twisting of infected roots to healthy roots (through soil root).
- The mycelium present in the infected roots transfer to healthy once and thus spread the disease and spreads also through air.

Epidemiology:

- Neglected plantations

- Sandy loam soils
- High plant population density
- Summer stressed plantations

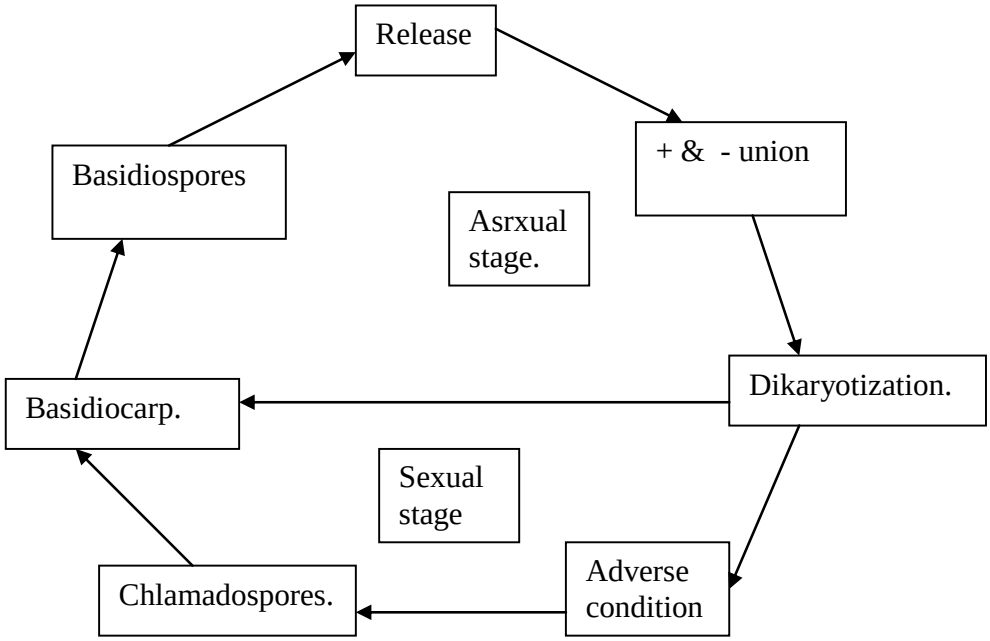
Management;

Cultural control:

- Fruiting bodies of the fungus and the dead stump and roots should be collected and burnt.
- Improving drainage facilities, avoiding dense planting of palms and adoption of clean cultivation of gardens help in checking the disease.
- The fungus infects many plant trees including avenue trees and such host trees should be avoided in the vicinity of the areca garden.
- The spread of the disease to neighboring trees can be prevented by digging deep trenches all round the affected palm and applying sulpher. Use drip irrigation during summer.

Chemical control: Soil drenching with calyxin 10ml/. lit or stem injection.

Biological control: Application of *Trichoderma viridae*, 100 gram per plant reduces the disease.



Life cycle of Anaberoga.

4. YELLOW LEAF DISEASE

Symptoms:

- Symptoms include yellowing of leaves and shedding of both matured and immature nuts. Endosperms of diseased nuts are soft, blackish and not suitable for consumption.
- Yellowing at the tips of leaf lets in 2or3 leaves of the outermost whorl is the first visible symptom.
- Brown, necrotic streaks run parallel to lamina in unfolded leaves, with the development of leaves, yellowing starts form the tips of leaflets, gradually extending to the middle of the lamina.
- One or two leaflets in any of the crown or the entire foliage may be affected by the disease. Tips of the chlorotic leaves eventually dry up.
- In advanced stages, leaves are reduced in size, stiff and pointed, closely bunched and puckered. Finally the crown falls off leaving of are base trunk.
- Root tips turn dark and gradually rot. Production of lateral root is reduced.

- Affected fruits fall off. Some of the palms exhibiting foliar yellowing may produce normal nuts and all nuts in the bunch may not show kernel discoloration.
- Blocking of xylem vessels of older leaves of diseased palms, degeneration of cortex and presence of tyloses in xylem are also noticed in diseased roots.

Causal agent: unknown etiology

Phytoplasma-like organisms.

Management:

- True Mangala seedlings and South Canara variety showed tolerance to this disease. The hybrid Saigon×mangala yielded max. Number of nuts with minimum disease intensity.
- Palms which received higher dose of potassium and magnesium recorded minimum disease intensity.
- Chlorotetracyclin hydrochloride (Aureomycin) and tetracycline chloride (achromycin) through root feeding and stem injection had no ameliorative effect on the disease.

5. BUD ROT:

Symptoms:

- The fungus *Phytophthora palmivora*. *P meadii* causing koleroga in bunches also pass on to bud and cause rotting.
- The first symptom of the disease is the discoloration of the spindle from the natural light green color to yellow and then brown.
- Infection spreads to young leaves which rot rapidly. As the infection spreads inside the bud the growing point of the stem also rots resulting in the death of the palm.
- The spindle slumps and can be drawn out with a gentle pull.
- The outer leaves then become yellow, droop and drop off one by one leaving a bare stem. Secondary organisms colonize the rotting bud and convert it into a slimy mass which would emit a foetid smell.

Causal organism*: Phytophthora palmivora*

Etiology:

- The mycelia is aseptate, intercellular mycelium & intercellular haustoria.
- Zoospores are the asexual spores borne in sporangia.
- oospores are the sexual spores borne in oogonium.
- Primary source of innoculum: oospores.
- Secondary source of innoculum: zoospores.

Epidemiology:

- This organism require cool weather condition, temperature requirement is 18-20˚ c, relative humidity is 98-100%, require cloudy weather, intermittent rainfall & high density plantation. It occurs in sever form in heavy rainfall tracts of Karnataka.
- It generally occurs in monsoon season.
- Fresh infection during November onwards becomes severe during succeeding months.

Management:

- Infected tissues of bud are to be scooped off and treated with Bordeaux paste.
- Destruction and removal of dead palms and also branches affected by mahali and drenching crowns of surrounding healthy palms with Bordeaux mixture 1% help in reducing the disease incidence.

- Soil application of *Trichoderma* reduces the inoculum in soil.

6. STEM BLEEDING

Symptoms:

- Both the young and old plants are affected but young palms are highly susceptible. Symptoms appear on the basal portions of the stem as small discolored depression during initial stages.
- Later the spots coalesce and cracks develop on the stem which eventually produces hollows upto varying depths along the infected portion.
- Crown of affected adult palms get reduced in size followed by reduction in yield. Finally a dark brown liquid oozes out from cracks.

Causal organism: *Thielaviopsis paradoxa* (de Seyenes) Hohn.

Primary source of inoculum: Dormant mycelia .

Secondary source of inoculum: Air borne conidia.

Epidemiology: More serious in kharif season , also more serious in case of poor drainage areas.

Management:

- Improving the drainage may help in minimizing the disease incidence.
- Root feeding with proper chemical. Application of hot coal tar or Bordeaux paste is effective in reducing the disease.

7. **Inflorescence die-back and button shedding**:

Symptoms:

- Die back of inflorescence is associated with low fruit set. About 60% of palms in the state of Karnataka, Kerala are infected by the disease causing severe shedding of buttons.
- Disease appears on the rachillae of the male flowers, then in the main rachis as brownish patches which soon spread from tip downwards covering the entire rachis causing it wilting. The female flowers of the infected rachis are shed.
- The fungus also infects the developing embryo inside the female flowers, which eventually shrivels up showing a brown discoloration.

- Under severe conditions the fungal infection proceeds from tip downwards producing the condition known as die-back.
- Concentric rings of light pink coloured conidial mass of the pathogen appear on the discolored portions of the infected inflorescence.

Causal organism: *Colletotrichum gloeosporioides* Penz.

Etiology:

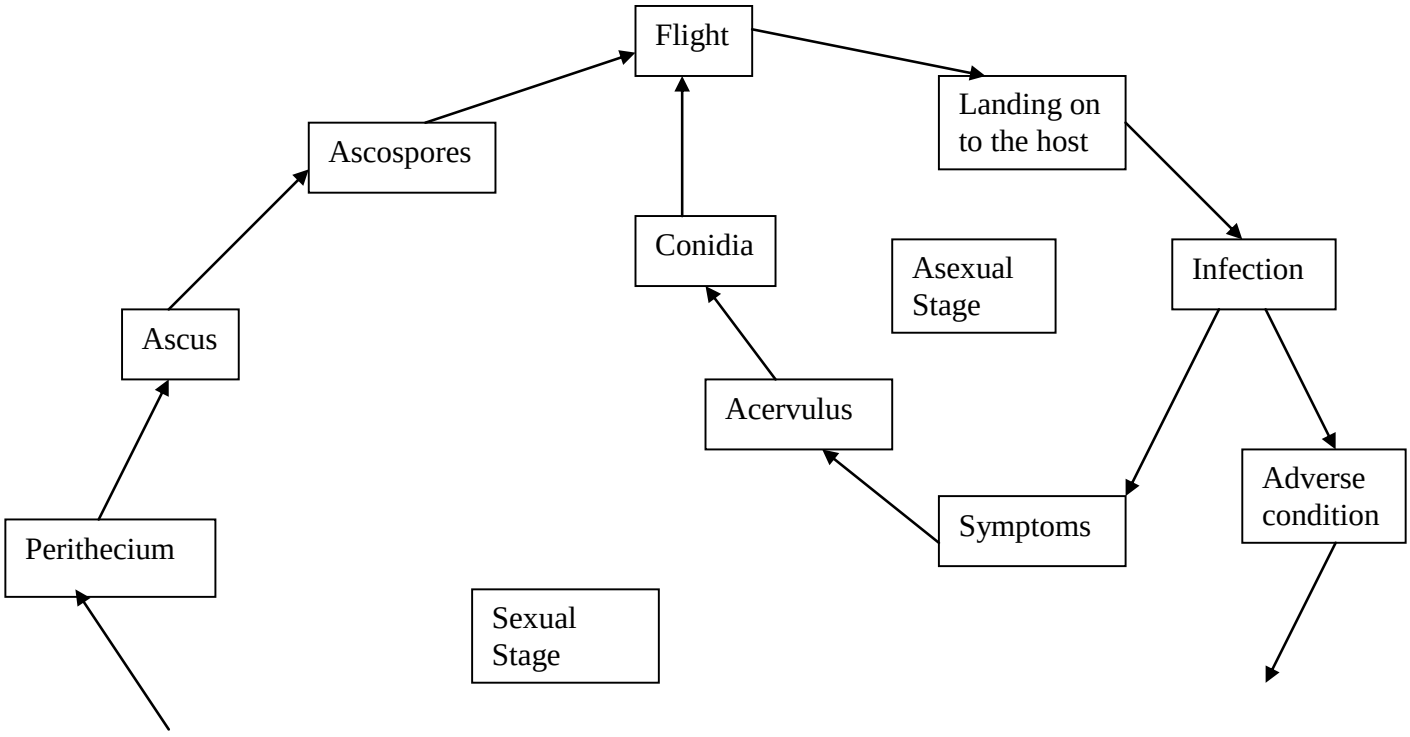
- Mycelium is septate , asexual spores are conidia borne in acervulus.
- Sexual spores are ascospores borne in Perithecium.
- Primary source of innoculum: Dormant mycelia.
- Secondary source of innoculum: Conidia.

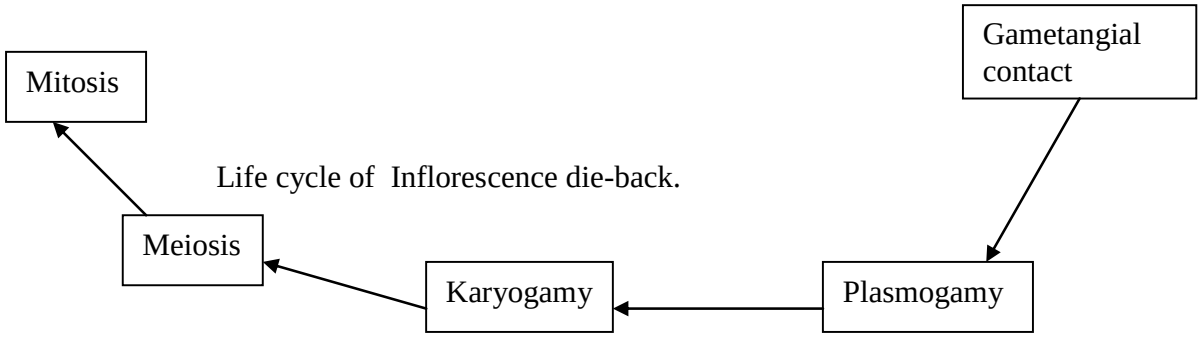
Epidemiology:

- The disease is present throughout the year, but is most serious during the dry period (Feb-May).
- Temperature requirement is 28-32˚c, & relative humidity of 90-92%,weak host.

Management:

- Summer irrigation
- Recommended N:P:K application/plant.
- Spray Carbendazim 0.1%.





MINOR DISEASES

a. **Red rust**:

- *Cephaleuros* sp. produces circular spots with sunken centers and yellow haloes on the foliage.
- Lesions are irregular on the stem. Infection destroys the epidermis.
  Causal organism: *Cephaleuros* sp.the alga,
- It affects photosynthesis, yield reduces & also quality reduces.

Management:

- Early identification & destroy, thereby reducing further infection.
- Provide proper irrigation & apply recommended N,P,K.
- Trimming with better aeration.

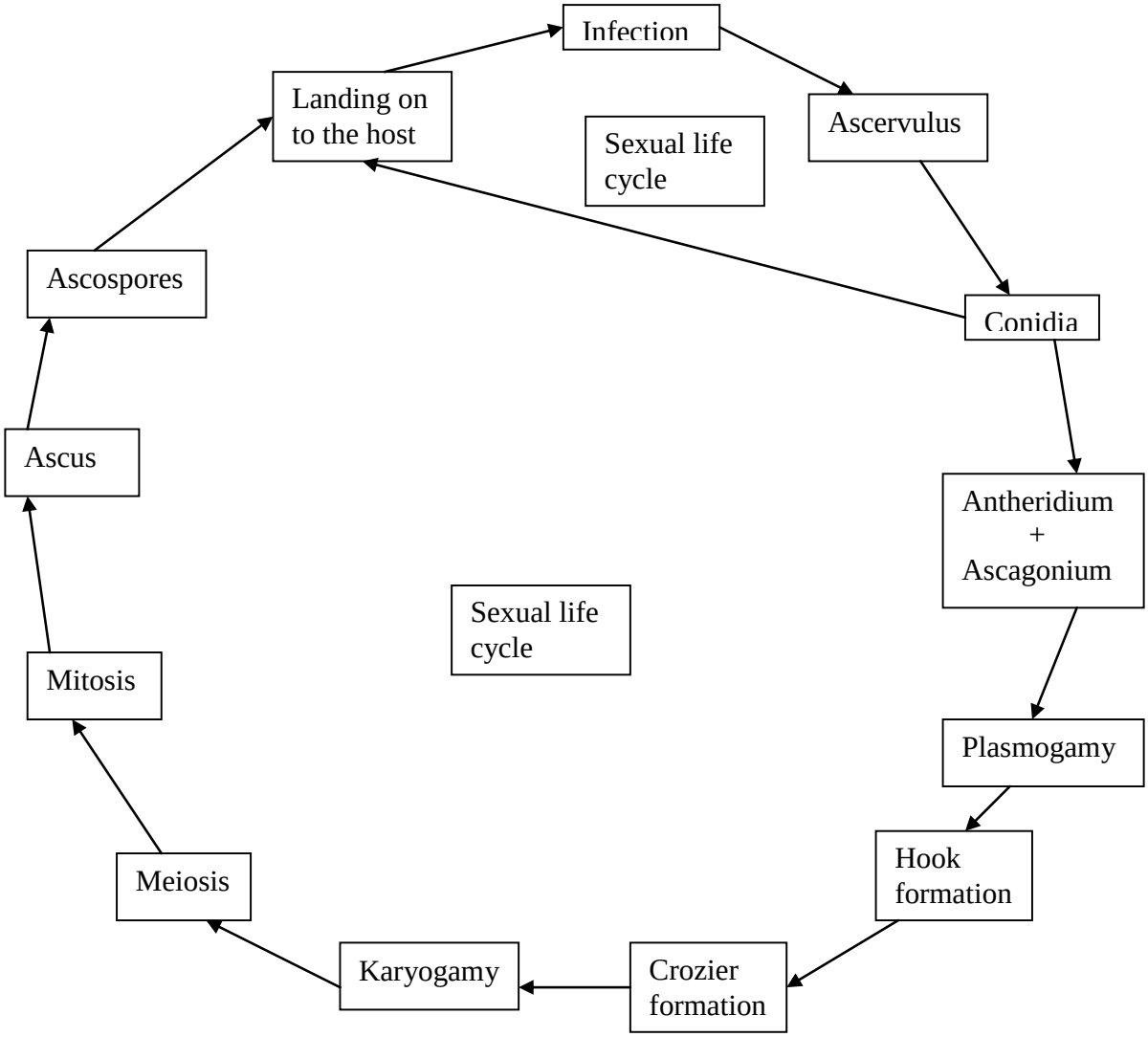
Spray systemic fungicide Benomyl 1.5g/litre.

b. YELLOW LEAF SPOT

Symptoms:

- Yellow specks measuring 3-10mm diameter appear on the leaves.
- These spots coalesce to form larger lesions surrounded by yellow haloes.
- Advanced stages the seedlings are stunted and in severe cases the seedlings die.

Etiology: *Curvularia* sp., C*olletotrichum* sp., *Phyllosticta* sp., *Helminthosporum* sp.and ***Alternaria tenuis*** has been reported to cause leaf spot of seedlings.



Life cycle of leaf spot colletotrichum

Epidemiology:

- The disease is severe during summer months (Feb-Mar) and continues to infect seedlings until the onset of rains.
- Seedlings (1- 2.5year old) exposed to the sun are susceptible.

Management:

- Improving drainage both in the nursery and main field and providing shade minimize the disease.

- Application of heavy doses of manures and spraying with zineb 0.2% or Bordeaux mixture 1% reduce the disease incidence.
- Fungicides like ziram (0.2%), COC (0.3%) are also effective in checking the spread of the disease.

c. Root rot or collar rot

- The rotting is caused by fungi like *Fusarium* sp. And *Rhizoctonia* sp.
- This is usually seen in nurseries with poor drainage.
- The fungi infect roots and cause wilting of seedlings.
- Sometimes bacteria enter the stem through the collar region and rotting of bud also.
- The severity of the disease can be minimized by providing good drainage in the nursery and drenching the soil with Bordeaux mixture or cheshnut compound.

d. Leaf blight:

- The disease is characterized by reddish brown spots which blight the leaves.
- Later black crusty appearance will form which is little hard.
- *Phomopsis palmicola* var.*arecae* as been reported as the causal organism for leaf blight of seedlings at transplanting stage. This leads to stunted growth.

Causal organism: *Pestalotiopsis palmarum* (Cooke), *Phomopsis palmicola* var. *arecae.*

Primary source of innoculum: Dormant mycelia.

Secondary source of innoculum: Conidia borne in acervulus.

Spread: Air borne and enter through stomata.

Epidemiology: Neglected orchards, summer irrigation, root infection. Poor soil fertility favours the incidence.

Management:

- It was suggested to apply N and K followed by spraying with Zinep to check the disease.
- Irrigation should be given properly.
- Weed management.
-

Reference: DISEASES OF HORTICULTURAL CROPS

By Dr.G.Arjunan, G.Karthijeyan, Dr. D.Dinakaran and Dr.T.Raghuchander

BETEL VINE

BETEL VINE

Scientific name: *Piper betle*

Family: - Piparaceae

Origin: - Western Ghat of India

Introduction:

Beetle vine is a cash crop of India. It has been referred in the ancient Indian literature dating the back of 340bc it was said to be popular among Aryas. Beetle vine is an important, traditional and ancient crop of India currently more than 200 cultivar are cultivated in several states of India for its leaves which are used for chewing purposes. The cultivators and consumers name the cultivars after their localities, villages and town. Thus the cultivar with prefix Desi in their names invariable refers to the cultivar Bangla in West Bengal, cultivar Kapoori in Maharastra and cultivar Desevari in Madhya Pradesh. The traditional nomenclature is thus confusing and attempts to clear the confusion were made. On the basis of photochemical constituents beetle vine cultivars have been divided in to five types of these, Bangla and Kapoori are the major types.

Importance of Beetle vine

It is mainly used for the chewing purposes along with areca nut and lime and most of the medicinal and Ayurvedic medicine preparation and also biting of any poisonous insects or snack healing capacity it has and also used in curing of fever, headache, liver disorder, and cold, cuff and kidney disorder and also cure the Astama.

DISEASES

1. LEAF ROT *Phytophthora parasitica* f. *piperina* **(Dastur)**
2. PYTHIUM FOOT –ROT: *Pythium vexans* (De Bary)
3. LEAF SPOT: *Colletotrichum capsici* (Petch)
4. POWDERY MILDEW: *Oidium piperis* (Uppal, Kamat and Patel)
5. BACTERIAL LEAF BLIGHT: *Pseudomonas betlicola* **(Patel, Kulakarni and Dhande)**
6. FUSARIUM WILT: *Fusarium oxysporum* **(Scchlecht)**
7. ROOT-KNOT DISEASE: *Meloidogyne incognita*

1 .LEAF ROT

Causal Organism; *Phytophthora parasitica* var.*piperrina*

P. nicotianae var. *parasitica* f. *piperina* **(Dastur)**

Symptoms:

Symptoms appears only during the rains when both temperature and atmospheric humidity are highly & favorable.

On leaves:

- The first symptoms of the disease are the development of a brown to blackish and then it becomes soft & deliquescent in appearance under the continuous humid condition.
- As when disease advance spot rapidly increase in diameter under moist condition and extends to the major part of the leaf causing a soft rot.
- The rot may extend to the petiole & in some cases to the stem also.
- On the lower side of the infected leaf in wet conditions a white cottony growth appears at the light colored margins of the spots as well as this white growth is due to sporangia & sporangiophores of the fungus coming out through stomata disintegrated lower epidermis.
- If wet conditions are not continuous and if rain lasts only for a day or two with intervening dry warm periods the diseased areas develop concentric

zones of development due to alternate favorable and unfavorable periods of growth.

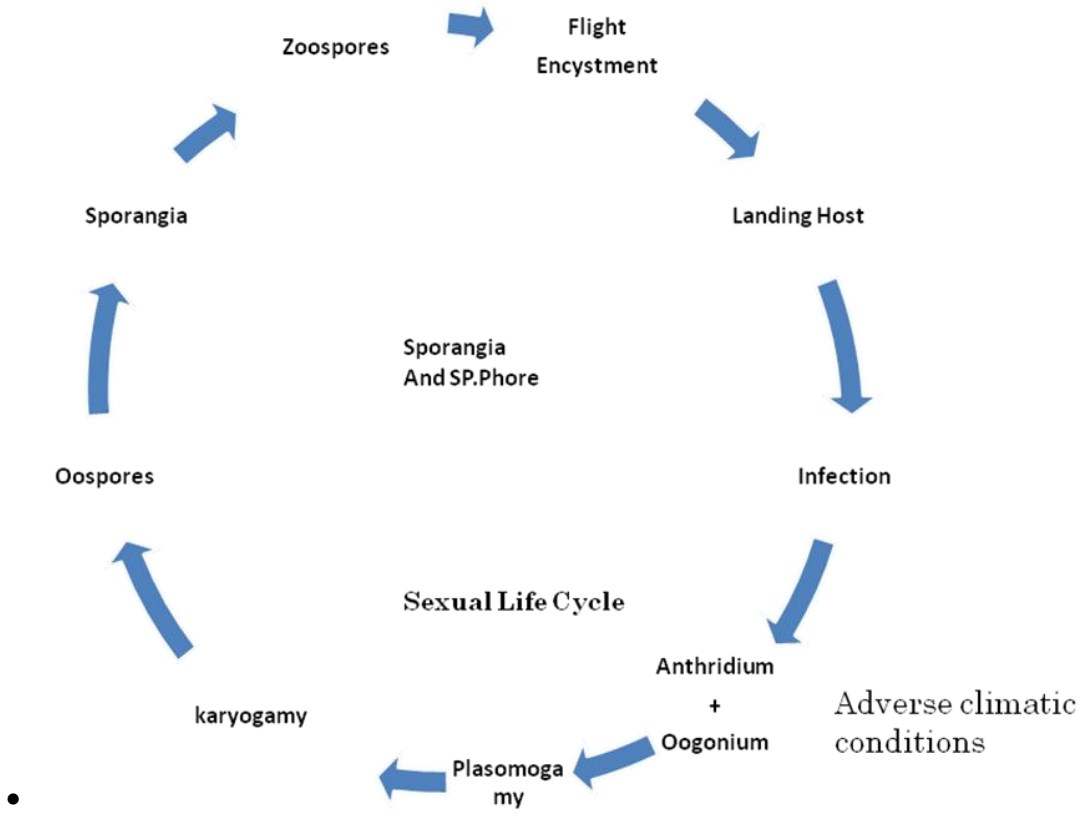
- One or more than one spots may be found on a leaf at any position in the plant may be attacked but those within 2-3 feet of the ground level are more commonly affected than others leaves.
- It also infect root system and causes root rot or wilt.

Epidemiology

The Sporangia develops only at 20-31^{0}C when relative humidity is of 100%.

Etiology

- Mycelia is aseptate, zoospore are borne in sporangia.
- oospores are sexual spores borne in Oogonium.
- Primary source of inoculum: Oospores
- Secondary source of inoculum: Zoospores



MANAGEMENT

- Cuttings for plantation purposes should be obtained from healthy orchards. All the affected parts of the plant should be carefully cut and destroyed.
- Spraying the foliage with fungicides before and during rains gives effective protection. Leaves can be harvested only ten days after any spray.
- Affected vines are dipped in 1% Bordeaux mixture, sprayed twice a month. Also spraying of 1.5% concentration of *Azadirachta indica* (Neem) extracts.

2. PYTHIUM FOOT ROT

Causal organisms:

Pythium vexans **(de Bary)**

P. piperinum **(Dastur)**

P. *splendens* var. *hawaianum*

SYMPTOMS:

- Affected Plants droop, the upper succulent parts of the vines wilt as if from want of water.
- The green parts then turn pale yellow & later brown, the leaves shrivel and of the plant dies. The basal part is rotten & can be easily pulled; out owing to the destruction of the roots.
- The symptoms and control measures of the foot-rot disease caused by the species of *Pythium* and *Phytophthora* are more or less similar and have been described under foot-rot due to *Phytophthora parasitica* f.sp. *piperina*

Etiology:

- The fungi are having septate mycelia with Inter & intracellular haustoria's.
- Sexual spores are the ascospores borne in ascus and the asexual spores are Conidia borne in sporangia.
- They mainly survives as a dormant mycelia and spread as an air and soil borne conidia.

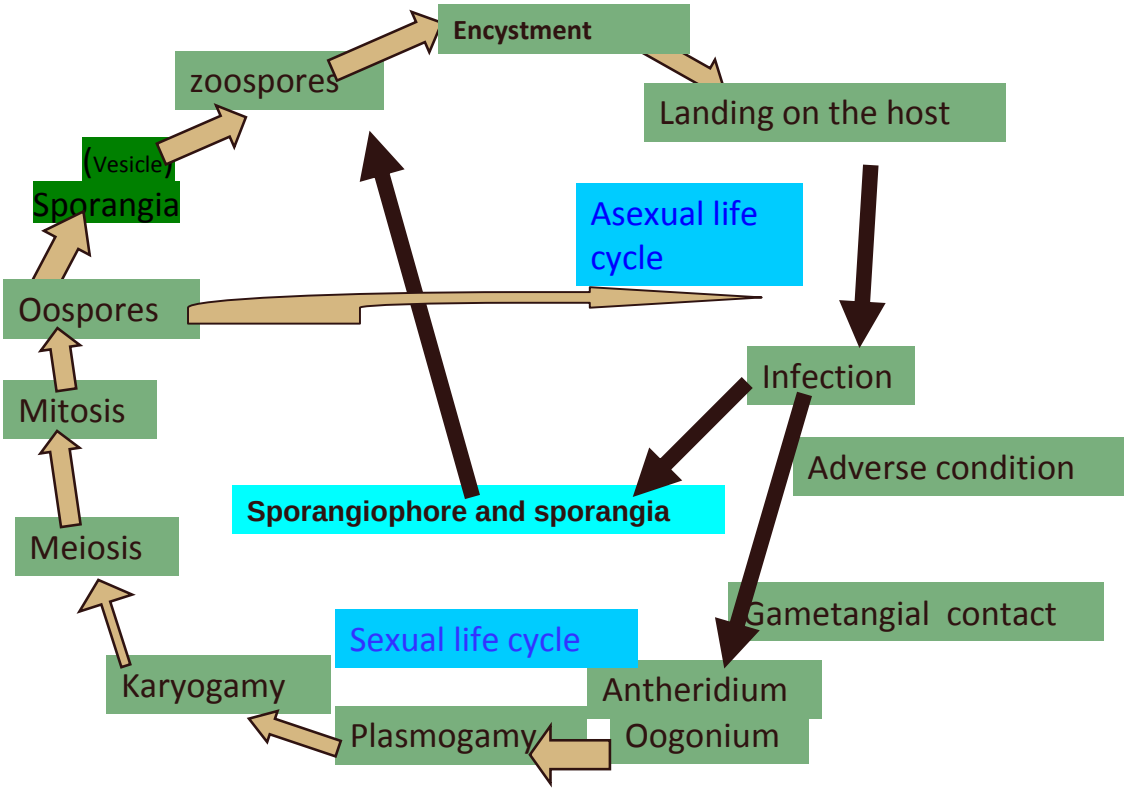
Primary source of inoculum: oospores borne in oogonia

Secondary source of inoculum: zoospores borne in sporangium

Spread: Air borne and Soil borne zoospores

Epidemiology:

- The fungi required high soil moisture and the soil temp of 22 to 24^0c avoid low lying area and reduce the planting density for the proper penetration of light to reduce the inoculums load.



LIFE CYCLE OF *Pythium* spp.

MANAGEMENT

- Use of non–nitrogenous manures, e.g. Bone meal or super phosphate, judicious use of irrigation water & admission of sufficient sunlight.
- Control of the diseases can be accomplished by applying Bordeaux mixture 1% to the infested soil.
- Dipping the cuttings in Bordeaux mixture 0.5% for 1 hour before planting could effectively control the disease. Chaurasia suggested foliar spray of tetracycline@500ppm concentration to control the foot rot caused by *Pythium* sp. (may not work satisfactorily\\\\\\\\\0

3. LEAF SPOT

Causal Organism: *Colletotrichum capsici* ***(Petch)***

Symptoms

- On Leaves: the leaf spot is irregular in shape & size, light to dark brown surrounded by diffused chlorotic yellow hallow marginal leaf tissues becomes black, necrotic &gradually spreads towards the leaf centre.
- Occasionally diffused yellow, halo also develops
- in the anthracnose stage circular, black lesions that occur rapidly increase in size and girdle the stem culminating in the death of the vine.
- Fungus produces the asexual fruiting body Acervulus. Then fungi move to the spike on individual plants

Etiology:

- The fungi are having septate mycelia with inter and intracellular haustoria.
- Sexual spores are the ascospores borne in ascus and the asexual spores are Conidia borne in sporangia.
- They mainly survives as a Dormant mycelia and spread as a air and soil borne conidia.

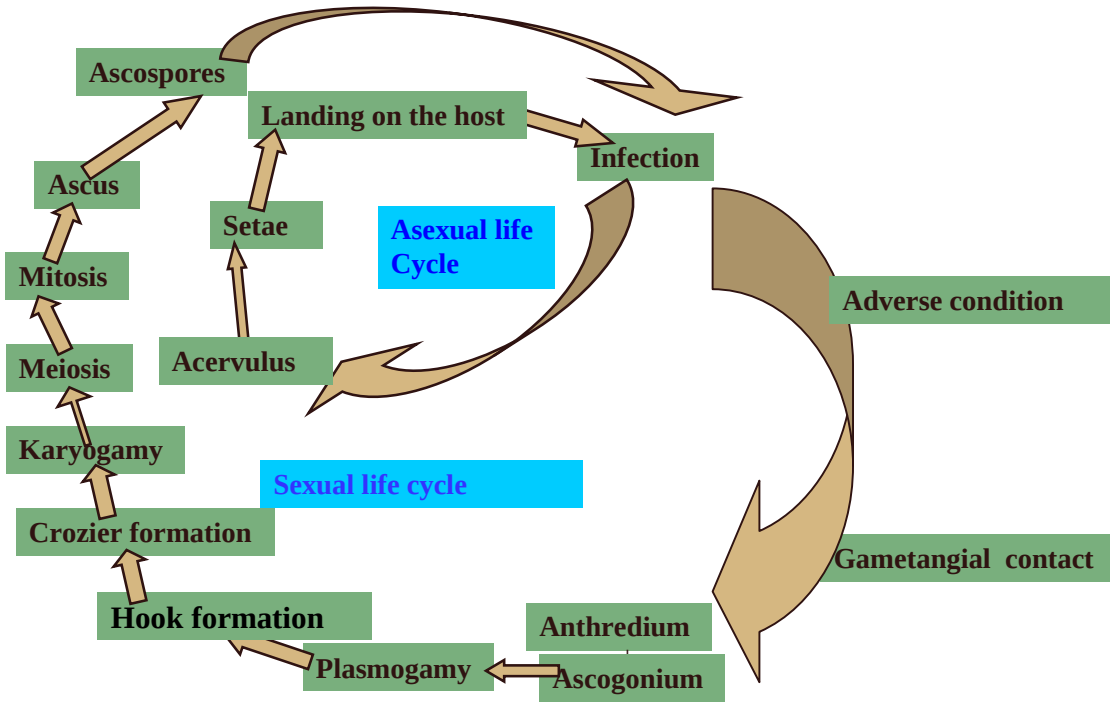
Primary source of inoculum: Ascospores borne in ascus and chlamydospores. Sexual fruiting body is perithecia

Secondary source of inoculum: Air and soil borne conidia

Spread: Air borne and soil borne conidia

Epidemiology:

The fungi are a required Temp of 30-32^{0}C, and relative humidity of 90-95%and the susceptible host.



Life cycle of *Colletotrichum capsici*

MANAGEMENT:

- At initial stage, affected leaves, spikes should be collected and destroyed. Early identification of the disease and spray with carbendazim).1% or Companion (0.2%) is found to be effective.
- Low nitrogen application with increased potassium make the plants resistance to this disease. Application of *Trichoderma viridae* to the soil along with FYM. Destruction of dead, refuse and spraying the plants with Bordeaux mixture 0.5%. Cuttings for planting should be taken from diseased free vines.

POWDERY MILDEW:

Causal organism: *Oidium piperis* ***(Uppal, Kamat and Patel)***

Symptoms:

- Early leaf infection appears as the formation of circular light grayish white powdery patches or spot which gradually enlarges soon powdery mass of fungal growth powders first on the lower surface of the leaf. Under ideal conditions both the leaf surfaces get covered by the white floury mass of fungal growth.
- This is followed by the yellowing of the leaves & then becoming brittle, resulting in early leaf falls.
- The growing shoots are also affected in severe cases the whole crop may be destroyed. Impact is photosynthesis reduces and yield reduces.

Control measures:

- Application of wettable sulphur 0.3% is effective in controlling the disease. The control of powdery mildew by spraying with Bordeaux 0.5% partially controls the disease and also by the application of 0.5% suspension of colloidal sulphur.
- The spraying of Arsenium album @2000 potency also recommended to control the *Colletotricum* leaf spot diseases of piper beetle.

4. BACTERIAL LEAF SPOT:

Causal Organism: *Xanthomonas campestris* pv. *beticola* **(Asthana and Mahmud)**

Symptoms:

- The first symptoms of the disease in affected orchards are diminutive.

- Pale yellow spots, rapidly turning dark purple appears on a along or between the veins on either leaf surface.
- The spots in farmer positions are roughly circular or angular while in latter, they are irregularly elongated or branched like fern leaves.
- Only in case of advanced decay, the lesions are visible on the both surfaces. The infected leaves gradually turns yellow and falls.

Etiology:

The bacteria are Gram –ve monatrichous, Rod shape, single celled Aerobic Bacteria.

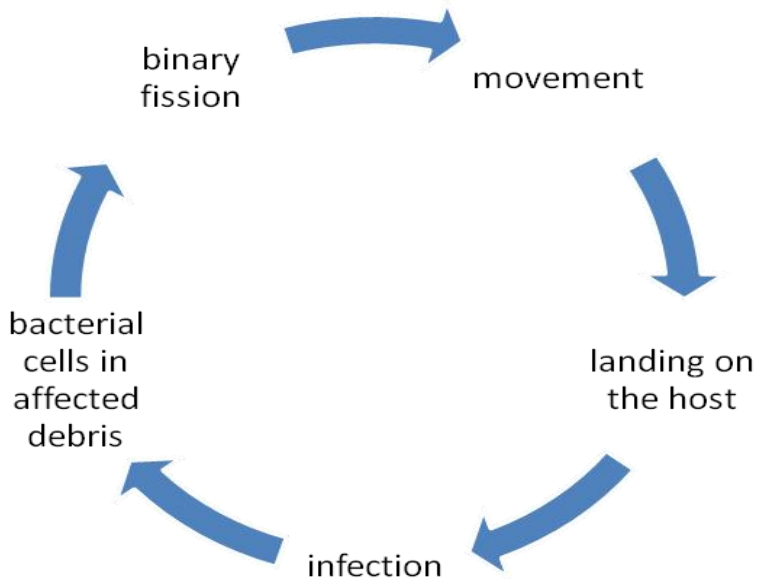
Primary source of inoculum: Bacterial cells in affected debris

Secondary source of inoculum: Air borne bacterial cells

Spread: Splash borne and air borne

Epidemiology:

- The bacteria require of 30-32^{o}C and relative humidity of 80-85%, Cloudy weather and intermittent rainfall with a Susceptible hosts.
- The bacteria survives in affected plants and spread through rain splash and air borne bacterial cells, and enter through wounds are hydathode.



Management:

- Neem formulation spray 0.3% during the month of Oct-Nov. This will also reduces the population of nematode when applied through soil irrigation water,
- Control the diseases by irrigating the gardens a week before planting with Bordeaux mixture 1%. Spray streptomycin @ 2000 ppm or neomycin.
- Cut and burn the affected plant parts. Vacitracin @ 2000 ppm & Polymycin @ 1000 ppm effectively controls the leaf spot. Foliar spray of *Azadirachta indica* extracts @ 3.0 %.

5. BACTERIAL LEAF BLIGHT

Causal Organism: *Pseudomonas betlicola* ***(Patel, Kulakarni and Dhande)***

Symptoms:

- Water soaked area appears on the lower surface and yellow halo appears on the corresponding upper surface.
- Elongated brown spots of variable length appear on the vine in severs infection, stem canker &large areas of leaf lamina are covered causing blight leaf.

Mode of spread:

It is a Soil borne gram –ve bacteria lopotrichus, they are facultative saprophytes (6-8 months in affected plant roots, debris.). They survive in the infected planting material as facultative saprophytes.

Spread irrigation water, Soil borne bacterial cells and enter through wounds.

Life cycle as same as *Xanthomonas campestris.*

Management:

- Application of Bordeaux mixture 0.5% OR copper oxy chloride.O.3% effectively control the disease. Spraying of streptomycin @2000ppm conc. Or tetracycline @ 2000ppm conc.

FUSARIUM WILT

Causal Organism: *Fusarium oxysporum* (Scchlecht)

Symptoms:

- Initially the crop shows the symptoms like yellowing. After the vine is going to severally infested and turns brown color.
- Then start browning of leafs and drying of vines and ultimately going to died.

Etiology:

- The pathogen produces Chlamydospores as a vegetative resting structure.
- The fungi survive as chlamydospores borne terminally or intercalary and spread through air borne Micro and Macro conidia.

Management:

- Application of Bordeaux mixture 0.5% is effective to control the disease.
- Foliar spray of *Azadirachta indica* leaf extracts @3.0% conc. *Allium satium* clove extract @ 20% conc. Incorporation of bio-agent, |*Trichoderma viridae* to soil along with FYM also manage the disease effectively.

6. SCLEROTIUM WILT:

C.O: *Sclorotium rolfsii* (Sacc)

Symptoms:

- Beetle vine of all ages are vulnerable to the infection particularly at the collar region.
- White cottony mycelia growth creep over the infected or of the stem and soon much small mustard like sclerotia appearance in the soil near the collar region of the vine.
- At the stage the vine wilts, dries off and leaves droops. The decay of stem below and at soil level, where dense, white cottony mycelial mass found at the site of entry and wilting of the arial organs.

- Numerous Sclerotia develop on the rotting stem and the soil around the infected plants. There is abundance of mycelia out the infected tissue.
- In the host, the mycelium is both inter and intra cellular and destroys the middle lamella result in soft rot. The plants are susceptible at any stage of their growth.
- The sclerotia are produced in plenty and are responsible for perpetuation and dissemination of the pathogen.

Etiology:

Dormant mycelia and sclerotial bodies present in the affected host debris and in soil. The fungi survival as sclerotial bodies and spread through air borne mycelia strands.

Management:

- Application of mustard oil cake, ammonium sulphate, sodium nitrate and ammonium phosphate reduce the mortality percentage.
- Earthing up of the vines to cover the sclerotia to a depth of 75 mm to control the disease. Ploughing to a depth of 22 to30cm also proved equally effective.
- Incorporation of bio-agent, |*Trichoderma viridae* to soil along with FYM also manage the disease effectively.

7. NEMATODE DISEASE

Causalorganism: *Meloidogyne incognita*

Symptoms:

- Root-knot disease caused by *Meloidogyne incognita* and *Meloidogyne javanica* are the most common.
- The affected plants show growth reduction and yellowing and abnormal thickening of leaves with necrosis commencing from the tip and margins of leaf and extending inwards.
- The disease causes reduction in quality and quantity of leaves, sometimes leading to serious wilt disease that greatly affect the growth of plants and

produce heavy losses to the farmers. Heavy losses due to root knot disease therefore require chemical method of control.

Management:

- Soil sterilization with 4% formaldehyde .Cultivate the crop with nematode free soil.
- Apply neem cake or oil cakes will reduce the nematode infestation.
- Application of Carbofuran 1.5 kg/ ha of soil.

References:

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BELLADONNA – *Atropa belladonna*

Introduction:

Atropa Belladonna (balck or deadly night shade) is a perennial shrub that grows upto 4.5 feet tall with oval leaves, greenish purple flowers and with black globular berries.

Active constituent of *Atropa belladonna* are atropine hyoscyamine and scopolamine.

Atropa belladonna is used as decoction (tea like), ointment, as smoke.

List of Diseases

1. Root rot/wilt: *Fusarium solani*, *Pythium butleri* and *Phytophthora nicotianae* var. *nicotianae*
2. Leaf spot: *Cercospora atropae*
3. Damping off: *Pythium ultimum*, *Rhizoctonia solani* and *Phytophthora parasitica*.
4. Downey mildew: *Peronospora* spp.
5. Leaf necrosis: *Ascochyta atropae*
6. Mottlevirus: virus

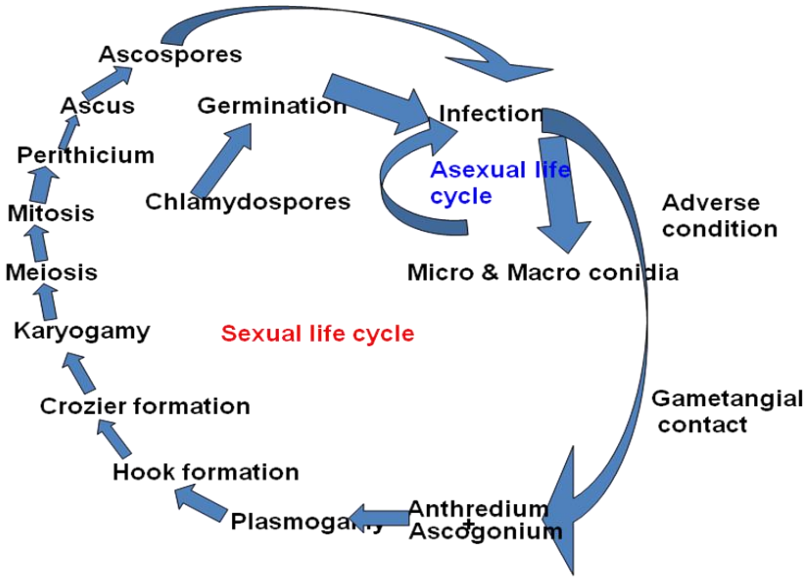
1. Root rot/wilt: *Fusarium solani*, *Pythium butleri* and *Phytophthora nicotianae* var. *nicotianae*

Symptoms of *Fusarium solani* affected plants:

- All the stages of the Plant are affected.
- In young seedling, the fungus causes pre and post emergence damping off of seedlings.
- Drooping and yellowing of older branches and leaves. In the advance stages, drying of whole epical portion are also seen..
- The tissue at collar region above and below the soil surface become brown and appear quite distinct from healthy tissue
- Older plants when affected invariably wilts .

Causal Organism :	*Fusarium solani* :
Etiology :	Septate mycelia, intravascular
Vegetative spores :	Chlamydospore (resting spores)
Sexual spores :	Ascospore
Asexual spore :	Micro and macro conidia
Primary Source of Inoculum :	Chlamydospores in soil and in crop debris
Secondary Source of Inoculum :	Soil and air borne micro and macro conidia

Epidemiology :	Temp. 30 - 32^{0}C, RH:90:92%,acidic pH(5.5:6.5), sandy loam soil, susceptable host



LIFE CYCLE OF FUSARIUM ROOT ROT
Fusarium solani

Causal Organism :	*Rhyzoctonia solani*
Etiology :	Septate mycelia, sub epidermal haustoria
Vegetative spores :	Sclerotial bodies
Sexual spores :	Absent
Asexual spore :	Mycelial strands (sterile fungi)
Primary Source of Inoculum :	Sclerotial bodies in soil
Secondary Source of Inoculum :	soil borne Mycelial strands
Epidemiology :	Warm weather,Temp.28 – 32 ^{o}C, optimum moisture, succepteble host Neutral pH

Management:

- Destroy affected debries and summer plouging.
- Avoid dence planting.
- Use healthy plot and disease free planting material.

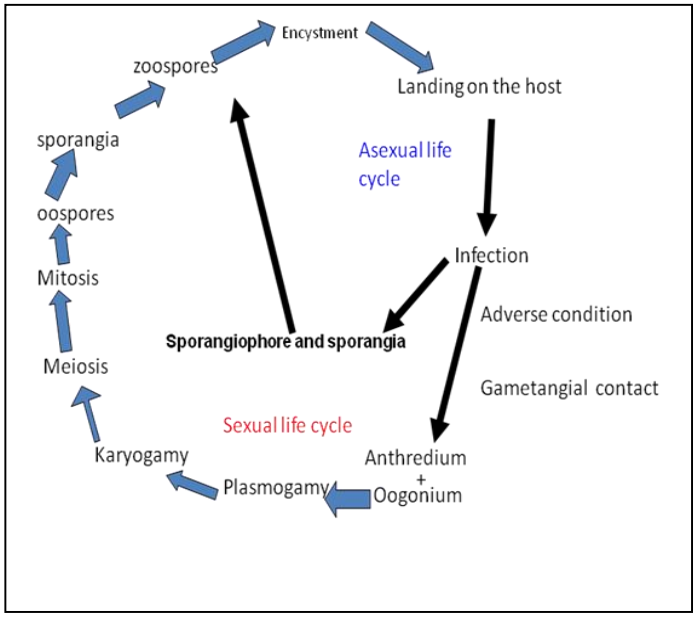
- In a nursery fumigation of the soil with methyl bromide and treating the seeds with Captan @2gm/kg of seeds.
- Crop rotation (after three years crop of belladonna, rotation may be followed by planting the field) with a crop like rye or wheat.

2. Damping off: *Pythium ultimum*, *Pythium debaryanum*, *Rhizoctinia solani* and *Phytophthora parasitica.*

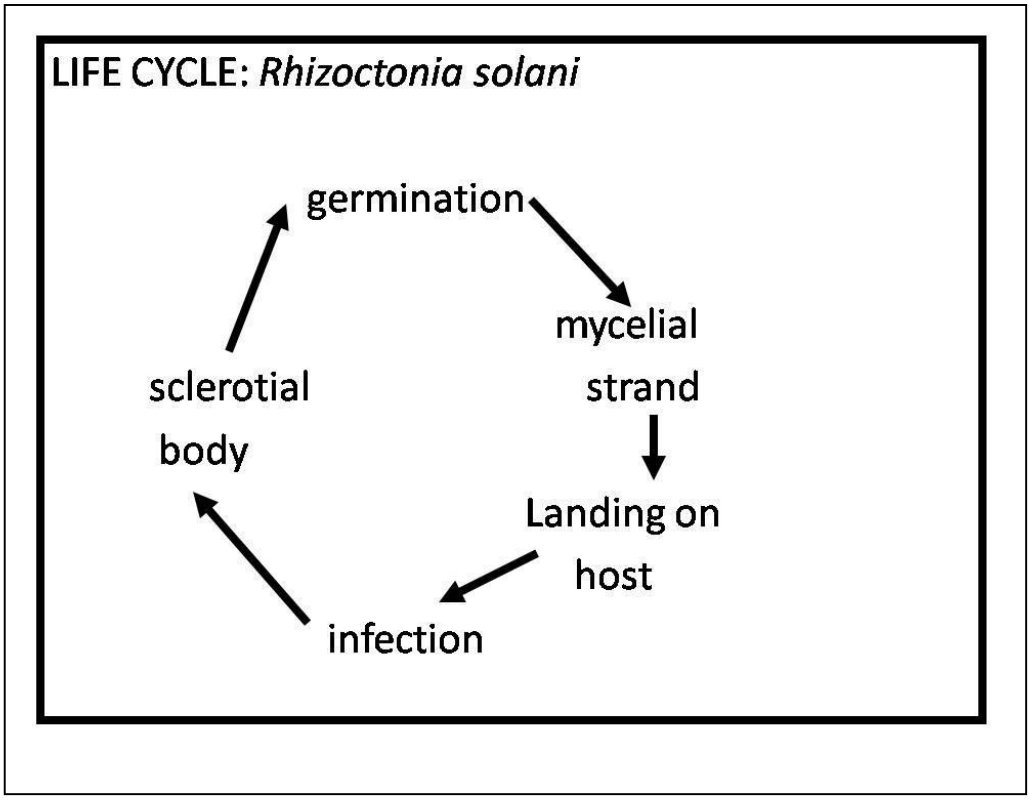
SYMPTOMS

Roots of affected seedling or sprouts show water soaked lesion at the base below soil level and exhibit rotting, reddening, drooping down and falling of leaves.

Causal Organism :	*Pythium ultimum*
Etiology :	Aseptate mycelia intercellular mycelia and intracellular haustoria
Vegetative structure:	Dormant mycelia
Sexual spores :	Oospore
Asexual spore :	Zoospore and Sprangia
Primary Source of Inoculum :	Oospore
Secondary Source of Inoculum :	Air borne zoospore
Epidemiology :	Cool climate, Temp.18 - 22 ^{0}C, RH 90:95%, susceptible host.



Causal Organism :	*Rhizoctonia solani*
Etiology :	Septate mycelia, sub epidermal haustoria
Vegetative structure :	Sclerotial bodies
Sexual spores :	Absent
Asexual spore :	Mycelial strands (Sterile fungi)
Primary Source of Inoculum :	Sclerotial bodies
Secondary Source of Inoculum :	soil borne Mycelial strands and sclerotial bodies
Epidemiology :	Warm weather,Temp.28 - 32 ^{0}c, optimum moisture, susceptible host, Neutral pH



Management:

- Use healthy seeds.
- Follow raised bed method.
- Reduce seedling density.
- Application of biological agents (*Trichoderma* spp.).
- Soil Drenching with mancozeb (0.25%) .

3. Cercospora leaf spot

Symptoms:

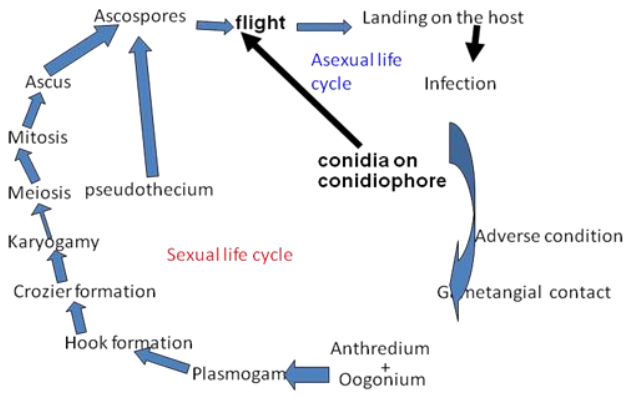
Round to angular, brown spots with chestnut colored margins on both side of leaves. The conidiophores produced on the spots are olive brown and tuft whip like many celled conidia can be seen on the conidiophores.

Causal Organism: *Cercospora atropa*

- **Etiology**: Septate mycelia, Inter and intra cellular haustoria .
    - Asexual spore: Conidia
    - Sexual spore: Ascospores
    - Vegetative structure: Dorment Mycelia
    - Primary Source of Inoculum: Dormant Mycelia.
    - Secondary Source of Inoculum: Air borne conidia.

Epidemiology:

- Warm weather,30-32°C.
    - Relative Humidity 85-90%.
    - Poor nutritional management.
    - Susceptible Host.



LIFE CYCLE OF LEAF SPOT

(*Cercospora atropae*)

Management:

- Select healthy plot and use healthy planting material.
- Crop rotation with non host crop.
- Application of biological agents (*Trichoderma* spp.)
- Spray mancozeb 0.25%.

4. Downy mildew: *Peronospora parasitica*

Symptoms:

- Initially small dots like structure are seen on the lower surface of leaves that later developed in to pustules, that further increase in size and produces downy growth.
- In advanced stage the leaves wither away.
- Whitish downy growth consist of enormous amount of sporangiophores, sporangia and mycelia..

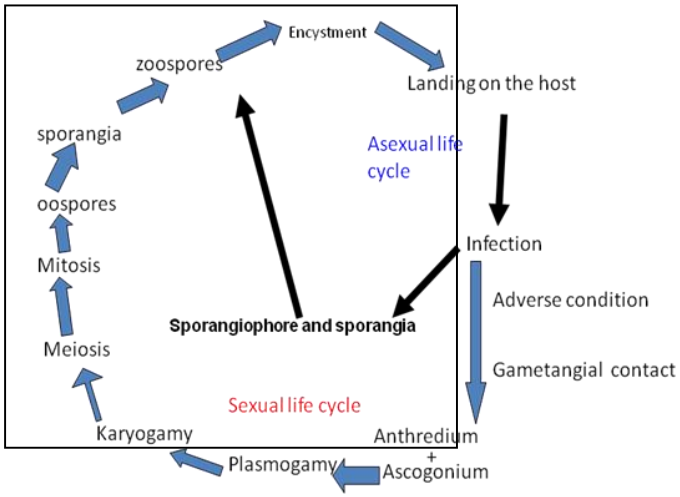
Causal Organism: *Peronospora parasitica*

Etiology:

- Aseptate mycelia, sporangiophore are at acute angle, inter cellular mycelia and intracellular haustoria.
- Asexual spores: Zoospores and sporangia.
- Sexual spores: Oospores.
- Primary Source of Inoculum: Oospores present in debris.
- Secondary Source of Inoculum: Zoospores

Epidemiology:

- Temperature 18-22^{0}C
- Relative humidity 95-99%
- Susceptible host.



LIFE CYCLE OF DOWNEY MILDEW

Management:

- Burn the affected debries,
- Crop rotation with non:host crop,
- Proper nutrition management
- Aerial spray of Copper oxy chloride 0.3%

5. Leaf necrosis: *Ascochyta atropae*

Symptoms:

- Greyish, white irregular spot with slight depression on the upper surface of leaves.
- The spots coalesce and become necrotic causing defoliation and death of the plants.

Causal Organism: *Ascochyta atropae*

Etiology:

- Septate inter and intracellular haustoria.
- Asexual spores: Conidia, Vegetative spores (Chlamydospores), Dormant mycelia.
- Sexual spores: Ascospores.
    - Primary Source of Inoculum: Dormant mycelia and chlamydospores in soil
    - Secondary Source of Inoculum: Air borne Conidia

Epidemiology:

- Cool weather. (Temp. 18-22^{0}C)
- Relative Humidity 90-95%
- Poor management
- Susceptible host.

Management:

- Collect and Burn the affected leaves,
- Avoid high density planting.
- Crop rotation with non:host crop,
- Proper nutrient management.
- Aerial spray of Mancozeb 0.25%

6. BELLADONNA M0TTLE VIRUS

Symptoms:

- The characteristics symptoms are slight clearing of viens and crumpling of the leaves, followed by a light or dark green mottle, together with blistering and distortion of the leaves and stunting of the plants.
- Vector are not known.
- Primary Source of Inoculum: Affected planting material, collateral hosts

Management:

- Use disease free seeds
- Destroy the affected plants by burning or burying them deep in the soil.
- Equipments should be washed thoroughly.
- Soil solarization or fumigation with methyl bromide helps to reduce virus spread through soil.

Camphor (*Cinnamomum camphora*)

Introduction

Tree, young branches glabrous, terminal and axillary buds covered with bracts forming a small cone, young branches with clusters of scars from fallen bracts. Leaves broadly ovate, 7-10 cm long, 3-5 cm wide, and triple veined, with domatia in axils of main veins, glabrous, apex sharply acute, petioles slender, relatively long . Flowers are axillary, glabrous inflorescence shorter than leaves; sepals 1.5-2mm long, glabrous externally, pubescent within; staminoid and filaments pubescent. Camphor oil preparations have been used both internally and externally for a variety of ailments, ranging from respiratory problems to rheumatic pain. The principal use of camphor is to reduce cough.

DISEASEs OF CAMPHOR

1. **POWDERY MILDEW:** *Microsphaera alphifoides* (Griff)
   : Erysiphe cinnamomi
2. **Verticelium wilt:** *Verticillium* spp.
3. **Leaf spot:** *Pseudomonas* spp.
4. **Leaf blight:** *Alternaria* spp. (kuntze: Pers)

1. POWDERY MILDEW

Causal organism: *Erysiphe cinnamomi*

SYMPTOME:

- Whitish grey colour powdery growth on upper surface of leaf, powdery growth enlarges.
- In severe condition, it may move to lower surface.
- Leaf slowly cupping, later leaf dropping takes place.
- Powdery growth on stem. Powdery growth consists of oidia and mycelia strands.
- The stem and petioles in later stages are also affected and are covered with a dirty white mycelia and oidia.
- With the advancement of the disease, the leaf lamina develops complete or partial chlorosis and the affected leaves eventually dry up

ETIOLOGY:

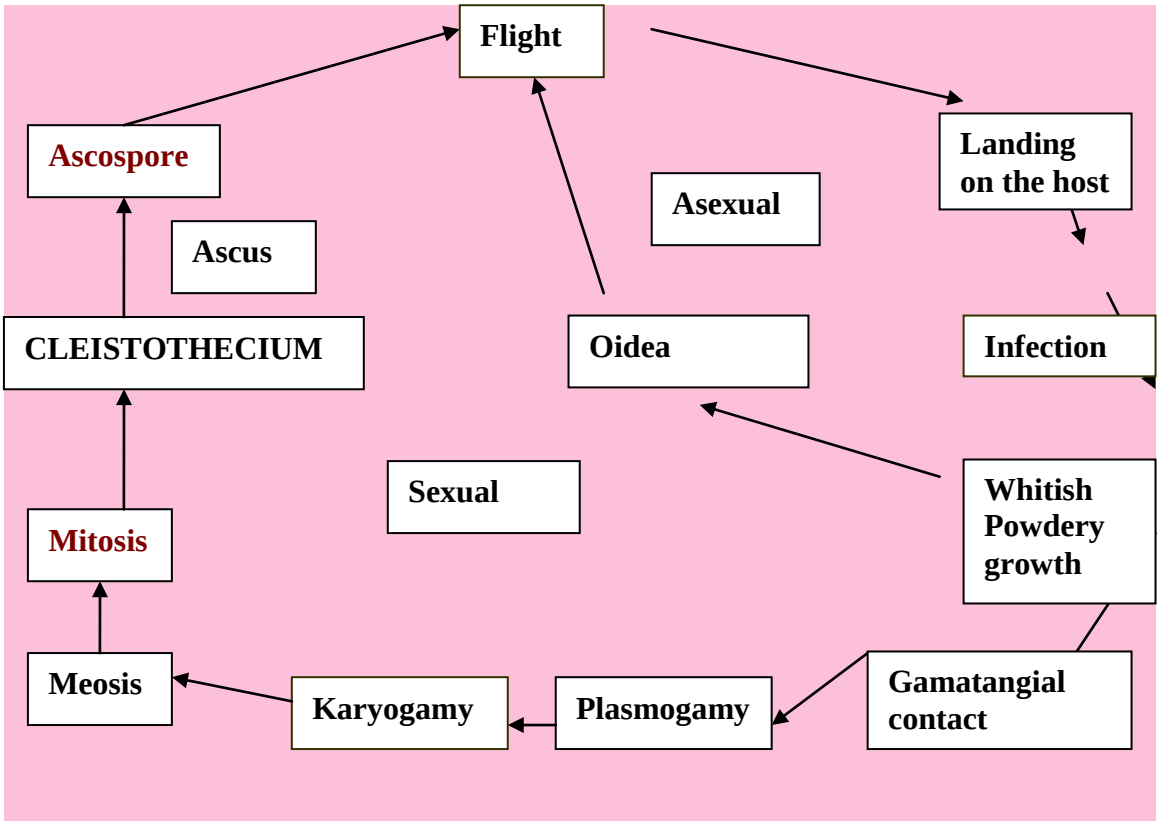
- Septate, ectophytic mycelia with sub epidermal haustoria.
- Asexual spores are barrel shaped conidia bearing in chains.
- Sexual stage is Ascospores in ascus and the fruiting body is cleistothecium

PRIMARY SOURCE OF INOCULUM: Dormant mycelia, cleistothecium present in crop debris.

SECONDARY SOURCE OF INOCULUM: Barrel shaped conidia.(Oidia)

SPREAD: Air borne

LIFE CYCLE:



Epidemiology:

- The optimum Temperature for the spread of the disease is 28 to 30^0
- Requires Warm weather.
- This disease is more at the time of September- October months
- Relative humidity required is 80 to 85 %

MANAGEMENT:

- Remove affected plant parts and destroy.
- At early infection stage spray with wettable sulphur -0.3% followed by, spraying with carbendazim -0.1%t, calixin -0.15%.
- Crop rotation with non-host crop.
- Low nitrogen and increased K application reduces the incidence of disease..

VERTICILLIUM WILT

CAUSAL ORGANISM: *Verticillium* spp.

SYMPTOMS:

- Affected plants are stunted in growth and leaves develop dark green patches followed by interveinal and marginal yellowing.
- Leaves wilt, dry and eventually fall.
- A brown discoloration can be seen in the xylem vessel on cutting through the stem and roots .
- Low partial wilt but lower leaf yellowing, V shaped yellowing of leaf margine .No epinasty but lower leaf drys off.

ETIOLOGY:

Septate mycilia, V shaped conidiospores on which single celled conidia is formed.

Mode of spread: The fungi survive in the soil on diseased plant debris and infect healthy plant by contact with root. Furrow irrigation, organic manure and tillage spread the pathogens.

Primary Source of Inoculum: Dormant mycelia and chlamydospores in soil and crop debris.

Secondary Source of Inoculum: Conidia

EPIDEMIOLOGY

Disease spread at the temperature of 28 to29^0 C. Relative humidity 80 -85 %. Low soil moisture, alkaline p^H, affected soil, susceptible host, black clay soil. Low nitrogen reduces disease severity.

MANAGEMENT:

- Crop residues should be ploughed deep and clean seeds to be sown.
- Polyethylene mulching reduce wilt effectively .
- Neutralize pH by applying gypsum
- Destroy the affected plant parts by burning.

- Crop rotation with non host crop is to be followed.
- Biological agent such as *Tricoderma viridae* application.
- CHEMICAL: Carbendazim 0.1% as both soil drench and seedling dip.

LEAF SPOT

CAUSAL ORGANISM: ***Pseudomonas* spp.**

SYMPTOMS:

- Disease affect the aerial part of the plant.
- Spots on the leaflets are water soaked, round, oval or irregular.
- Several such spots may coalesce to produce a blighted appearance.
- No yellowing, healthy plant sudden wilts due to faster spread of the disease.
- No epinasty. Vascular browning, white or milky white colored oozing are common.
- Complete plant dries up

ETIOLOGY:

Gram –ve bacteria, lopotrichus, rod shaped, unicellular bacteria, reproduction by binary fusion.

Mode of spread and survival:

- They are present on the plant debries and the seeds.
- Infection usually occurs through leaf stomata .

Primary Source of Inoculum: Affected self sown crop, soil.

Secondary source on inoculum: Soil born bacterial cells through irrigation water.

EPIDEMOLOGY:

- High humidity that is 85 -92 % and free water facilitate disease development.
- The optimum Temperature for disease development is 24 to 27 ^{0} c.
- High soil moisture is needed with Neutral pH.
- Affected sandy loam and sandy clay soils.

MANAGEMENT:

- Clean seed offer better control.

- Seed treatment with Streptomycin 0.05% is affective.
- Provide good soil drainage, wide row spacing, Host destruction, eradication of weeds.
- Use clay loam soil Crop rotation with non host crop
- Avoid movement of water from infected to healthy area.

LEAF BLIGHT

Causal organism: *Alternaria* spp.

It is a weak parasite affects on older leaves.

Symptoms:

- The infection starts with the minute dots on the leaf with irregular chlorotic areas on the tip portion of the leaves , then circular to oblong concentric black velvety rings appear in the chloroted area.
- Then the lesions develop towards the base of the leaf. The spot join together and spread quickly to the entire leaf area leading to blight.
- Sometime a yellow hollow develops around each lesion.
- As disease advances, spot size increases and complete blightening takes place and leaves gradually die from the tip downward.

Mode of spread:

- They spread mainly through air born spores.
- Prophylactic sprays with Mancozeb 0.25% gives good control of the disease.
- Warm weather with humid condition caused by rain or heavy due helps in the spread of the disease and is favorable for the development of the conidia.

Primary Source of Inoculum: *Dormant mycelia,*

Secondary Source of Inoculum: *Air borne conidia.*

Epidemology:

- The optimum Temperature for the development of disease is 28 to 32^0C
- Relative humidity is 85 to 90 %.
- Nutritionally poor soil, Susceptible host favours the disease.

Management:

- Recommended NPK & FYM application.
- Use disease free planting material.
- The disease can be controlled by three foliar sprays with Mancozeb 0.25%.
- Use of biological agents like *Trichoderma viridae.*

Reference: Diseases of Horticultural crops, by

- Dr.G.Arjunan.
- Dr.G.Karthikeyan
- Dr.D.Dinakaran
- Dr.T.Raghuchander

COCOA

Botanical name: *Theobroma cacao*

Family: Streculiaceae

Chromosome number:2n=20

Native: Amazon vally of south America

Introduction:

It was introduced in India for commercial cultivation in early sixties. Cocoa variety of the forester group came into cultivation in historic times. It is a tree, hardy and vigorous and which is why they now form the greater part of all cocoa grown. It is a rich source of fat (37%) and protein (7%). It also produces theobromin. It is used in beverage industries. Cocoa is used in bakery for chocolate preparation, ice cream , biscuits etc.

DISEASES

l. **Major disease:**

1) Seedling die - back : *Phytophthora palmivora*.
2) White thread blight : *Marasmius scandens*
3) Black pod disease : *Phytophthora palmivora*
4) Charcoal pod rot : *Botryodiplodia theobromae*
5) Witches broom : *Crinipellis pernicios*

II. **Minor diseases:**

a. Pink diseases: *Pelicularia salmonicolor*
b. Stem canker: *Phytophthora palmivora*
c. Cherella rot : *Colletotrichum gloeosporioides*
d. Vascular streak: *Oncobasidium theobromae*.
e. Cacao swollen shoot virus. (CSSV)

Major diseases:

1) Seedling die –back

Causal organism: *Phytophthora palmivora*(Butler)

Seedling die back is severe on young seedlings during rain period. It has been observed in the cocoa nursery in Karnataka, Kerala & Tamilnadu.

Symptoms:

- This disease is more severe on one month old cocoa seedlings although the disease is noticed in 1 to 4 month seedlings.
- Infection may start from the tip of the stem or from the cotyledon stalk or from the collar region.
- The disease appears as dark brown to black, water soaked, and linear lesions.
- The lesions extend to leaves through the petiole resulting in wilting and subsequent defoliation of the seedlings.
- Defoliations and die back of the seedlings are noticed during advanced stages of the disease.

Etiology: *Phytophthora palmivora*

- The mycelium is aseptate and 7 micro mm in diameter.
- Sporangiophores are simple or branched.
- Sporangia are inverted pear shaped terminal &.Zoospores is 8 to 10 micrometer.
- Oospores are spherical and measures 35 to 45 micrometer in diameters.

- Primary source of inoculum are oospores
- Secondary source are zoospores and sporangia

Epidemiology:

- Cool weather.
- Acidic ph
- Temperature of 18 to 25 degree

Management:

- All the infected seedlings in the nursery should be removed and destroyed.
- The disease can be controlled effectively by providing adequate drainage and soil drenching with Bordeaux mixture 1.0% or copper oxychloride 0.3%.
- A combination of seed dressing & soil drenching with coccid at a concentration of 0.91 kg in 45 litre of water effectively controls the pre and post emergence seedling death.
- Application of bio-agent *Trichoderma viridae* to soil along with FYM.

2) **White thread blight**:

Causal organism: *Marasmius scandens*

Symptoms:

- The young branches of the affected plants contain white mycelial threads of the fungus which spread longitudinally and irregularly along the surface of the stem.
- On the leaf lamina it spreads in the form of a much branched fine threads.
- The fungus invades the cortical tissues which eventually turn dark brown to black. The diseased leaves also turn dark brown.
- The dead leaves in a branch eventually get detatched from the stem but are found suspended by the mycelial thread in a row.
- The extensive death of the young branches & suspended leaves in a rows are the common field symptoms of white thread blight.

Mode of spread & survival:

- The disease spread from plant to plant & to different branches of the same plant through the mycelium.
- The dead leaves with the mycelial mat can be easily carried by wind on to the leaves &stems of the healthy plants & initiate the disease.

Epidemiology:

High humidity, less aeration and sunlight due to thick shade are the pre disposing factors for the occurrences of white thread blight disease.

Management :

- Damage can be reduced by removal of the dead materials & pruning of affected parts.
- Shade regulation & some structural pruning of branches are necessary to reduce the humidity in the canopy & the disease.
- Paste with coc at cut ends.
- Bio agent *Trichoderma viridae*

3) **Black pod disease:**

Causal organism : *Phytophthora palmivora* (Butler)

Symptoms:

- First sign of the disease is appearance of brown spot on the pod.
- The brown discolorations rapidly spread in all directions.
- The discoloration spreads over the whole pod.
- Internal tissues of diseased pods become brown.
- Infected beans become discoloured.

- Primary source of inoculum is oospores.
- Secondary source of inoculums is zoospores and sporangia..

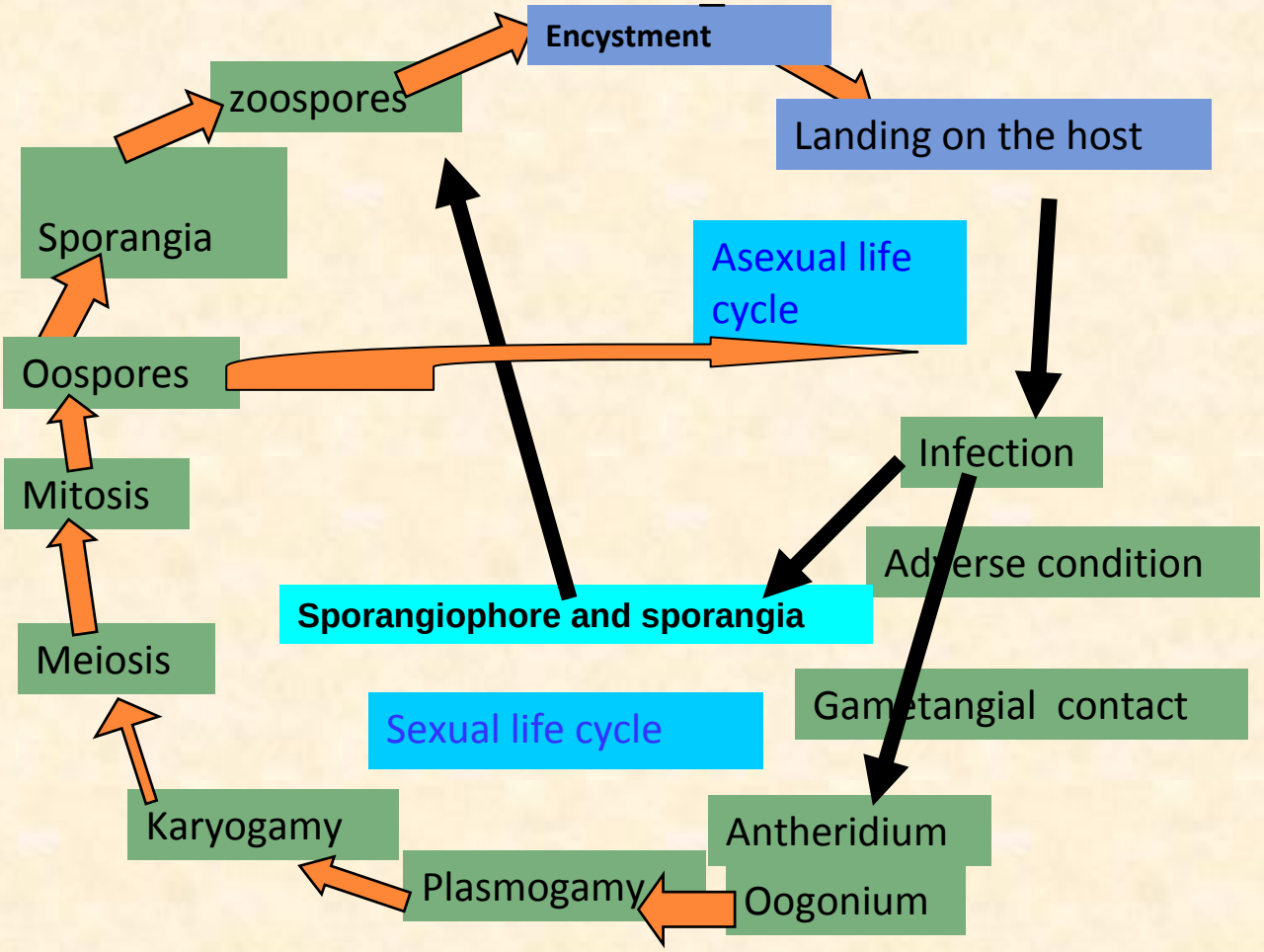
Mode of spread & survival:

The spread is by splashing rain, insects and rodents and by contact between healthy and diseased pods. Ants have been found to spread the disease.

Epidemiology

Closer spacing between trees , damp locality and cool damp weather favor the rapid spread of the disease.

Life cycle



Management:

- Avoid inter crop with areca
- Proper spacing
- Affected pods should be destroyed.
- Regular removal & destruction of infected pods at weekly intervals.
- Proper pruning of cocoa tree is also essential to minimize the shade.
- Spraying just before the onset of the monsoon with Bordeaux mixture @1% or coc 0.3% @ intervals of two weeks.
- Bio agent *Trichoderma viridae*

4) **Charcoal pod rot:**

Causal organism: *Botryodiplodia theobromae*

The disease is severe during summer months.

Symptoms

- The infection appears as dark brown to black spot on any place on the pod surface & spreads rapidly.
- The beans may not develop fully & get mummified.

Etiology:

Fungus: *Botryodiplodia theobromae*.

Pycnidia are upto 5mm in diametre.

Conidia are hyaline and thin walled, becoming thick walled, dark brown and one septum.

Management:

- Avoid intercrop with areca
- Proper spacing.
- Affected pods should be destroyed
- Sprayin g with Bordeaux mixture 1 % is recommended to control.
- Spray mancozeb 0.25%
- Proper pruning of cocoa tree is also essential to minimize the shade

- Bio agent *Trichoderma viridae*

5. **Witche's broom**

Causal organism: *Crinipellis perniciosa*.

Symptoms: more and more axillary bud production. Pale yellowing. Broom like appearance.

Mode of spread & survival: basidiospores which cause infection are released during night and spread through wind.

Management:

- Young blooms before the production of sporophore should be removed.
- Varieties like scavina-6 & hybrids of this variety are resistant .
- Avoid inter crop with areca
- Proper spacing

Minor diseases:

1) Pink disease:

Causal organism: *Pellicularia salmonicolor*

Symptoms:

The first visible symptom is the appearance of salmon pink encrustation of fruiting bodies of the fungus of the bark of the stem.

Etiology:

The mycelia of the fungus is hyaline, thin walled and sparsely septate, hyphae are 7-15micromtre in diameter, the asexual spore is hyaline.

Management

- Avoid inter crop with areca
- Proper spacing
- The disease is controlled by reducing over head shade, proper pruning to improve aeration inside the garden.
- Painting the cut ends with Bordeaux paste & regularly spraying the trees with Bordeaux mixture1% during rainy season.

2) **Stem canker**:

Causal organism: *Phytophthora palmivora*.

Symptom:

- Reddish brown liquid oozes out from the lesion which later dries upto form a rusty deposit.
- Tissues beneath the out lesion appear as reddish brown discoloration.
- The cankers girdle the main stem or branches & the pods in them wilt the leaves are discoloured.

Mode of spread:

The infection spread from peduncle and then to the cushion and bark .

Management:

- Infected pod should be removed & destroyed.
- Disease can be controlled in the early stages by the excision of diseased bark followed by wound dressing with Bordeaux paste.

3 Cherelle rot:

Causal organism: *Colletotrichum gloeosporioides*.

Symptom: Infected stalk becomes shrunken. The internal tissues of the pod become discoloured. Abundant pinkish slimy mass of conidial is produced on the lesions under high humid conditions. Ultimately the diseased pod turns brown to black & remains on the tree as mummified fruit.

Management:

- Infected pod should be removed & destroyed.
- Disease can be controlled in the early stages by the excision of diseased bark followed by wound dressing with Bordeaux paste
- Spraying with carbendazim 0.1% or mancozeb 0.25% controls the disease.

4. Vascular streak die-back:

The causal organism *Oncobasidium theobromae*.

In India, VSD has recorded only from kerala state

Symptoms:

- The first visible symptoms of VSD is the yellowing of a single leaf in the second or third flush from the twig with sets of green patches scattered over the yellowish lamina.
- Such leaves fall off prior to the older leaves of the same branch.
- The bark in the leaf fall region of the branch becomes rough due to swelling of lenticels.
- The auxillary buds of the fallen sprout and then rapidly die.

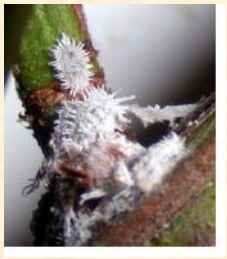
- At the later stage, die back symptom appear on these branches as the result of infection the xylem vessels turn brownish which appear as streaking with in the vascular tissues.
- Hence the disease is known as vascular streak disease.

Management:

- One of the most important cultural practices recommended for controlling VSD, apart from the use of resistant genotypes is regular pruning of infected branches.
- Monthly spray of Hexaconazole 0.1% has been found to offer good protection against the VSD.
- Nursery losses from VSD can be controlled by use of plastic roof over nursery

Cocoa swollen shoot:

Symptom:



Family: *Caulimoviridae*

Genus: *Badnavirus*

Species: *Cacao swollen shoot virus*

Acronym: CSSV

Some of these recommendations

- Space trees properly,
- Weed regularly,
- Cut down and remove diseased trees, etc.
- They simply let the infected areas lay fallow for three years and then cleaned it back up and the Capsid was gone.

Reference:

Diseases of horticultural Crops by:
Dr.Santakumari, Kerala Agricultural University

Coconut Diseases

The coconut palm, ***Cocos nucifera* Linn.,** with its tall, slender. and uniformly thick stern and massive crown with large. number of leaves, bearing bunches of nuts in their axils is cne of the most beautiful and useful trees in the world (Menon and Pandalai, 1958). lnspite of its hardy nature, the coconut palm is affected by a number of diseases (Nambiar, 1994).

This perennial palm though known for its adaptability to different soil conditions, moisture stress and vagaries of climate, is often subjected to attack by plant pathogens causing various diseases (Henry Louis, 2002). Anon (1979) 173 fungi associated with coconut and Brown (1973) recorded 35 fungi from coconut leaves, in India. The roots, stem and the crown regions are attacked at different growth stages of the crop, which may result in considerable economic loss to the grower.

Besides fungal pathogens, bacteria, phytoplasma, virus and nematodes have also been reported to cause diseases in coconut (Menon and Pandalai, 1958;Nambiar, 1994; Srinivasulu et.al., 20013). In India, basal stern rot (Ganoderma wilt), bud rot, stem bleeding, root (wilt) and leaf rot are important diseases of coconut and are serious constraints to the production and productivity of the crop.

List of Coconut Diseases-

I. Bud Rot-(*Phytophthora palmivora*)

II. Trunk and Root Rot Or Ganoderma-Wilt- (*Ganoderma lucidum*)

III. Fruit Rot Or Mahali (*Phytophthora palmivora*)

IV. Stem Bleeding: (*Thielaviopsis paradoxa*)

V. Leaf Blight Or Grey Leaf Spot (*Pestalotia palmarum*) :

VI. Red Ring Disease *(Rhadinaphelenchus cocophilus*)

VII. Crown Choking :

VIII. Cadang- Cadang :

IX. Lethal Yellowing :

X. Linking MLO And Lethal Yellowing In Coconut Palms

XI. Leaf Scorch Decline :

DISEASES OF KNOWN ETIOLOGY-

BUD ROT -(*Phytophthora palmivora*)

This is one of the serious diseases of the coconut and is fatal, since the growing part of the plant is damaged. Bud rot incidence is high in palms growing in marshy, water-logging areas and in environments that promote high humidity (above 90%). The incidence is mostly found to be severe during, monsoon when RH is very high and temperature is below 24°C. The pathogen remains dormant in the leaf base in dry weather and becomes active after receiving the monsoon showers, which indicates that unfavorable climatic conditions appear to be the primary cause of this and the fungal infection is considered to be only secondary.

Symptoms :

- The first symptom is the discoloration of the youngest leaf, withering of the central spindle of the crown, rolling and death of growing point
- The tender leaf bases degenerate into a soil mass of purified material, emitting foul smell that attracts flies.
- When the base of the bud is badly affected, the palm finally succumbs.
- Bud rot is highly infectious and is spread by the wind during rainy season.

Aetiology-

- **Mycelia:**Aseptate, intracellular haustoria,
- **Asexual spores:** Zoospores,
- **Sexual spores:**Oospores

Life cycle of *phytophthora palmivora*

- **Primary Source of Inoculation** – Dormant Mycelia/oospores

- **Secondary Source of Inoculation** – Zoospores and sporangia
- **Mode of action**-Through stomata

Epidemiology -

- Cool Weather loving fungi.
- Temperature- 18^0-20^0C.
- Relative.Humidity-100%
- Closed Plant Population,
- Time of South-West monsoon,
- Susceptible host.

Control :

1. In the bud-rot affected plantation, regular spraying with **1% Bordeaux mixture** just before and after monsoon to adjacent healthy palms is an effective preventive or prophylactic measure. **Orchard sanitation** by removal of dry material from the crown is also essential.
2. If the disease is detected in early stage itself, application of Bordeaux paste on the crown, after thorough cleaning and removal of infected material, can check the disease.
3. The treated portion should be given a protective covering with polythene sheet to prevent washing off of the paste. It is best to remove infected palms and treat the surrounding palms.

TRUNK AND ROOT ROT OR GANODERMA-WILT (*Ganoderma lucidum*)

Trunk/root rot is caused by a root infecting fungus called *Ganoderma lucidum* which usually remains within the tissues. This pathogen also causes root rot in areca and stem decay in oil palm. Its occurrence is restricted to, sandy and sandy-loam soils.

This malady was first noticed in **Thanjavur district** at Tamil Nadu after the cyclones of 1952 and 1955 and hence called 'Thanjavur wilt'. Now it is widespread in other Districts, viz; Kanyakumari, Tiruchirapally, South Arcot and North Arcot and also - the border areas of Kerala. Ganoderma- wilt is prevalent in Tamil Nadu, Andhra Pradesh, and Karnataka mainly; and minor incidences reported in Maharashtra, Gujarat and Orissa. The affected palms die within 2 or 3 years after infection. In dead palms, brackets of *Ganoderma lucidum* and *G. applanatum* are also seen.

Symptoms :

- Though the seat of infection is the base of the trunk/root
- The characteristic symptom is visible on the crown,' withering and drooping of the older leaves which remain hanging around the trunk for several months.
- The new leaves become reduced in size and yellowish in colour, the inflorescences become suppressed and the palms remain barren.
- Bleeding patches occur at the base of the trunk and slowly extend higher up the stem and ultimately kill the plain.

The major symptoms are:

- Palms show wilting due to internal rotting and crown topples.
- Withering and browning of outer leaves, followed by yellowing and leaf drooping, flaccidity of' spindle leaves.
- Reduction of the size of spindle, arresting the crown and fruit-set.
- Decay of finer roots extends to bole region and slowly gets upwards into stem base.



Etiology:

- Ganoderma is a heterothallic fungi.
- **Mycelia-** Septate
- **Vegetative spores-** Chlamydospores.
- **Sexual spores**-Basidiospors
- **Mode of spread**-Air

Primary Source of Inoculums- Chlamydospores

Secondary Source of Inoculums- Basidiospores

Epidemiology-

- Neutral pH
- Sandy loam soil,
- High plant density in plantation.

Disease Management :

1. Cultural practices should be followed judiciously. Repeated ploughing in affected areas may be minimized, closer planting avoided, good drainage to be provided, adequate irrigations need to be given, providing mulches or green manuring at the basin of the palm
2. Diseased palms should be removed and burnt.
3. Bleeding patches should be chiseled completely, followed by hot coal tar application; Plate 15. Stem bleeding' (Courtesy: CPCRl).Isolation trenches (1 cm x 30 cm) may be dug up around diseased palms to prevent root contact.
4. Application of 5 kg neem cake along With sufficient organic matter and 500 gm phosphate + 1200 gm potassic fertilizer may be applied per palm per year, so as to keep proper nutrient in the soil.
5. Drenching with 40 L of 1% Bordeaux mixture and stem injection or root feeding of 2 gm Aureofungin solution + 1 gm copper sulphate in 100 ml thrice a year, for only one year may reduce intensity of this malady.

STEM BLEEDING: (*Thielaviopsis paradoxa*)

This malady was first reported from Sri Lanka in 1906 and then from India in 1922. This is most common in Kerala, South Coastal Tall1il Nadu and Goa. This is more of, symptom or expression of abnormal condition caused by mall factors, causes damage to the trunk and reduces yield.

Symptoms:

- The first symptom is the **exudation of a dark reddish-brown fluid** through cracks of outer tissue or wounds of lower parts of the trunk.
- The tissue inside the trunk is decayed and the epidermis is destroyed.
- The fluid turns black in colour as it dries up on the bark.
- The crown becomes smaller.
- This disease covers palms of all ages but the spread is more rapid in young palms.

- Bleeding of the stem is associated with fungal infection.
- The fungus associated with the disease is *Thielaviopsis paradoxa*, which is a wood parasite, isolated from affected stem tissues.
- This parasite establishes itself inside tissues of the trunk, after getting entry through cracks and wounds on the trunk.

Primary Source of Inoculum- Dormant Mycelia

Secondary Source of Inoculum- Airborne conedia

Epidemiology :

- Kharif season.
- Unfavourable soil conditions play a major role.
- Shallow laterite soils also develop stem bleeding symptoms in palms.
- High relative humidity

Control :

- The rotting tissues should be cut away with a sharp chiseland the exposed surfaces paintecl, with hot coal tar or 10·96 Bordeaux paste.
- This is a serious disease caused by *Bipolaris halodes*. Normally, the leaf rot disease is found superimposed on root (wilt) affected palms.
- If cavities are found, they have to be filled up with cement for reinforcing.
- Since the pathogen is a wood parasite, mechanical injury to. the infected palm ,should be avoided.
- The organic matter content lot of the soil should be increased. Application of neem cake @ 5 kg/palm is beneficial.
- Improvement in drainage and soil conservation in drought areas are essential.
- Application of Bavistin in soil has been found to be beneficial in reducing infection.

FRUIT ROT OR MAHALI -(*Phytophthora palmivora*)

Fruit rot is also called 'Mahali'. It is used by the fungus *Phytophthora pulmivora* during monsoon period. It affects immature as well as mature nuts. Dropping of buttons becomes more virulent after the rains when the atmospheric humidity is high with low temperature.

Symptoms :

A water-soaked area develops near ,the fruit stalk during the monsoon period. The fruit will appear dark green at first and in The fruit rot may extent into the' husk and further into the kernel cavity.

Control :

1. Fruit rot and button shading caused by fungal infection can be controlled by spraying the young bunches with 1% Bordeaux mix, during the pre- and post-monsoon periods.

2. Irrigation during summer months is particularly important for retention of buttons.

3. Regular manuring and proper cultural practices may reduce the disease incidence.

GREY LEAF BLIGHT OR GREY LEAF SPOT (*Pestalotia palmarum*) :

Leaf spot disease is caused by *Pestalotia palmarum* which is widesperead in the major coconut growing countries. The incidence of the disease is usually influenced by the nutrient· status of the soil and the palm as well. Young palms are mostly susceptible in soils deficient in potash and rich in nitrogen.

Symptoms :

Leaf spot symptoms develop only on the mature leaves in theform of small yellowish-brown spots on the leaflets which gradually become oval in shape with a grayish band. In advance stage; the affected portion of the leaflets show a burnt or blighted appearance.

Aetiology :

- Septate mycelia.
- **Asexual fruitin body:** Conidia borne in acervulus.
- **Sexual fruitin body:** Pestalotia.

Primary source of inoculums: Dormant Mycelia

Secondary source of inoculums: Air bornee Conidia

Control :

1. Removal of the older affected leaves and spraying the foliage.
2. Improvement of drainage condition and adequate application of potassic fertilizers are very essential to suppress the disease. Spraying of 1% Bordeaux mixture during pre-monsoon period will be beneficial.

RED RING DISEASE (*Rhadinaphelenchus cocophilus*)

This disease is caused by nematode, *R. cocophilus* which is an endo-parasite, mostly confined to the Western Tropics. However, this disease is not prevelent in India.

Symptoms :

The leaflets of the outer whorl turn yellow, starting from the tips by browning and death of leaves. The young palms (4 to 7 years old) are more susceptible' t6 infection. The infections spread through the soil under wet conditions when the root system comes, in contact with nearby infected palm spp.

Primary Source Of Inoculum: Affected soil, Affected Planting material .

Secondary Source Of Inoculum: Through Irrigation water, root root contact.

Control-

Digging isolation trenches around the infected palms will check the spread of the nematode to the healthy palms. The heavily affected palms may be cut and removed.

CROWN CHOKING :

The incidence of this malady was first observed in 1964 in Assam and then in West Bengal. The analysis of soil and leaf samples indicated that· the calcium content of diseased palms showed significantly high, while the boron content is in very low concentration. Young palms of the age group of 5 to 10 years are mostly affected; however, the disease is noticed in the bearing palms also .

Symptoms :

The first symptom is the emergence of shorter leaves with deformed and crinkled leaflets which are associated with severe tip necrosis. Those deformed leaflets fail to unfurl and ultimately give a choked appearance to the frond. Hence, this deformity of the' palms is called "crown choking". In case of young palms, peripheral leaves crown around the bud and prevent normal unfurling of the flag leaf In acute cases, necrosis of the primordial tissue takes place and the crown dies, but not suddenly. The affected palm looses vitality slowly and succums finally within 3 to 4 years.

Control :

Application of borax at 50 g/palmto the coconut basin resulted in recov~ry of the affected palm (Chakravarty. et al., 1973); whil!" Cecil and Pillai (1978) recommended 250 gborax/palm.Prolonged drougi!1t followed by certain downpour as in 1973 and 19,74 are also causes of its spread. Heavy bearing, middle-aged palms are most susceptible to this malady. In certain investigation, the presence of Diplodia and Thielaviopsis colonies are detected. In a ffected palms, the deficiency of nutrients, particularly nitrogen and zinc are observed. Recently MLOs are detected in affected pal ms.

Symptoms :

1. Abnormally large crown with more number of leaves having large petioles and big size of leaflets develop.
2. Inner leaves become darker than normal, while outermost whorl shows yellowing. Afterwards, leaves become smaller in size and pale in colour and leaflets fail to unfold properly showing fan-like appearance.
3. Fronds bend abnormally from the middle and start drooping.
4. Nuts become smaller, round containing sponge-like meso carp; some nuts form longitudinal cracks.
5. As the disease progresses, the palms become barren with a tapering stem;
6. Roots start extensive rotting and their generation becomes poor, resulting in the palms succumbs to the disease in the course of a few years.

Remedial Measures :

1. Destruction of badly affected palms may prevent spread of the disease; since presence of MLO has recently been detected in affected palms in East Godavari area.
2. Application of a mixture of river sand and farmyard manure or tank silt with normal dose of NPK can reduce the intensity of this malady and increase nut yield-)

CADANG- CADANG :

The name Cadang-Cadang signifies 'dying-dying' from the dialect of Sicol area in Philippines and reflects the slow but persistent lethal progress of the disease. This is one of the most serious disease of coconut in this country, which is also locally known as 'yellow mottle decline'. The slow reaction of the palm is a major problem to combat the disease. This disease is a slow killer, takes 5 to 8 years to die and thus only older palms succumb. Young palms affect before yellowing stage, never bearing fruits.

Soil :

This disease incidence is influenced by poor nutritional status and poor soil structure. It is assumed that this disease is due to certain micro-nutrient deficiency, particularly copper or toxicity of nickel.

Symptoms :

The symptoms and type of spreading have been generally accepted as indicating virus origin and the involved organism is identified as viroid. The first visible symptom is a decrease in size of nuts, the fibrous layer becomes thinner and thinner. Irregular yellow translucent spots appear in the pinnate of young leaves and turn orange-yellow mottling as the leaves .mature and size and number or spots increase. On the lower surface of the leaves, a peculiar 'water-soaked' type of spot appears. Young leaves become short, brittle and frond as a whole become smaller and tend to remain upright position in the crown. Both male and female flowers become dwarf and the flower production usually ceases within the second year after appearance of leaf symptoms. In late stage, the central fronds become bronze-yellow, main bud dies and falls off, showing crownless. As the disease progresses, roots are generally detioriate and rotting becomes extensive.

Remedial Measures :

1. Clean culture, cutting and burning of infected palms al e suggested.

2. Replanting with resistant Dwarf cultivars is desirable.

3. Good soil management may suppress this malady.

LETHAL YELLOWING : (Phytoplasma Like |Organism)

Lethal yellowing is a pandemic disease of coconut palm which has destroyed thousand of palms in South Florida earlier and in recent years, this malady is most common in' Jamaica. 'the rate of spread of 'Lethal Yellowing". (LY) in Jamaica is similar to that of LY in Florida (McCoy, 1976). The term 'Lethal Yellowing' was first used my Nutman et a!., (1955), to denote a specific disease of coconut palms in Jamaica and subsequently applied to diseases of identical syrnptomology in other countries. Parthasarathy .(1974) observed mycoplasma-like-organisms (MLO) in phloem tissue by Electron Microscopic examination.

Symptoms :

The first symptom. of lethal yellowing in mature coconut palms is the premature dropping of most of the nuts regardless in size. Next symptom is to develop necrosis of new inflorescence with blackening of tips and most of the male flowers become dead and thereby no fruit set on such' flower stalks.Next, the lower fronds turn yellow which spreads gradually to younger leaves. However, yellowed leaves are found turgid and not flaccid as in case of root (wilt) disease. Those leaves become yellow, ultimately turn brown, desiccate and hang down.Finally, the newly emerged spear leaf collapses and death of the terminal bud occurs and the top of the palm falls away within 6 months after appearance of the symptoms. Lethal Yellowing spreads not only first but it kills rapidly.

Primary source of inoculums- Infected leaf and plants.

Secondary source of inoculums- Phytoplasma transmitted by bornee leaf hoppers.

Epidemiology:

- Neglected orchard,
- Sucseptable host.
- Summer season,
- High vector population.

LINKING MLO AND LETHAL YELLOWING IN COCONUT PALMS

The presence of MLO within the phloem vascular tissue of coconut palms affected by LY was reported in 1972 by many workers. Firstly, VILO have consistently been detected in diseased but not healthy palm tissue. Secondly, linking MLO to LY is the antibiotic response of diseased palms, particularly tetracycline. Thus, antibiotic treatments were developed as a disease management tool.

Control of Lethal Yellowing :

I. Rapid removal of affected palms will show the apparent rate of disease spread;

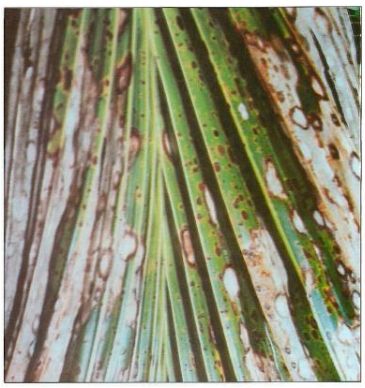
2. Imported Malayan Dwarf palm which is found to be resistant cultivar can be replanted in diseased gardens.

3. Stem injection of tetracycline group anti-biotic would suppress symptoms development, since mycoplasma are known to be sensitive to tetracycline.

4. Spreading of insecticides like diazinon or dimethoate biweekly, may reduce the vector (M. crudus) population substantially and thereby reduce LY to a great extent.

LEAF SCORCH DECLINE :

Leaf scorch decline is a disorder of coconut pal ms, first detected in Sri Lanka as early as 1955. The volume of inflorescence sap collected from LSD-affected palms was reduced compared to healthy palms, but the composition of the sap remained unaltered.



Soil Condition :

Rapid tappering associated' with Leaf Scorch Decline occurs under adverse soil and environmental conditions. The gro'lvth is adversely affected, the' root system is severely damaged, tapped continuously and succumb. In laterite and gravelly soils, impeded drainage through hard pan beneath, may be an adverse soil physical factor in Leaf Scorch Decline. A

relatively high rate of tappering is observed in shallow and compact soils and those have not been fertilized regularly.

Symptoms :

Necrosis on lower whorl of fronds of grown up palms and downwards curling of leaflets are the main characteristics,of Leaf Scorch Decline. After a short period, the crown is reduced in size and the trunk begins to tap. As a- result; formation of inflorescence may cease completely Extensive damage of root system and root decay are found common in affected palms.This malady is often associated with cracking of heavy clay soil and visible magnesium deficiency symptoms in leaves.

Remedial Measures :

1. Structural improvement of laterite/gravelly soil with addition of organics may improve the condition of affected palms.
2. Round bench terracing at a height of 0.5 m with coconut husks, 1 m away from the base of the palm and filling the space with porous soil, helps to induce new root formation.
3. Regular balanced manuring, including application of magnesium sulphate 1 kg/palm/year will be benefiCiaI')

Further References-

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Coffee

Introduction

Coffee has a place of pride among the plantation crops in India & mainly cultivated in the hilly tracts of Karnataka, Kerala & Tamil Nadu & to a lesser extent in non-traditional areas such as Andhra Pradesh, Orissa, West Bengal, Maharashtra & North Eastern states. *Arabica* & *Robusta* are the two economic species of Coffee commercially cultivated in India. Arabica occupies an area of 1, 27,934 ha. With an average productivity of 730 Kg/ha. While Robusta is grown on 1, 42,887 ha. With an average productivity of 732 Kg/ha. Coffee being an export oriented commodity & contributes nearly Rs.1, 400 crores of foreign exchange exchequer. As an agro based rural enterprise primarily this industry is a source direct employment for about 4 lakhs in the area of cultivation apart from the providing indirect employment to several people in the processing & trading centre.

In India, though coffee is susceptible to several fungal diseases of economic importance, viral & bacterial diseases were not reported so far. Among the two commercially cultivated species, Arabica coffee is more susceptible than Robusta. Leaf rust, black rot, pink disease, anthracnose, root diseases, berry blotch, collar rot & brown-eye-spot are the important diseases which needs regular plant protection measures for improved crop production.

Integrated Disease Management (IDM) is considered as a mean by utilizing all the suitable methods in a compatible manner that minimize the pesticides use as disturbance to the environment & maintain the pathogen population level below economic damage. The current disease management programme in coffee is designated as IDM & most of the IDM components are generally practiced for the effective management of important diseases of coffee.

COFFEE DISEASES

SL NO	DISEASES
	MAJOR DISEASES
1.	Leaf rust - ***Hemileia vastatrix***
2.	Black rot - ***Pellicularia koleroqa***
3.	Pink disease - ***Cortcium salmonicolor***
4.	Anthracnose a. Twig die back - ***Colletotricum gloeosporioides*** b. Stalk rot of berries & leaves - ***Colletotricum gloeosporioides*** c. Brown blight of leaves - ***Colletotricum gloeosporioides***
5.	Root diseases a. Brown root - ***Fomes noxius*** b. Red root - ***Poria hypolateritia*** c. Black root - ***Rosellinia bunodes*** d. Santavery root - ***Fusarium oxysporum***
6.	Berry blotch - ***Cercospora coffeicola***
7.	Fusarium bark disease - ***Fusarium stilboides***
8.	Nursery diseases a. Collar rot - ***Rhizoctonia solani*** b. Brown eye spot - ***Cercospora coffeicola***
	MINOR DISEASES
1.	Grey blight of leaves - ***Pestalotiopsis clavispora***

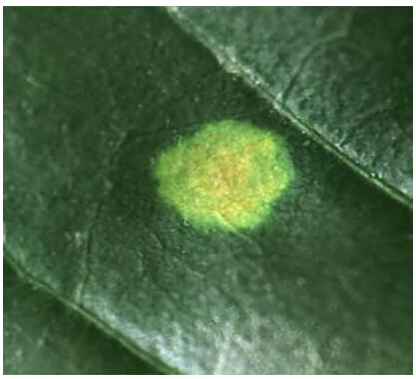
2.	Black leaf - ***Cylindrocladium illicicola***
3.	Target leaf spot - ***Myrothecium advena***
4.	Tip burn - ***Myrothecium roridum***
5.	Sclerotium disease - ***Sclerotium coffeicola***
6.	Coffee blight - ***Phoma costarricensis***
7.	Sooty mould - ***Capnodium braziliense***
	FLOWERING PARASITES
1.	Shoot parasite - ***Cuscuta reflexa***
2.	Root parasite - ***Balanophora indica***
	STEM WASTING DISORDER(KONDLI)

MAJOR DISEASES

1. LEAF RUST/ORIENTAL LEAF DISEASE

Coffee leaf rust caused by ***Hemileia vastatrix*** Berk. & Br. Is one of the most importance diseases & pests of tropical plants. It has been considered as one of the classic diseases, since it ruined the economy of ***Srilanka*** changed to the **Tea cultivation** & also the social habit of the people from coffee drinking to Tea. Besides India, Coffee rust has been reported from 50 coffee growing countries. Leaf rust disease was noticed in India during **1869** and in the early years it caused severe damage to the flourishing plantations sending the coffee production staggering down as no control measures were available during the period.

Symptoms



- Coffee rust attacks mostly leaves & very rarely the young branches.

- Initially pale yellow circular spots measuring 2-4mm in diameter.
- Appear on the lower surface of the leaves which later turn to orange yellow powdery mass of urediniospores.
- The spots enlarge & become more irregular as they coalesce with the adjacent spots. With the aging,
- The central portions of the spots become brownish & later necrotic, whereas the middle zones of the version continue to sporulates.
- Severe infection can cause heavy defoliation & dieback of branches.

Crop loss

- Rust affects the berry yield in many ways, by reducing the photosynthetic area, by occupying leaf area, inducing defoliation & reducing the vigour of the plants due to altered physiology.
- Depending on the severity of rust not only fewer flowers are formed but also the flower & the fruit fall prematurely the remaining berries after development do not reach maximum size.
- In severely affected areas the pathogen causes foliage loss up to 50% & even 70% loss of coffee berries.

Causal organism, taxonomy & life cycle

The causal organism of leaf rust ***Hemilia vastatrix*** has been classified under

Class- Basidiomycotina,

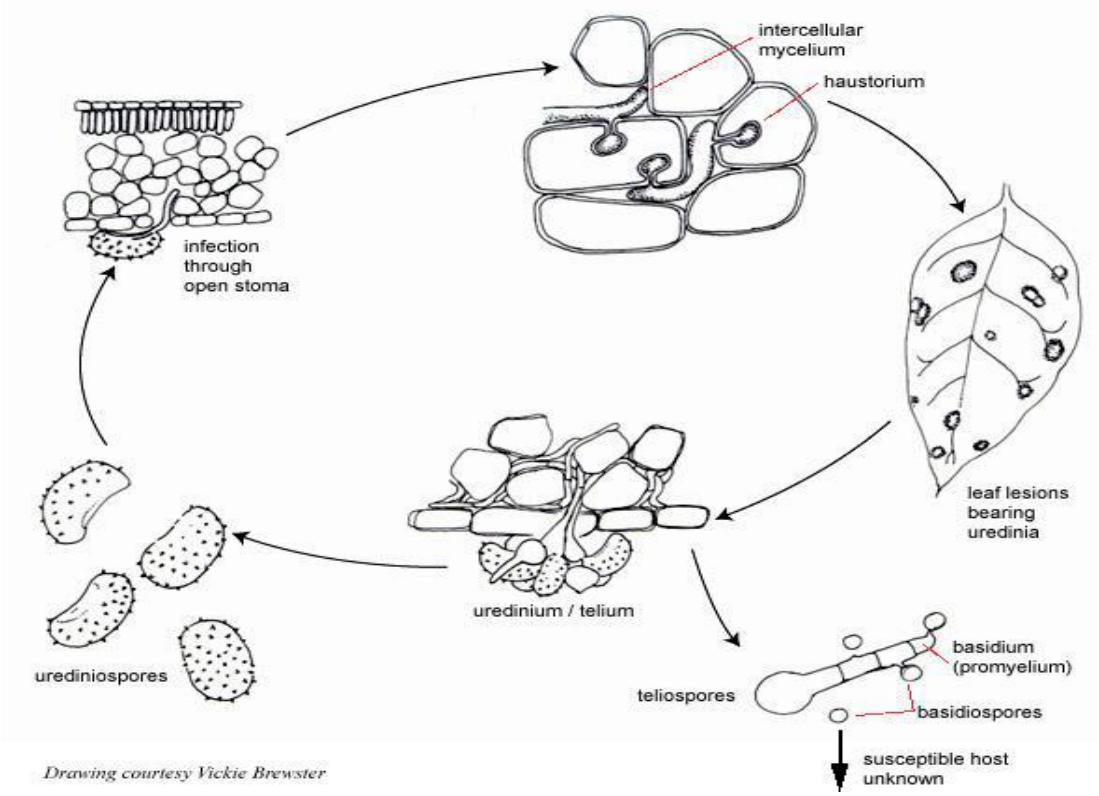
Sub- class-Teliomycetidia,

Order- Uredinals

Family- Pucciniaceae.

- In nature, coffee leaf rust fungus produces only uredinial, telial & basidial stages. But the perpetuation of the fungus in nature is only by anomorphic urediniospores.
- The teliospores are produced only during unfavourable conditions & it germinates in situ under favourable conditions by producing basidiospores which are apparently functionless on coffee.

- Alternate hosts have not been reported so far. Pycnial & aecial stages of the fungus have not been noticed either natural or under control conditions.
- . Uredospores act as secondary source of inoculum.



- Teliospores present in fallen leaves acts as primary source of inoculum
- Uredospores act as secondary source of inoculum.

LIFE CYCLE OF ***Hemileia vastatrix***

Mode of spread & survival

- One lesion produces 1.5 lakhs uredospores which are spread by rain splash & wind.
- Many animals can also carry spores over long distances.
- Infection requires the presence of water for uredospore germination & only occurs through stomata, which are on the underside of the leaf.
- Epidemics develop during the rainy season because of the necessity for water.

Favorable factors & disease progress/Epidemiology

- Wet weather with wind during May to November,

- Intermittent & sun shine, mist or rain during dry weather from Nov-Mar thin or no over head shade is the favourable factors for the disease development.
- Under suitable conditions, the disease make its appearance after blossom showers during Mar-Apr. the foliage present at that time are mostly of previous season & the fungus remains dormant.
- Such leaves during the dry weather sporulate to form fresh urediniospores.
- The disease reaches is peak from Sep-Nov & results in severe defoliation.

Control:-

Cultural management

- Various agronomic practices like spacing, shading, fertilizing & pruning operations reduce the rust infection level.
- Spacing:-Increased plant spacing decrease the relative humidity & thus the relative incidence of leaf rust. Hence avoid dense planting to minimize the rust incidence.
- Shade:- Leaf rust incidence is generally lesser under medium shade than in open or thin shade.
- Fertilizer:- Keep the vigour of the bush during the crop development period by applying balanced fertilizer, as plant yield is one of the major factors that influence the rust development.
- Pruning:- Pruning of dry & unproductive branches is done to reduce the die-back of branches & to facilitate formation of new branches. Mostly recommended before the blossom showers to reduce the initial inoculums.

Biological control

- *Verticillium hemileiae* parasites of rust spores occur mostly during rainy season at high relative humidity near saturation.
- Role of a biological agent is very limited due to its failure to establish even for a short period under low humidity.

Resistant varieties

Twelve cultivars of Coffee Arabica (Sln. 1 to Sln.12) were evolved at CCRI..

Chemical control

Copper based fungicides especially freshly prepared Bordeaux mixture 0.5% has been found effective & economical for the control of leaf rust under field conditions.

Number of systematic fungicides were tested & among them oxycarboxin, carboxin, pyracarbolid, triadimefon, propiconazole, hexaconozole & epoxyconazole showed curative & eradicant effect on rust pathogen.

Spray schedule for the control of leaf rust

1. Bordeaux mixture 0.5% pre- blossom (Feb-Mar), Pre-monsoon (May-June), Post-monsoon (Sept-Oct).
2. Triadimefon 0.02% Pre-monsoon (May-June), Post-monsoon (Sept-Oct).
3. Hexaconozole 0.01% Pre-monsoon (May-June), Post-monsoon (Sept-Oct).
4. Propiconazole 0.02% Pre-monsoon May-June), Post-monsoon (Sept-Oct).
5. Oxycarboxin 0.03% Pre-monsoon, Mid-monsoon (July-Aug), Post-monsoon (Sept-Oct).
6. Epoxyconazole 0.0026% Pre-monsoon (May-June), Post-monsoon (Sept-Oct).

2. BLACK ROT/KOLEROGA/THREAD BLIGHT

Also called ***Koleroga*** is considered to be the second importance disease of coffee in India. Pathogen attacks on both **Arabica** & **Robusta** coffee. But the severe incidence of the disease was seen on Arabica coffee cultivars. Black rot disease was reported from almost all coffee regions of Karnataka, Kerala & Tamil Nadu coming under the influence of heavy South-West monsoon.

Symptoms

- The black rot pathogen infects leaves, developing berries & young shoots.
- The most striking symptoms are blackening & rotting of the infected leaves, developing berries & young twigs.
- Affected leaves get detached from branches & hang down by means of slimy fungal strands.

- On the green berries characteristic blackening starts from a side & spreads gradually in a narrow band.
- Close examination reveals the presence of characteristic threads of mycelia running along the twigs, petioles & spreading mostly on the lower surface of the leaves.
- When the affected leaves & berries become dry, they reveal the presence of white web consisting of closely interwoven mycelium.
- Defoliation & berry drop from the infected branches occur in advanced stage of the disease.

Crop loss

- Damage caused by this fungus varies from place to place & season to season.
- However, in severely diseased areas a loss of 10-20% of crop for the whole estate & 70-80%or even more on an individual bush has been recorded.
- Foliage loss by this pathogen which leads to severe die-back & destruction of wood where crop has to borne for the next should also be taken into account while estimating the crop loss.

Favourable factors/Epidemiology

- Continuous monsoon with out a long dry spell,
- saturated atmosphere with 95-100% RH,
- thick overhead shade, plants sheltered from sunlight & wind in valleys,
- Frequent or continuous mist during the monsoon

are the favourable factors for the out break of the disease.

Causal organism, taxonomy

The causal organism of black rot pathogen is ***Pellicularia koleroga*** classified under

Class- Basidiomycontia

Order- Polyporales,

Family- Thelephoraceae.

Koleroga noxia Donk, ***Pellicularia koleroga*** Cke., are the different synonymous names proposed to this fungus.

Initiation of disease

- Earliest symptoms of disease appear on the bushes which are affected during the previous season.
- Under favourable conditions infection starts at the place where the leaves come in contact with branches which harbour the sclerotia.

Spread of disease

- Primary spread of the fungus is mostly by contact from leaf & bush to bush through vegetative mycelium.
- Affected leaves get detached & carried by wind to other plants & cause further infection.
- Secondary spread through the basidiospores either by wind or rain dispersal.

Collateral hosts

This fungus not only affects several plant species generally occurring in the forest but also a few economically important horticultural crops such as orange, pear, fig etc.

Control

Black rot is effectively controlled by combining physical, cultural methods. The present control measure & spray schedules for effective management of the disease are as follows:

Cultural management

- Maintenance of good drainage, free circulation of air & sunlight
- Thinning of the overhead shade in the black rot endemic blocks before the onset of the monsoon.
- Centering & handling of the bushes by removing criss-cross branches, dead & dry branches, suckers & dried leaves of the shade trees fallen on the canopy of the bush before imposing pre monsoon spray.

- Removal & destruction of the affected leaves & berries along with the mycelial thread in the initial stage under wet conditions.

Chemical control

- Adequate coverage of Bordeaux mixture 1.0% on both surfaces of leaves & also to the developing berries just before the onset of monsoon & during the break in monsoon.
- Several systematic & prophylactic fungicides were tested, among them carbendazim, carboxyl & captafol were found effective.

3. PINK DISEASE

This disease occurs on the branches.

Symptoms

- Affected branches show a pink encrustation, hence the name pink disease.
- On the brown wood of infected branch longitudinal cracks develop through which pinkish encrustation bursts.
- In advanced stage, entire branch may show a pinkish encrustation.
- Cobweb like mycelia strands are seen on affected branches.
- Infected branches lose their leaves & die.

Favourable factors

Continuous monsoon, relative humidity near saturation & thick overhead shade are the favourable factors for the disease development.

Causal organism, taxonomy

The causal organism of pink disease ***Corticium salmonicolor*** B. Br. is classified under

Class- Basidiomycotina,

Order- Polyporales &

Family- Thelephoraceae.

Control

- 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.

4. ANTHRACNOSE:- ***Colletotricum gloeosporioides***

This disease affects leaves, twigs as well as berries. Anthracnose of coffee caused by ***Colletotricum gloeosporioides***, Is a bark inhabiting fungus which is generally a weak pathogen but under certain conditions of the host & the environment becomes virulent.

Causal organism, taxonomy

The causal organism is classified under the

Class- Deuteromycotina,

Order- Melancoloniales,

Family- Melanconiaceae.

The fungus causes three different diseases of coffee viz., twig die back, stalk rot of berries & leaves & brown blight of leaves.

a. Twig die-back or summer die-back

This disease occurs during dry weather from Oct-May & reaches its peak level after blossom showers.

Symptoms

- Yellowing or blighting of any leaf on the green wood.
- Yellowing, necrosis of nodes & internodes towards the tip.
- Twig wilts & defoliates, dies forward towards the apex & depicts a die-back appearance.
- Floral buds on the infected branches fail to open.

- Affected plants put on new vegetative growth on the primaries & secondaries near the main stem takes place.
- Affected plants in the exposed area bear the new leaves which are small, crinkled, chlorotic, thick, thick & leathery.
- Internodes are short & give a fan shape appearance.

Favourable factors

- Debility of twigs or branches due to defoliation caused by heavy incidence of leaf rust,
- Crop strain, inadequate over head shade, prolonged drought & soil moisture stress were the pre disposing factors for the disease development.
- The fungus invades the debilitated branches under the influence of low temperature, mist or dew during night & early hours.

Control

- Pruning of badly affected plants during Feb-Mar.
- Maintaining adequate overhead shade to protect the bush from sun scalding & mulching of leaf litter around the plants for conserving soil moisture during dry weather.
- Application of balanced nutrients to maintain vigour of the plants.
- Protect the plants by spraying 0.5% Bordeaux mixture in Feb-Mar(Pre-blossom), Apr-May (Pre-monsoon) & Sep-Oct (Post-monsoon).

b. Stalk rot of berries & leaves

Stalk rot of berries & leaves are generally noticed on Arabica & also on robusta coffee during Jul-Aug under the heavy pour of South-Western monsoon conditions.

Symptoms

- Necrosis of nodes & internodes from the junction of brown & green wood top wards the apex followed by berry drop & defoliation.
- Berries & leaves drop down due to necrosis & decay of the stalk portion. Generally, the rotting stalk remains on the branch while berries are shed.

One or two nodes from the tip of the affected branches may show total berry drop.

- Even if some berries remain, they show premature ripening towards the end of Sep or Oct & remain as lights during crop harvest.

Favourable factors

- Low temperature, relative humidity (95-100%),
- surface wetness of plants due to rain or mist,
- wounds on the stalk of berries & leaves & excess soil moisture during monsoon are the most favourable factors for the disease development.

Control

1. Provide good drainage by cleaning trenches & cradle pits to remove excess water around root zone.
2. Maintain thin overhead shade.
3. Removal of mulch to expose the soil around the plants
4. Pre-monsoon spraying of Bordeaux mixture 0.5% in May-June giving a good coverage of branches & stalk of the berries.

c. Brown blight of leaves

This disease is generally seen on leaves during the hot weather. Injury caused by sun scalding or any other type of wounds on leaves predispose them for infection by ***Colletotricum gloeosporioides***.

Symptoms

- Round necrotic spots measuring up to 25 mm in diameter appear on leaves.
- Two or more such spots may coalesce & the entire or a portion of it may look blighted.
- Necrotic spots are brown in colour hence the name brown blight.
- Fructifications of the fungus are as black dots on the spots on upper or lower surface of leaf.

Control

1. Maintain good overhead shade to avoid sun scalding of leaves.

2. Spraying 0.5% Bordeaux mixture to protect the leaves from the rust fungus appears to give adequate protection against brown blight also.

5. ROOT DISEASES

There are four types of root diseases affecting coffee viz., brown root disease, red root disease, black root disease & santavery root disease.

Brown, red & black root disease are observed both on **Arabica** & **Robusta**, while santavery root disease is noticed only on Arabica.

a. Brown root disease

This disease also known as stump rot & is mostly associated with the rotting stumps of shade trees. Disease spreads to neighbouring plants by means of root contact of infected stumps or plants. The causal organism of brown root disease ***Fomes noxius*** Corner has been classified under

Class-Basidiomycotina,

Order-Polyporales

Family- Polyporacea.

Symptoms

- Affected plants show gradual yellowing of leaves, defoliation followed by death of the entire plant.
- Stem near the ground level becomes spongy & soft. Root system shows development of thick brown encrustation adhered with small stones.
- The brown fungal encrustation gives the name brown root disease.
- Interior of the roots show dark brown to black wavy lines.

Collateral hosts

The pathogen also reported on shade tree like dadap & silver oak, apart from infecting commercially important plantation crops such as citrus, tea, cocoa, nutmeg, oil palm & rubber.

b. Red root disease

The causal organism of red root disease ***Poria hypolateritia*** Berk has been classified under

Class- Basidiomycotina,

Order- Polyporales

Family- Polyporaceae.

Symptoms

- Gradual yellowing of leaves, defoliation followed by death of the above ground parts are the aerial symptoms which are identical as described under brown disease.
- Root system of dying or dead plants show red encrustation covered with soil & gravel adhering to it.
- The red encrustation is nothing but the fungal rhizomorph.
- The affected root appears deep red in colour when washed in water which is a good diagnostic symptom of this disease.

c. Black root disease

The causal organism of black root disease ***Rosellinia bunodes*** (B. & Br.) Sacc & ***Rosellinia arcuta*** Petch has been classified under

Class- Ascomycotina,

Order- Sphaeriales

Family- Xylariaceae.

Though the disease has been reported on coffee, its spread & severity is limited unlike the brown & red root disease.

Symptoms

- Aerial symptoms are almost same as described under brown root disease. On affected roots, black fungal rhiozomorph or black woolly mycelium are seen. In transverse section, thread like black lines or dots can be clearly seen.

- On the stem near the ground level fan shaped black fungal mat with pellet like fructification are also seen.

Management of brown, red & black root diseases.

1. Isolate the affected plants & one row of apparently healthy adjoining plants with 60cm deep & 30cm wide trench. The soil from the trench should be thrown into affected area & not to the outside.
2. Uproot the affected coffee plants along with the root system & burn.
3. Add agricultural lime @ 1-2 kg per pit uprooting the plants & fallow the land for 6 months before planting.
4. Whenever a shade tree is felled, it is advisable to uproot the stumps as far as possible to avoid the brown root disease in future.
5. Drench the soil with carbendazim 50 WP @ 0.4%/plant in the initial stage of the disease during pre & post monsoon period.
6. Application of well composted organic manure @ 10-15 kg per plant would also help in suppression of pathogens.
7. To trackle the spread of red & brown root disease, biocontrol approaches has been initiated using Trichoderma.
8. Soil application of 3-5 kg of the mixture of bioagent *Trichoderma* in compost to the affected coffee plants in drip cycle during Sept-Oct & May-Jun in a year is found effective.

d. Santavery root disease

The causal organism of disease is ***Fusarium oxysporum*** has been classified under

Class- Deuteromycotina,

Order- Moniliales,

Family- Tuberculaiaceae.

Symptoms

- Sudden wilting yellowing of leaves followed by defoliation & death of aerial parts.
- Roots show in transverse section, brown to pinkish discoloration of the inner portion. Scrapping the bark of the stem near the ground level shows internal discoloration.

Favourable factors

Low or high soil temperature, poor physical conditions of soil, moisture stress, inadequate shade & wounds on the roots are the predisposing factors for disease development.

Management

1. Uproot the dead & dying plants & destroy.
2. Treat the affected blocks with compost manure @ 10-15 kg per plant to improve the soil fertility.
3. Drench the soil with carbendazim @ 0.1% or carboxin @ 0.3% /plant in the initial stage of the disease.
4. Maintain adequate overhead shade.
5. Apply balanced nutrients & follow good cultural operations to maintain the vigour of the plants.
6. Lime the soil to raise the soil p^H if it is highly acidic.

6. BERRY BLOTCH

Berry spot & cherry are the other names for this disease. This disease is confined only to the berries & has been noticed in all the coffee tracts of south India. The disease become serious when the developing berries are exposed to sun from Aug-Nov. the diseased tissue of the skin becomes dry & hard & sticks fast to the parchment & such fruits are difficult to pulpy properly, thus lowering the quality considerably.

The causal organism ***Cercospora coffeicola*** B. & Cke. is classified under

Class- Deutromycotina,

Order- Moniliales

Family- Dematiaceae.

Symptoms

- Dark brown, irregular, slightly sunken necrotic spot on the exposed surface of the green berries.
- Necrotic spots enlarge in size & cover a major portion of berry surface.
- Skin of the affected berries show a purple halo around the necrotic spots.
- Affected tissue turns brown to black, shrivels, dries up & sticks fast to the parchment.

Favourable factors

Exposure of the developing berries to sun without adequate over head shade, hot humid conditions are the main predisposing factors for disease development.

Control

1. Maintain good overhead shade to avoid sun scorching of berries.
2. Spray the developing berries in the endemic blocks with 1.0% Bordeaux mixture when the incidence is just noticed.

7. FUSARIUM BARK DISEASE

It is important in South East Asia, Southern Africa & West Indies.

Symptoms:

- The pathogen infects the collar region of the stem & produce bark & canker. Bark scaling is the most common but least damaging symptom.
- The fungus grows beneath the bark layer, which becomes flaxy in texture.
- Cankers are then produced which can girdle the trunk & kill the tree.
- Damage is also caused due to young suckers where a necrotic brown lesion develops at the base, usually close to the junction with the main stem.
- The sucker may be killed or survive to have a constricted 'bottle neck' appearance at the base, which leaves the new stem weakened & liable to break as soon as a heavy crop is carried.

FUNGUS: ***Fusarium stilboides (***syn. ***Gibberala stilboides)***

Mode of spread & survival:

- The fungus is common inhabitant of coffee stem surfaces & survives saprophytic ally on dead coffee debris.
- It may also infect damaged coffee berries as a secondary invader.
- The pathogenic phase only occurs when the coffee is stressed by wounding or by climatic conditions.

Epidemology: Insect damage may initiate attacks. Unfavourable cultural conditions such as poor soil management, irregular pruning & drought predispose the plant to infection.

Management:

- Good soil management with adequate & timely mulching to conserve moisture in the top layers of the soil, proper pruning practices, improving to soil fertility, etc. reduce the infection.
- The protection of stem bases with Captan or captafol 0.4% a.i applied to trunk bases at pruning & while young suckers are maturing is also recommended.

- Pruning or other wounds should be protected with a fungicidal paint. Badly diseased trees should be destroyed.

8. NURSERY DISEASES

Coffee is mainly propagated through seeds. Seedlings are raised in two stages under pandel shade.

The seedlings in the nursery are affected by the following diseases.

a. Collar rot

Collar rot or Damping off disease occurs on seedlings of 1-3 months age in the nursery if the conditions are suitable for the growth of the fungus. Under favourable conditions seedling loss may go up to 10-20% depending upon the severity of the infection. Both the commercially important cultivars of coffee are susceptible to this pathogen.

The causal agent of collar rot fungus is reported to be soil inhabitant & is prevalent in all the coffee growing areas of India. The pathogen ***Rhizoctonia solani*** Kuhn. Is placed under

Class- Deuteromycotina,

Order- Myceliasterilia.

Symptoms

- The pathogen attacks both seeds & seedlings in the following two stages.
- . Pre-emergence damping off: Embryo & endosperm are invaded by the fungus before germination & the radical during germination. On account of this, seeds rot & disintegrate.

- . Post-emergence damping off: Seedlings show brownish discoloration on the stem near the ground level leading to rotting of the tissue. Growing apex wilts & the seedlings collapse & die.

Favourable factors

Impeded drainage in the nursery beds resulting in excessive soil moisture, thick overhead pandel, hot & humid weather, over crowding of seedlings create a faulty environment to seedling growth & pre-dispose them for infection by the fungus.

Control

1. Expose the nursery soil to the sun for 2-3 months.
2. Prepare raised seed beds adding jungle soil, compost & sand to drain off the excess moisture in the bed.
3. Avoid excessive watering.
4. Avoid over-crowding of seedlings by proper spacing of seeds while sowing.
5. Provide filtered overhead shade using coir mats.
6. Treat coffee seeds with carbendazim @ 2 g per kg.

b. Brown-eye-spot

Disease was reported from all the known coffee growing countries. Mostly the seedlings in the nursery & young plants in the new clearings suffer to a large extent when proper over head shade is lacking.

C.O: ***Cercospora coffeicola*** Botrytis & Cke.

Symptoms

- Leaves show circular necrotic spots with a dark brown margin & light brown or pale centre.

- Necrotic spots increase in size, the central portion turns light grey due to sporulation by the fungus & collapses leaving a hole at the centre.
- Affected leaves turn yellow & pre-mature defoliation of such leaves takes place.

Favourable factors

- Inadequate overhead shade in the new clearing, sudden exposure of the seedlings to bright sun shine due to removal of nursery pandal shade,
- Hot humid conditions during Apr-June & Sep-Nov are the predisposing factors for the disease development.

Collateral hosts & mode of survival

- The pathogen survives in the soil on the fallen debris as long has 35 weeks.
- It was also observed that *Bidens pilosa*, *Chenopodium ambrosoides* & *Ricinus communis* the commonly occurring weeds in coffee plantations serves as collateral hosts for this pathogen.

Control

1. In the nursery grow plants under pandal shade to avoid exposure to sun light.
2. Provide adequate mulch to conserve soil moisture for the young plants in the new clearings.
3. Spray Captan @ 0.2% once in 30 days interval.
4. In the new clearings maintain good overhead shade & spray 1.0% Bordeaux mixture.

9. DISEASES OF MINOR IMPORTANCE

a. Grey blight of leaves

C.O: ***Pestalotiopsis clavispora***

Symptoms

- Brown or grey necrotic spots up-to 1-2 cm in diameter on mature leaves. These spots enlarge & coalesce later & the leaves appear brown or grey.
- Black fructification on both sides of leaves in concentric rings is irregularly distributed on necrotic spots.

b. Black leaf

C.O: ***Cylindrocladium illicicola***

Symptoms

- Small circular water soaked necrotic black spots on the leaf blade mostly on the margin of upper or lower surface.
- Spots enlarge in size & the entire leaf or half of it turns black & rot hence the name black leaf.
- Affected leaves drop down.

c. Target leaf spot

C.O: ***Myrothecium advena***

Symptoms

- On leaves brown circular or irregular necrotic spots are formed.
- Concentric zonation visible on the upper surface of the leaves gives a characteristic target board appearance, hence the name target leaf spot.
- Severe infection may lead to defoliation.
- Mostly leaves near or touching the soil are affected.

d. Tip burn

C.O; ***Myrothecium roridum***

Symptoms

- In nursery 5-6 months old plants show infection of first internode & also tip pair of leaves.
- The symptoms observed are water soaked brown to grey discolouration of the internodes from the tip followed by defoliation & death similar to that of die-back.
- On necrotic tissue cushion shaped fructifications with shiny black centre & white margins were observed.

e. Sclerotium disease

C.O: ***Sclerotium coffeicola***

Symptoms

- Small circular necrotic spots on leaves.
- These spots gradually increase in size up to 25mm in diameter & show concentric rings of light & dark brown shades.
- Rhizomorphs of the fungus are seen on the necrotic spots.
- Mustard like sclerotia are formed on the necrotic spots.

f. Coffee blight

C.O; ***Phoma costarricensis***

- The disease affecting leaves of Coffee arabica was noticed in Karnataka.
- Severity of the disease leads to heavy defoliation.
- Wet weather, high humidity, low temperature & wounds caused by the insects under field condition are favourable for development of disease.
- Defoliation noticed was up to 30-35% & was seen at higher elevations.
- Young & mature leaves get affected.
- The disease appears to extend up to the tip portion of the tender twig also, when all the leaves on a tender branch get affected.

g. Sooty mould

C.O: ***Capnodium braziliense*** puttom.

- Sooty mould of coffee is seen whenever there is heavy attack of aphids & scale insects.

- The fungus feeds on the excreta and secretions of the insects & indirectly prevents the normal leaf functions.
- The leaves & shoots are covered with black sooty fungal growth, affecting the photosynthetic activity of the plants. It is ectopytic and not a pathogen.

Control

- By controlling the insects. Spray any systemic insecticides to prevent insects and will prevent the sooty mould.
- To avoid the fungus, spraying with 1kg fish oil resin soap + 1kg starch in 200 litres of water is recommended.
- The mouldy growth peels off when the starch dries.

10. FLOWERING PARASITES

Some flowering plants grow as parasites on coffee plants. Occurrences of such parasites are not of common observation in plantations.

a. shoot parasite

Cuscuta reflexa (dodder) or strange vine is generally observed on coffee plants either in nursery or in the estate near the fence hedge, if the latter is not kept free of this parasite.

- Dense strand of leafless yellow vines twining the plants.
- During dry weather from Nov-Jan they produce white flowers & form seeds.
- Primary infection comes from seeds & secondary spread from the neighbouring infected plants.
- This parasite gradually weakens coffee plants as it draws nourishment through haustoria & as a result host vigour is lost.

Control

1. Clean removal of the parasite from the infected coffee plants & burning assures good control. While removing the parasite, care should be taken not to leave the piece of vine or its haustoria on the plant as they will continue to grow again.
2. Fence hedge & the neighbouring plants should be kept free of this parasite to check the secondary spread.

b. Root parasite

Balanophora indica, the root parasite belongs to the family Balanophoraceae, & occurs on roots of coffee growing at higher elevations above 1000 m MSL. Affected plants gradually decline in their vigour.

- The parasite occurs in the form of root stock composed of tuberous out growths on the lateral roots of coffee plants during the South-west monsoon.
- In the early stages of development the tubers are small round bodies hidden inside the soil.
- Flower heads begin to appear by about November.
- The affected coffee bushes do not show clear cut symptoms of attack externally except for general unhealthy appearance & low productivity.

Control

Collect the tubers by digging the soil. All tubers should be collected before flowering & destroyed.

11. STEM WASTING DISORDER (KONDLI)

This is a non-parasitic disorder resulting from the toxicity of copper fungicides sprayed on young coffee plants in the nursery during the inclement monsoon weather from May-Sep.

Symptoms

- On 6-8 months old plants symptoms become apparent from Aug-Oct. affected plants show a constriction at the first or second node from the base.
- The stem portion above the constriction becomes swollen with gradual thinning of the stem below the constriction.
- The tip pair of leaves of the affected plants show copper bronze or pale yellow coloration.
- The plants become lean & lanky.
- The easily snap off at the constriction.

Management

1. Strictly avoid spraying copper based fungicides in the nursery.
2. To protect the plants in the nursery from diseases, spray organic fungicides like Captan, Dithane, and Foltaf etc.

12. **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.

Control: - -

- 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.

REFFERANCE: 1) Diseases of PLANTATION CROPS & SPICES

By P. Santha kumari

2) Diseases of HORTICULTURAL CROPS

By Dr. G. Arjunan. Mr. Karthikeyan.

Dr. D. Dinakaran Dr. T. Raguchander

3) WWW. Google.com

CROTALARIA

ETHNIC COMMUNITY OF PURALIA: PLANT: as tonic to pregnant women and to facilitate child birth ; tribes of HAZARIBAGH(Bihar) : Root : In urinary complaints; ORAON : Plant: against snake bite.

Phytography: Creeping herb or sub erect under shrub,30-60cm high; stem and leaves softly haired; leaves subsessile, simple, thin, 5-7.5cm long, obovate to ovate to oblong, stipules forming a broad wing; recemes lateral, leaf opposed,2-3 flowered ; flowers bracteate, yellow,1.25cm, calyx densely silky; pods stalked, 3-4.3 cm long, linear to oblong, 30-40 seeded. Seeds contain Usaramine

Diseases of Crotalaria

Fusarium wilt: *Fusarium udam*

Stem rot : *Sclerotium rolfsii*

Furasium wilt :

External Symptom :

- It is a fungal Disease.
- Lower leaf yellowing and drooping of apical/arial parts
- On mature plants, brown colored streaks appears on the side of the main shoot with few white branches while remaining survive.

Internal Symptom :

- **V**ascular bundle discoloration, later turns to brown to black colour.
- Mycelial strands can be seen in vascular bundles.

Etiology :

- Septate mycelia, intercellular mycelia.
- Asexual spores are Micro and macro conidia, on sporodochium
- Vegetative spores are Chlamedospores (dormant spores)
- Sexual spores are ascospores borne in ascus.

Primary source of inoculum:- Chlamedospores, dormant mycelia in crop debris and soil..

Secondary source of inoculum:- Micro and macro conidia through soil borne and through irrigation of water

Epidemiology:

Soil temperature 25-28^{0}C,

Relative humidity 80-85%

Low soil moisture

Acidic pH 5. 5 to 6.6

Susceptible host

Management :

- Use healthy seeds and treatment with Captan. 3 gm/kg of seed.
- Neutralize the soil pH.
- Affected plant parts should be cut and burn.
- Chemical- carbendazim 0.1% for soil drenching.
- Crop rotation with graminaceous crop like sorghum.
- Biological agent *Trichoderma viride* application after nutralizing the soil P^H

Stem rot: *Sclerotium rolfsii*.

It is a fungal Disease and soil borne organism.

Symptoms:

- Sclerotial bodies are sorghum like structures then they germinate and multiplies by producing mycelia.
- It colonises and girdle the seedling after infection.
- Once the epidermis destroys, the stem become yellow and root length reduces.
- Finally the death of plant.

Etiology: Septate mycelia, sclerotial bodies are vegetative structures.

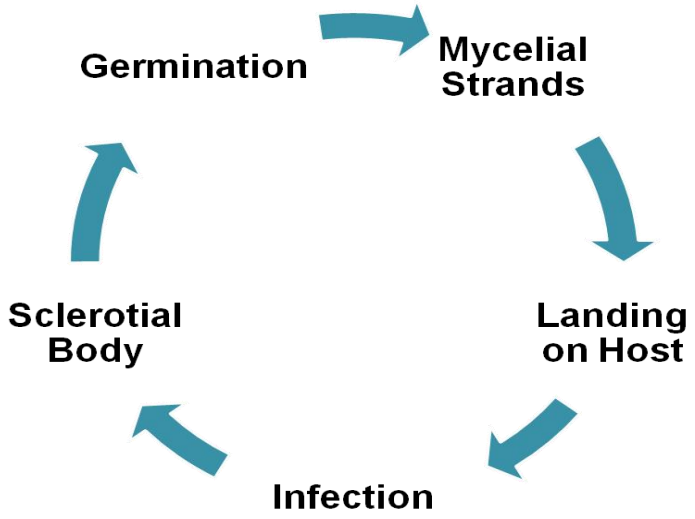
Asxeual spores: mycelial strands act as a conidia

Sexual spores: ascospores borne in Apothecium.

Primary source of inoculum: Sclerotial bodies.

Secondary source of inoculum: Mycelial strands and through irrigation water.

Epidemiology :- Warm weather, soil temperature 30-330C, relative humidity 65-70% Susceptible host. Sandy loam /red soil.



Management :

- Cut and burn affected plant parts.
- In main field provide good drainage to reduce the soil moisture.
- Chemical application soil drenching with Bordeaux mixture 1% or COC 3gm/ltr or metalaxyl 1.5gm/ltr.

- Biological agent *Trichoderma viride*.
- Low density planting and follow raised bed method.
- Drip irrigation.

- Reduces N application and increase K application

DATURA

Botanical name: *Datura metol, Datura stramonium*

Family : Solanaceae

Useful parts: Leaves, flowers and seed

Introduction :

- The species of datura are commonly found *Datura innoxia* is originated from
- Mexico it is 90 to 120cm tall annual shrub resembling to *Datura metol*.
- The plant as dense smooth hair.
- Spined leaves and fruits also with smooth spines.
- The flowers are White to purple, black in colour and therefore the plant is called white and black datura.

List of Fungal diseases

- Wilt of datura ***: Sclerotium rolfsii***
- Root & Foot rot : ***Corticium solani***
- Leaf spot : ***Alternaria tennuissima***

Viral diseases

- Distortion mosaic
- Rugose leaf curl
- Mosaic

Little leaf of datura caused by phytoplasma

1.LEAF SPOT: *Alternaria tennuissima*

Symptoms:

1. Concentric round spot on the leaves.
2. Spot size increases and covers the entire leaves.
3. Blightening of leaves.

Etiology

Septate mycelia, any one of the conidia or conidiophore is colored
Primary sources of inoculum; Dormant mycelia

Secandry. Sources of Inoculum: Air borne conidia

Epidemiology; :

Nutritionally poor soil, temp 28-35 D C, RH 85-90per cent, susceptible host.

Taxonomy:

Kingdome: Fungi

Division: Deuteromycota

Class: Deuteromycetes

Order: Moniliales

Family: Dematiaceae

Genus: Alternaria

species: tennuissima

Management:

- Collect and destroy affected plant parts
- Increased nutritional status
- Reduce plant population
- Biological agent
- Mancozeb 0.25% as foliar spray

2. Mosaic.

Causal organism : Mosaic virus.

Symptoms

- Young growing leaves & inflorescence shows mosaic symptoms.
- Leaves become yellow from the veins.
- Later leaves roll & falls off.

Primary .Sources of Inoculum: Affected planting material.

Secondary .Sources of Inoculum: Viruliferous vector
.

Epidemiology

Sevier in summer due to high insect vector population.

Management:

- Removal of alternate weed hosts, crop residues around main plot.
- Select healthy planting material.
- Application of less N and more K induces disease resistance.
- Spray systemic insecticide, dimethoate 0.2%, imidacloprid 0.05%.

3.Wilt : *Sclerotium rolfsii*

Symptoms;

1. The organism colonize at epidermal layer at collar region of plant, discoloration of collar region, girdling
2. Then the plant start drooping and drying then finally rotting takes place.

ETIOLOGY:

Septate mycelia, sclerotial bodies are vegetative, asexual structures and mycelial strands; sexual spores are ascospores borne on apothecium

Taxonomy:

Kingdome: Fungi

Division: Deuteromycota

Class: Deuteromycetes

Order: Mycelia Sterilia

Family: Mycelia Sterilia

Genus: *Scleotium*

species: *rolfsii*

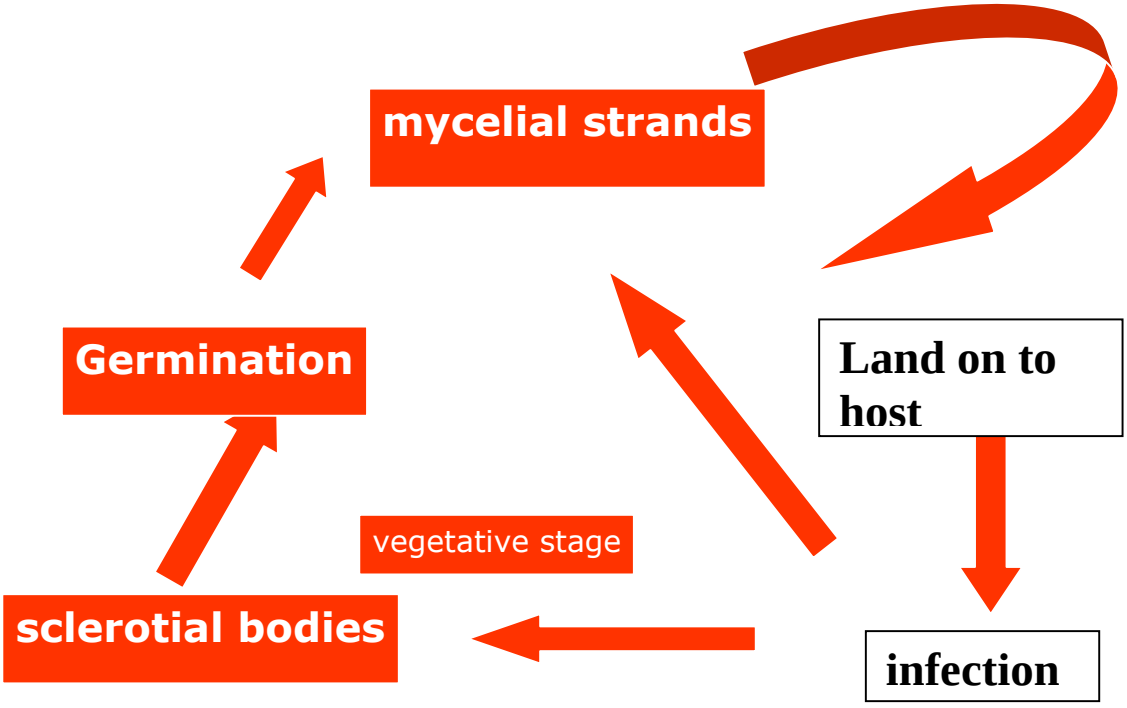
EPIDEMIOLOGY:

Warm weather 30-32oC,RH 70-80%,soil moisture

Primary Sources of Inaculam: Sclerotial bodies present in debris

Secondry Sources of Inaculam: Mycelial strands

LIFE CYCLE



MANAGEMENT:

- Affected debris destruction
- Summer ploughing
- Crop rotation
- Soil sterilization
- Biological agent
- Carbendizim 0.1% or Mancozeb 0.25% as soil drench.

4. Root & Foot rot : ***Corticium solani***

Symptoms.

- On leaves brownish black discoloration. Then completely affected leaves detached from the stem.
- On root it colonizes and rotting of the roots is the final symptom
- It also colonizes and causes foot rot

Aetiology:

Septate mycelia, sclerotial bodies are vegetative stage asexual spore are mycelial strands, sexual spores are besidiospores

Epidemiology:

Cool weather, Temperature 18-22^{o}C,Relative Humidity 75-90%, optimum soil moisture.

Primary Sources of Inaculam: Sclerotial bodies present in debris.

Secondry Sources of Inaculam: Mycelial strands, Basidiospores.

MANAGEMENT:

- Affected debris destruction
- Summer ploughing
- Crop rotation
- Soil sterilization
- Biological agent
- Carbendizim 0.1% or Mancozeb 0.25% as soil drenching.

5. Little leaf Phytoplasma;

Symptoms:

- The leaf size reduction which is a major symptom
- The number of lveases Internodal length decreases.
- Floral parts converted into foliage parts or leaves.
- Stunting of plants. Vector is leaf hoppers

Etiology:

primary sources of inoculum: Infected host with weed plants.
Secondary sources of inoculum: Leaf hopper vectors

Epidemiology:

Suseptable host
Favorable environmental condition

Management:

1. Cultural :

- Early identification and destruction
- Recomended N.P.K application
- Summer months deep plouing
- Chemicals: Dimethoate 0.2% or Imidacloprid 0.05%.

DIOSCOREA

Scientific name: *Dioscorea floribunda*

Family: Dioscoreaceae

Introduction :

Dioscorea is one of the costliest and most important medicinal plant used throughout the world. Because of their antifertility properties, they have gained tremendous importance in the health and family planning programmes of the developing countries.

List of diseases of diascoria

l. Damping off: *Pythium* spp..

2. Leaf spot: *Cercospora dioscoreae.*

3. Leaf fall & die back: *Colletotrichum* sp.

4) Leaf Blight: *Glomerella cingulata*

5) Tuber Rot: *Fusarium* sp., *Rhizoctonia* sp

l. Damping off.

Causal organism : *Pythium* spp,

1. Pre emergent damping off.
2. Post emergent damping off.

Symptoms:

1. Pre emergent damping off.

Tubers or crowns fail to germinate. Rotting of tubers or crowns take place inside the soil.

2. Post emergent damping off. Water soaking lesions on collar region, leading to rotting and damping off. .

Stem size reduction. Toppling over of seedlings & death.

Taxonomy:

Kingdom: Chromista

Division : Oomycota

Class : Oomycetes

Order : : Peronosporales

Family : Pythiaceae

Genius : Pythium.

Etiology:

- Aseptate Mycelia, inter & intracellular haustoria.
- Asexual spores: Zoospores and sporangia
- Sexual Spores: Oospores.

Epidemiology:

- Temperature:18-22◦C.
- RH: 90-95%
- Susceptible host

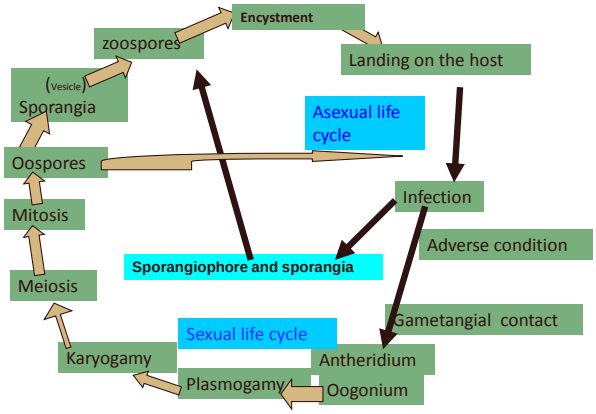
.

- Primary source of inoculums: Oospores and dormant mycelia in debris.
- Secondary source of inoculums: Air born zoospores.

Management:

- Use healthy tubers.
- Follow raised bed method.
- Reduce seedling density.
- Application of biological agents.
- Drench c.o.c 3g/l

LIFE CYCLE OF *Phythium sps.*



LIFE CYCLE OF *Phythium sps.*

2) Leaf spot: Causal organism: *Cercospora dioscoreae.*

Symptoms:

- Numerous irregular angular dark brown to black spots.
- Later the sports move to stem, the spots starts coilasce & blightning take place.
- .Later the leaves fall off.

Taxonomy:

Kingdom: Fungi:

Division: Deuteromycota

Class : Deuteromycetes

Order: Moniliales

Family: Dematiaceae

Genus: Cercospora

Species: dioscoreae.

Etiology:

- Septate mycelia, inter & intra cellular haustoria .
- Asexual spores: Conidia.
- Sexual spores: Ascospores.

- Vegetative structures: Dormant mycelia.

Epidemiology:

- Temp: 30-32^{0}C.
- RH > 90%.
- Susceptible host.

Management:

- Proper nutrient management .
- N-300Kg.
- P-150Kg.
- K-150Kg./ha/yr.
- Crop rotation with non host crop.
- Chemicals:Mancozeb-0.25% as foliar spray

LIFE CYCLE OF LEAF SPOT:

Affected plant parts having Pseudothecium as primary source of inoculums during favourable climate this will produce ascus in that ascospores are present because of lack of pressure inside the ascus they burst open and fly on to air and land on to the host, causes infection and causes leaf spot of diascoria.In the affected host conidia are present, they produces conidiophore and cause infection by flight b asexually.

During adverse climatic conditions the fungi switched on to sexual reproduction where gametangial contact followed by plasmogamy, karyogamy, mitosis and meiosis takes place by this inoculums is reproduced .

3) Leaf fall & die back: Causal organisms: *Colletotrichum sp.*

Symptoms:

- Younger leaves dries up & branches dries from tip downwards.
- In sever cases entire plant may die.

Etiology:

- Septate mycelia, Inter & intracellular haustoria.
- Sexual spores: Ascospores.
- Asexual spores: Conidia

- Primary source of inoculum: Dormant mycelia.
- Secondary source of inoculum: Air & soil borne conidia.

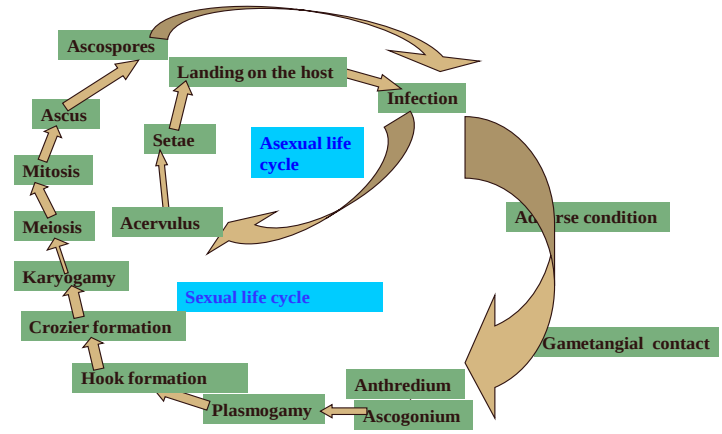
Epidemiology:

- Temp: 30-32^{0}C.
- R h: 90-95%.
- Susceptible host.

Management:

- Use healthy planting material.
- Maintain proper spacing: 60X45 cm.
- Cut & burn the affected portion.
- Chemicals: Carbendazim 0.1% as soil drenching.

LIFE CYCLE OF LEAF FALL& DIE BACK



LIFE CYCLE OF LEAF FALL& DIE BACK

(*Colletotrichum sps)*

4) Leaf Blight: Causal organism : *Glomerella cingulata*

Symptoms:

- Light brown small circular spots on upper surface of leaves.
- Spot size increase &coilage forming reddish brown to black patches.
- Then death of Tissue occurs and Plant dries up.

Aetiology:

- septate mycelia ,
- Sexual spores are ascospores borne in ascus , and the asexual spores are air borne conidia borne in acervulus .
- Epidemiology;
- warm weather fungi, with a temperature range of 28-30^{0}C ,
- relative humidity 80-85%,
- susceptible host.

Management;

Aerial spray of carbendazim 1.5g/l, together with treating the tubers with the same.

5) Tuber Rot: Causal organism: *Fusarium sp.*, *Rhizoctonia sp.*

Fusarium sp.

Symptoms: Complete loss disease. lower leaves show yellowing. Wilting of plant. Vascular discoloration.

Etiology:

- Septate mycelia,
- micro& macro conidia ,as asexual spores borne in sporodochium
- Sexual spores are ascospores borne in perithecium .
- Primary source of inoculum : Chlamydospores, affected tubers.
- Secondary source of inoculum : Micro& macro conidia.

Epidemiology:

- Temperature- 28-32^{0}C.
- RH - 80-85%.
- Acidic pH - 5.5 to 6.0
- Susceptible host.

Taxonomy:K: Fungi: D: Deuteromycota: C: Deuteromycetes: O: Moniliales: F: Tuberculariaceae: G: Fusarium

Management:

Cultural:

- Summer plouging.
- Soil sterilization.
- Affected plant uproot & burn.
- Neutralize the soil PH
- Recommended N:P:K
- Crop rotation.

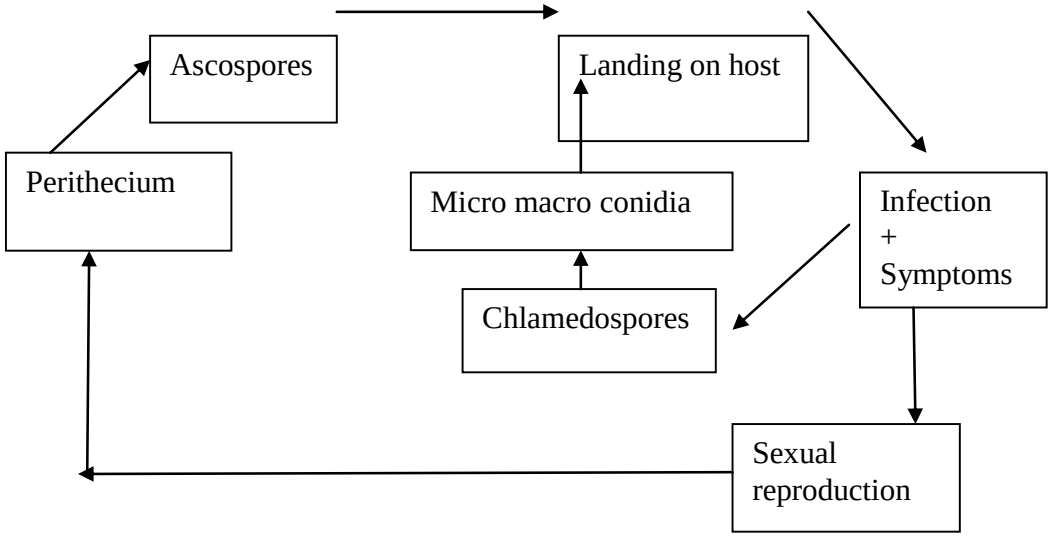
Chemical:

- Carbendazim 0.1% (Soil drenching)

Biological:

- Apply *Trichoderma viridae.*

LIFE CYCLE OF TUBER ROT:



Rhizoctonia sp.

Symptoms:

- Organism colonizes on collar region.
- Rough cankerous growth on collar region.Girdling of stem..
- Aerial part dries & droops.

Etiology:

- Septate mycelia, inter & intra cellular mycelia.
- Asexual spores: Mycelial strands

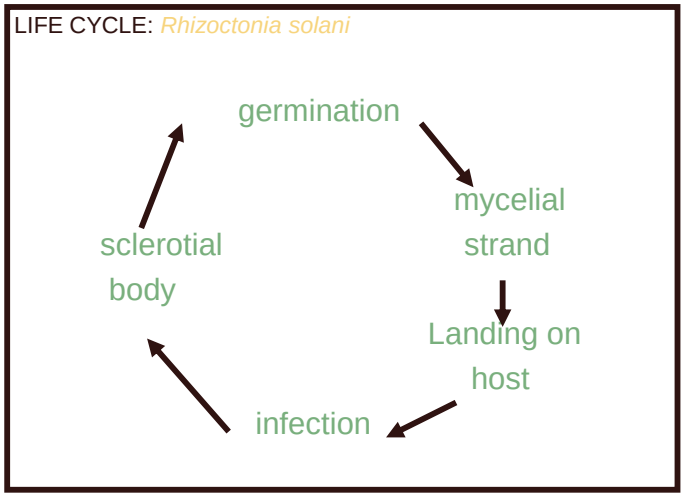
Taxonomy:

Kingdom: Fungi: Division: Deuteromycota: Class:Deuteromycetes: Order: Mycelia Sterilia: Genus: *Rhizoctonia*

Epidemiology:

- Temperature: 28-32^{0}C.
- RH:65-80%
- Susceptible host.
- Primary source of inoculum: Sclerotial bodies.
- Secondary source of inoculum: Mycelial Strands.

LIFE CYCLE: *Rhizoctonia solani*



Management:

- Select healthy plot & planting material.
- Tuber treatment with bavistin2g/Kg of tubers.
- Neutralize the soil Ph.
- Application of biological agents – *Trichoderma* spp.
- Crop rotation with non host crops.
- Drenching with C.O.C.0.3%, carbendazim 0.1%. .

HEMP

Introduction:

It is a tall medicinal annual herb, 1.2-4.8m height with erect angular stem. It is largely cultivated in temperature countries for its strong fibers.

List of diseases of hemp:

1. Leaf spot: *Cercospora cannabina.*

2. Wilt: causal organism: *Fusarium* spp..

3. Phyllody: causal organism: Phytoplasma.

1. Leaf spot*: Cercospora cannabina*

Symptoms:

- On leaves: Characteristic dark brown spots.
- Round to oval an irregular in shape spots enlarge with concentric rings.
- It become necrotic leading to withering & drooping.

Etiology:

- Mycelia: septate. Intercellular mycelia and intracellular haustoria
- Asexual spores: whip like conidia
- Sexual spores: ?
- Primary source of inoculums: Dormant mycelia.
- Secondary source of inoculums: Air born conidia.

Epidemiology:

- Temperature: 28-30^0 c
- Relative humidity: 85-90%
- Cloudy weather.
- Susceptible host.

Management:

Cultural:

- Cut the affected leaves.
- Recommended N:P:K
- Drip irrigation.

Chemical:

- Mancozeb 0.25% or Carbendazim 0.1%.

2. Wilt: causal organism: *Fusarium*spp.

Symptoms:

External: Older leaves yellowing, upward drooping, leaf epinasty.

Internal: Brownish black discoloration, blocking of vasicular bundle.

Etiology:

- Mycelia septate, intercellular and produces intracellular haustoria.
- Asexual spores: micro and macro conidia born in sporodochium.
- Sexual spores: ascospores
- Primary source of inoculums: Chlamydospore
- Secondary source of inoculums: micro and macro conidia.
- Spread: through irrigation water, soil.

Epidemiology:

- Temperature: 28-30^0 c
- Soil: sandy soil.
- Ph: Acidic 5.5-6.5
- Soil moisture: optimum.

Life cycle:

- Perithecium is a sexual fruiting body. It has ascus, when it matures it produces ascospores.These ascospores flight on the air & by chance factor lands on the host.
- It enters the host through natural openings. It starts infection process.
- The host shows wilt symptoms & produces micro and macro conidia & again lands on the host like asexual life cycle continues.
- If conditions are adverse like high or low Temperature, high or low Relative humidity it starts sexual life cycle.
- Plasmogamy, hook formation, crosier formation, karyogamy, meosis, mitosis takes place & produces ascospore. Like sexual life cycle runs.

Management:

Cultural:

- Summer ploughing.
- Soil sterilization.
- Affected plant up root & burn.
- Neutralize the soil PH
- Recommended N:P:K
- Crop rotation.

Chemical:

- Carbendazim 0.1% (Soil drenching)

Biological:

- Apply *Trichoderma viridae.*

3. Phillody: causal organism: Phytoplasma.

Symptoms: Proliferation of floral parts. Adherence of vegetative shoots formed by converted stamen & carpel.

Etiology:

- It is prokaryotes, pleomorphic, obligate parasite, reproduction by binary fusion.
- Primary source of inoculums: Affected plant
- Secondary source of inoculums: vector.
- Spread: Leaf hopper vector

Epidemiology:

- Temperature: 28-32^0 c warm weather.
- Relative humidity: 80-85

Management:

- Initial identification & burn.
- Control vectors.
- Spray lannate 0.2%, Indoxicarb 0.2%, Imidacloprid 0.05% at 15 days interval.

MINT: *Mentha sp*.

Family: Labiatae
Introduction:

It is the primary source of menthol and other constituent are menthon , methyle acetate, terpenes. Mints are aromatic, almost exclusively perennial, rarely annual, herbs. They have wide-spreading underground rhizomes and erect, square,branched stems. The leaves are arranged in opposite pairs, from simple oblong to lanceolate, often downy, and with a serrated margin. Leaf colors range from dark green and gray-green to purple, blue, and sometimes pale yellow. The flowers are produced in clusters ('verticils') on an erect spike, white to purple, the corolla two-lipped with four subequal lobes, the upper lobe usually the largest. The fruit is a small, dry capsule containing one to four seeds.

LIST OF DISEASES OF MINT.

1. PODERY MILDEW: *Erysiphe cichoracearum*

2. **WILT**: *Verticillium albo-atrum*

3. **RUST**: *Puccinia menthae*

4. **LEAF SPOT** :*Curvularia lunata*

5. **LEAF BLIGHT**: *Alternaria* spp

6. **STOLON ROT**: *Rhizoctonia bataticola*

1) **POWDERY MILDEW**: C.O: *Erysiphe cichoracearum*

Symptoms:

- Small chloratic spots appear on the upper surface of leaves.
- The corresponding lower surface showing brownish discolouration prior to the appearance of powdery patches.
- Later appearance of white /grey colour powdery growth on both upper &lower surface of leaves It leads to heavy defoliation

TAXONOMY

K:Fungi

D: Ascomycota

C: Ascomycetes

O: Erysiphales

F: Erysiphaceae

G: Erysiphe

SP: cichoracearum

Etiology:

- External septate mycelia, Haustoria sub epidermal. Septate mycelia produces conidiophore on which barrel shaped conidia are borne in chains
- Asexual spores : Barrel shaped conidia borne on Oidium.
- Sexual spores : Ascospores borne in Ascus. Asci are situated in Cleistothecium

Asexual fruiting body: Oidium

Sexual fruiting body: Cleistothecium.

- **Primary Sources of Inoculum**: Dormant mycelia and Short period cleistothecium.
- **Secondary Sources of Inoculum:** Air borne barrel shaped conidia.

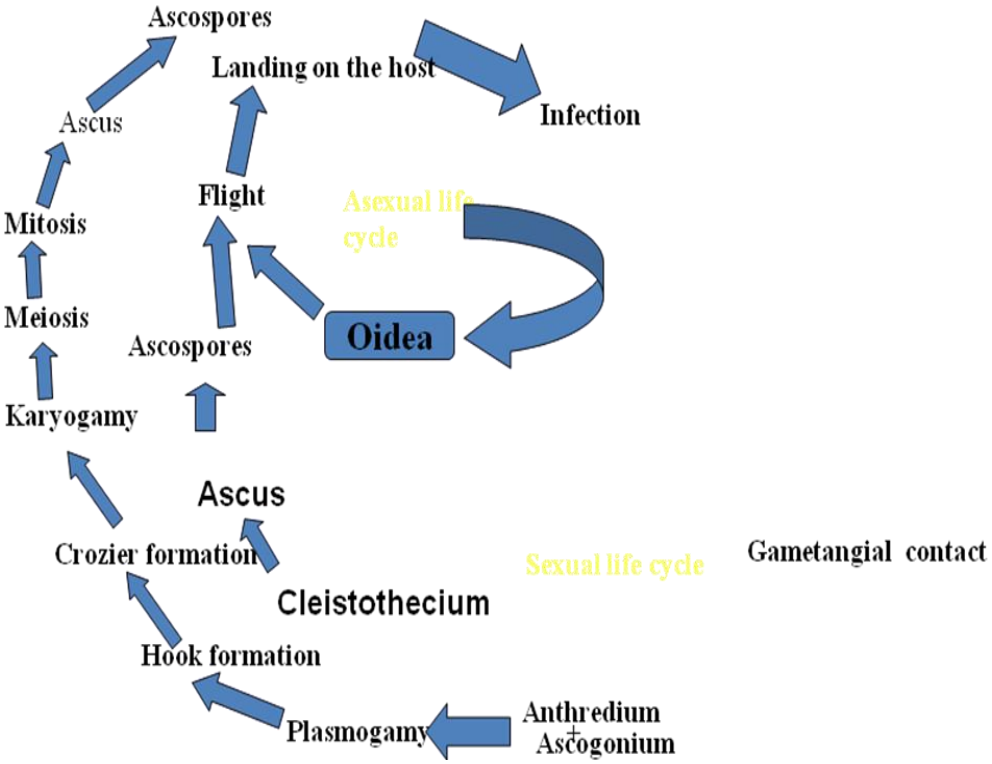
Epidemiology:

- Warm weather:
- Temp: 28-32°C.
- R.H: 85-86%.

- Cloudy weather.
- Susceptible Host

Life cycle of powdery mildew life cycle

- Affected plant parts having cliestothium as primary source of inoculum during favourable climate this will produce ascus in that ascospores are present because of lack of pressure inside the ascus they burst open and fly on to air and land on to the host, causes infection and causes powdery mildew of mint.
- In the affected host conidia are present , they produces oidium and cause infection by flight asexually.
- During adverse climatic conditions the fungi switched on to sexual reproduction where gametangial contact followed by plasmogamy, karyogamy, mitosis and meiosis takes place by this inoculum is reproduced .



Management:

- Crop rotation with non host crops
- Altering the date of sowing
- Proper nutrient management.
- Avoid dense planting.

Chemical :

- Prophylactic aerial spray- Wettable Sulphur 0.3% or Carbendazim 0.1% or Calyxin 0.15% at 10-15 days interval

2) **Rust**: *Puccinia menthae*

Symptom:

- Brown rusty pustules on the lower surface of leave.
- The spots initially circular ,slightly elevated and later Coalesce to form irregular spots.
- Chloratic streaks on the upper surface, telial stage is characterized by swelling on the upper portion of the stem.
- Defoliation and death of the leaves can be seen in severely affected plants (Leaf blighting)

Taxonomy:

Kingdom: Fungi

Division: Basidiomycota

Class: Basidiomycetes

Order: Uredinales

Family: Pucciniaceae

Genus:*Puccinia*

Species:menthae

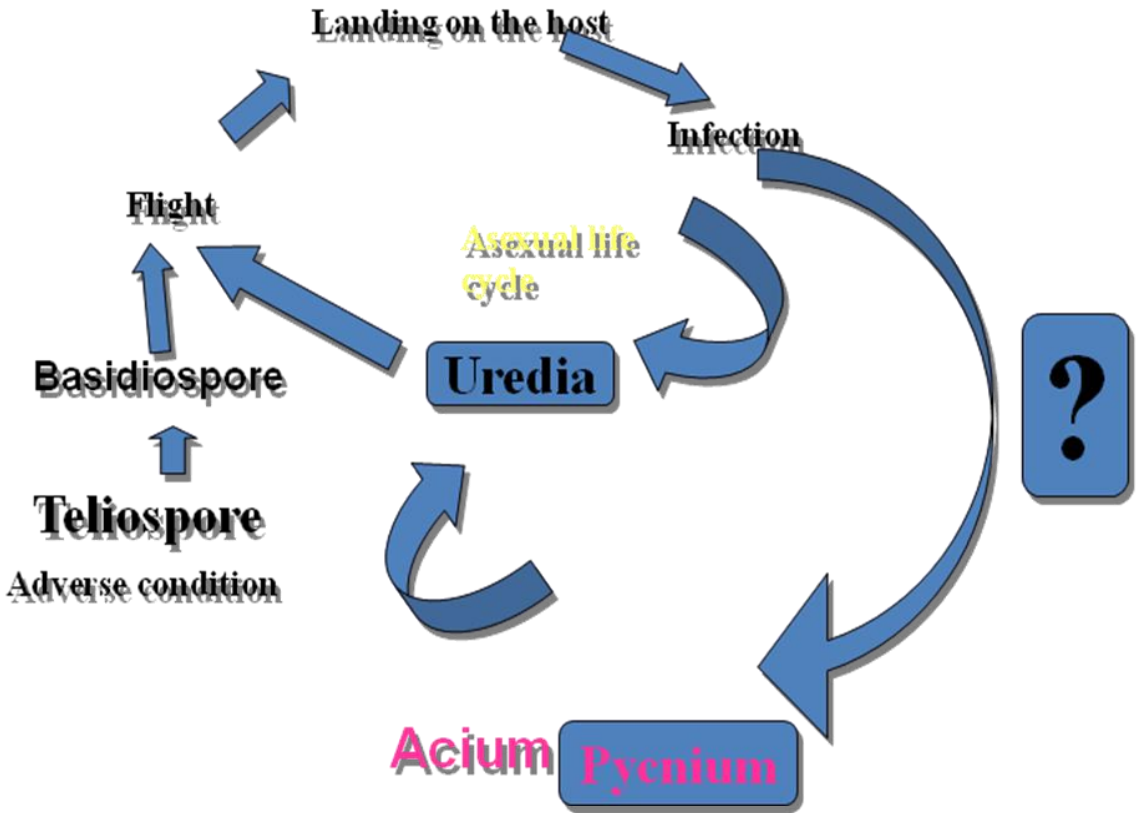
Epidemiology:

- Temperature 17-27^{o}C
- RH:90-92%
- Long day hours 1-2 hours dew period in morning

Etiology:

- Septate mycelia, Intercellular mycelia Intracellular haustoria
- Asexual Spores: Uredospores in Uredium
- Sexual spores: Teliospores in Telium

Life cycle of *Puccinia menthae*



Management:

- Crop rotation with non host crop.
- Spray mancozeb 0.25%.
- Hexaconazol 0.1%

3)**LEAF SPOT** : *Curvularia lunata*

SYMTOMS:

Small unclear brown spots scattered over the leaf lamina.

The minute spot increase in size, forming big spherical or irregular patches.

Severe in neglected crops

EPIDEMIOLOGY:

- Nutritionally poor soil,
- Temp 28-32^{o} C,
- RH 85-90per cent,
- Cloudy weather
- Susceptible host.
- Primary Sources of Inoculum : Dormant mycelia
- Secondary Sources of Inoculum : Air borne conidia

ETIOLOGY:

- Septate mycelia, inter and intracellular haustoria. any one of the conidia or conidiophore is coloured
- Asexual spores-Air borne conidia on conidiophore,
- sexual spores- Ascospores
- vegetative structure is dormant mycelia.

Life cycle

- Affected plant parts having Pseudothecium as primary source of inoculum.

- Favourable climate it will release ascospores they flight on to air and land on to the host, causes infection and causes leaf spot of senna.
- In the affected host conidia are present , they produces conidiophore and cause infection by flight b asexually.
- During adverse climatic conditions the fungi switched on to sexual reproduction where gametangial contact followed by plasmogamy, karyogamy, mitosis and meiosis takes place by this inoculum is reproduced

MANAGEMENT:

- Collect and destroy affected plant parts
- Increased nutritional status
- Reduce plant population
- Biological agent *Trichoderma* spp.
- Mancozeb 0.25% as aerial spray

4) **LEAF BLIGHT**: *Alternaria alternata*

SYMPTOMS:

- Lower most leaves first infected &disease later develop on upper leaves.
- The infected leaves shows round to oval to irregular or slightly irregular dark brown spots on the upper surface of the leaves with concentric rings.
- Spot size increases and covers the entire leaves Later Blightening & detaching of leaves

ETIOLOGY:

- Septate mycelia, coloured muricate conidia

EPIDEMIOLOGY:

- Nutritionally poor soil, temp 28-32^{o}C, RH 85-90per cent, susceptible host.
- Primary Sources of Inoculum : Dormant mycelia
- Secondary Sources of Inoculum : Air borne conidia

TAXONOMY:

Kingdom: Fungi

Division: Deuteromycota

Class: Deuteromycetes

Order: Moniliales

Family: Dematiaceae

Genus*: Alternaria*

Species: alternata

MANAGEMENT:

- Collect and destroy affected plant parts
- Proper nutritional management.
- Reduce plant population
- Mancozeb 0.25% as aerial spray

5) **Stolon Rot**: C.O: *Rhizoctonia bataticola & Sclerotium rolfsii*

Symtoms

Aerial symptoms:

- Initially yellowing of leaves & stunted growth. advance stages the plants wilts followed by death of above ground parts.

Below ground symtoms:

- Stolons exhibit pinkish brown lesions initially. Which gradually turns into dark brown lesions.
- Later turns to dark brown to black patches that increase in size resulting in soft decay.

Etiology:

- Septate mycelia, sub epidermal haustoria
- Asexual spores: Mycelial strands
- Sexual spores: Basidium (Basidiospores)
- Vegetative structure: Sclerotial bodies

EPIDEMIOLOGY:

- Warm weather, soil temp 28-32^{o}C. Optimum moisture, neutral pH
- Primary Sources of Inoculum : Sclerotial bodies present in the debris
- Secondary Sources of Inoculum : Soil borne mycelial strands

TAXONOMY:

Kingdom: Fungi

Division: Deuteromycota

Class: Deuteromycetes

Order: Mycelia sterilia

Family: Mycelia sterilia

Genus*: Rhizoctonia*
Species: bataticola

LIFE CYCLE:

- The fungi produces sclerotial bodies these are like sorghum seed like vegetative structures.

- When there are congenial conditions the sclerotial bodies germinate and causes disease the affected host having mycelial strands again they germinate and cause infection that how disease cycle continues.

MANAGEMENT:

- Affected debris destruction
- Summer ploughing
- Crop rotation
- Soil sterilization
- Biological agent *Tricoderma* spp.
- Carbendizim 0.1% or Mancozeb 0.25% as soil drenching.

6) **WILT**: *Verticilium albo-atrum*

Complete loss disease

Symptoms :

Aerial symptoms:

Initially lower leaves starts V shape yellowing. Dwarfing unilateral development of the branches. Etiolating of leaves leading to wilting death.

Internal symtoms:

Light tan colour discolouration of vascular bundles.

Etiology: Septate mycelia inter and intra-cellular haustoria ,produces V shaped conidiophore on which round shaped small conidia are borne

Vegetative structures: Sclerotial bodies

Sexual spores: Ascospore

Asexual spore: Micro and macro conidia

Primary Sources of Inoculum : Dormant mycelia

Secondary Sources of Inoculum : Soil and air borne micro and macro- conidia

Epidemiology:

Temp. 30-32^{o}c, RH-90-92%, alkaline pH, Black Clay soil, low moisture, susceptible host

LIFE CYCLE OF WILT

- Perithecium is a sexual fruiting body.
- It has ascus, when it matures it produces ascospores.
- These ascospores flight on the air and chance factor lands on the host.
- It enters the host through natural openings.
- The host shows wilt symptoms & produces micro and macro conidia & again lands on the host like asexual life cycle continues.
- If conditions are adverse like high or low Temperature, high or low Relative humidity it starts sexual life cycle.

Management:

- Collect and burn affected plant parts.
- Use soils free from nematode.
- Crop rotation with non host crops.

Application of biological agents *Trichoderma* spp.

Soil drenching with carbendazim 0.1%

NEEM: *Azadirachta indica*

FAMILY: Meliaceae

INTRODUCTION:

Neem is one of the most valuable and the least exploited of tropical trees. It is commonly know as neem tree. Every part of the tree from its roots, trunk, bark, leaves, flowers, fruits , seeds, sap, and gum are known to have some use and have a place in the traditional folklore and medicine.

LISTS OF DISEASES:

Fungal diseases:

1) POWDERY MILDEW: *Oidium azadiractae (Erysiphae)*

2) Root rot: *Ganoderma lucidum*

3) Leaf web blight: *Rhizoctonia solani*

4) Leaf spot: *Pseudocercospora subsessilis*

Bacterial diseases:

1) Bacterial wilt: *Pseudomonas azadiractae*

2) Angular leaf spot: *Xanthomonas azadiractae*

1) POWDERY MILDEW: - *Oidium azadiractae (Erysiphae)*

Symptoms:

- Grayish powdery growth on the upper surface of the leaves and the powdery growth seen on young leaves.
- Leaves wrinkle and defoliate.
- On older mature leaves necrotic patches. Powdery growth on twigs, flower and on fruits also in severe conditions
- Fruit dropping is the common symptom. Powdery growth reduces the photosynthetic area, thus reduces the growth and yield drastically

Etiology:

- Septate mycelia, Sub epidermal haustoria.
- Asexual fruiting body: Oidium
- Sexual fruiting body: Cleistothecium
- Primary Sources of Inoculums: Dormant mycelia, Cleistothecium.
- Secondary Sources of Inoculums: Air borne conidia (barrel shaped)
- Survival: Pathogen in the affected debris

Epidemiology:

- warm weather
- Temp. - 28-32°C.
- R.H: 80-85%.
- Cloudy weather.
- Susceptible Host.

Management:

- Avoid dense planting
- Proper nutrient management (higher K application)
- Crop rotation with non host crops

Chemical : Prophylactic spray 3-4 times with wettable sulphur 0.3% or carbendazim 0.1% or calixin 0.15% at 10-15 days interval (aerial spray)

LIFE CYCLE OF POWDERY MILDEW

- Affected plant parts having cliestothium as primary source of inoculum.
- favourable climate, ascospores released from cleistothecium.
- Ascospores fly and land on to the host surface.
- causes infection by producing subepidermal haustoris and the induces powdery mildew symptom.

- Powdery growth comprising of oidia.
- Oidia releases barrel shaped conidia after maturity and the asexual life cycle continues
- During adverse climatic conditions the fungi switched on to sexual reproduction where gametangial contact followed by plasmogamy, karyogamy, meiosis and produces ascospores, ascus in cleistothecium.

2) Root rot: *Ganoderma lucidum*

Symptoms:

- Lower leaves yellowing and gradually yellow progresses upward and drooping of branches take place.
- Later leaves bent or fall down**.**
- On stem : longitudinal cracking and through this crack gummy oozing Basidiocarp (mushroom like) formation. Root rotting after the death of the tree.

Etiology:

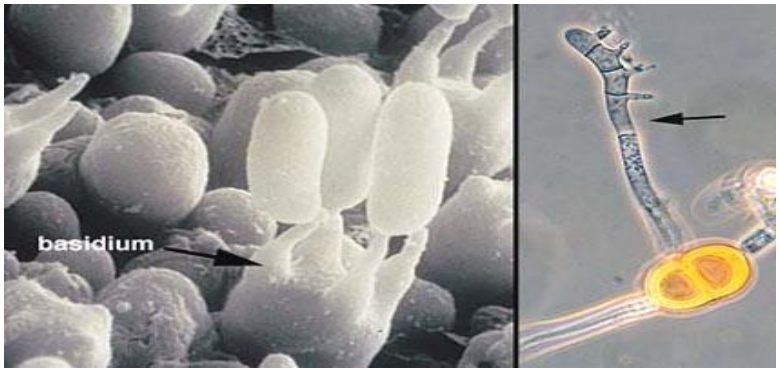
Septate mycelia, Inter and intra cellular Haustoria

Primary Sources of Inoculums: Basidiospores, Chlamydospores (survival)

Secondary Sources of Inoculums: Dormant mycelia (present in wounded exposed roots)

Epidemiology:

- Warm weather
- Temp. - 30-32°C
- R.H - 80 - 90%.
- Ph - Slightly alkaline
- Susceptible Host
- Root to root contact
- HDP



Management:

- Maintain Proper plant density
- Application of clay soil
- Summer irrigation
- Root feeding with Calixin @ 20 ml/100 ml of water
- Remove and burn severely affected plants
- Apply *Trichoderma* spp. to the soil

3) Leaf web blight: *Rhizoctonia solani*

Symptoms:

Water soaked lesions on the leaf, stem and twigs. Affected leaves are blighted. Mycelial growth and dark brown sclerotia are seen on affected parts

Etiology:

Mycelia spate, binucleate, branched at right angle Club or ovate basidium Basidiospores produced on sterigmata. Septa at the base of origin of branches

Asexual spores - Mycelial strands (act as Conidia, air borne)
Sexual spores - Absent (Unknown), sometime basidiospores
Vegetative structures - Sclerotial bodies (Survival)

Primary Sources of Inoculums - Sclerotia (resting structure)
Secondary Sources of Inoculums - Mycelial strands (air or water borne)

Taxonomy:

Kingdom: Fungi.Division: Deuteromycota:
Class: Deuteromycetes
Order: Mycelia Sterile: Genus: *Rhizoctonia*: Species: *solani*

Epidemiology:

- Temperature: 28-320C
- RH: 65-80%
- Susceptible host

Management:

- Field sanitation
- Seed treatment with Bavistin @ 1.5 ml/lit.
- Summer ploughing

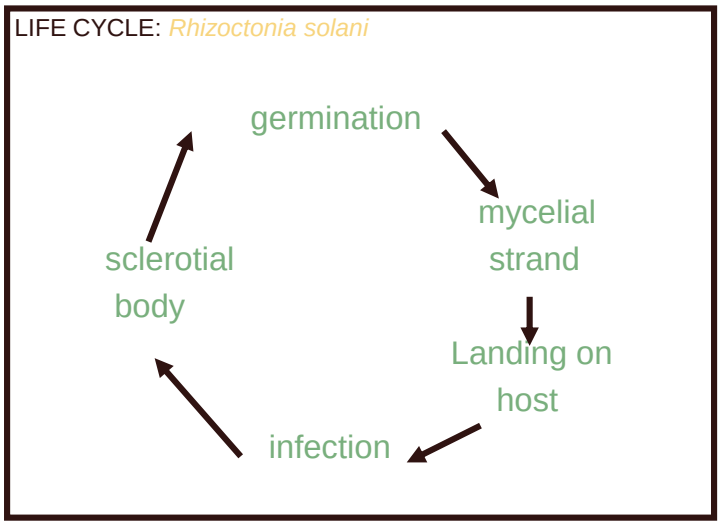
- Crop rotation with non host crop
- Biological agent –*Trichoderma* spp.
- Neutralize the soil pH
- Soil drenching with COC 0.3%.

LIFE CYCLE:

It is a Duteromycetes fungi produces sclerotial bodies these are sorghum seed like Vegetative and resting structures.

Congenial conitions sclerotial bodies germinate and produce mycelial strands.

Mycelial strands act as conidia and causes disease.



4) Leaf spot: C.O: *Pseudocercospora subsessilis*

Symptoms:

- The leaf spots are first noted on older, fully expanded leaves as brown,subcircular to irregular lesions with a dark brown border.
- Upon enlargement, leaf spots coalesce to form large, dark-brown necrotic areas ultimately followed by abscission of the leaves.

Etiology:

- Septate mycelia, inter and intracellular haustoria.
- Primary Sources of Inoculums: Dorment mycelia (affected debries), Ascospores
- Secondary Sources of Inoculums: Air born conidia
- Asexual spores – Conidia (air borne)
- Sexual spores - Ascospores
- Vegetative structure: Mycelial strands

Epidemiology:

- warm weather,
- Temp.: 28-32°C.
- R.H: 85-90%.
- Susceptible Host

A) Upper leaf surfaces *B) corresponding lower leaf* surface

LIFE CYCLE OF LEAF SPOT:

- Affected plant parts having Pseudothecium as primary source of inoculum during favourable climate this will produce ascus in that ascospores are present because of lack of pressure inside the ascus they burst open and fly on to air and land on to the host, causes infection and causes leaf spot of neem .
- In the affected host conidia are present , they produces conidiophore and cause infection by flight b asexually.
- During adverse climatic conditions the fungi switched on to sexual reproduction where gametangial contact followed by plasmogamy, karyogamy, mitosis and meiosis takes place by this inoculum is reproduced .

Management:

- Removal of alternative weed hosts, crop residues around main plot.
- Select healthy planting material.
- Application of less N & more K induces disease resistance.
- Spray systemic insecticide – dimethoate 0.2% or imidacloprid 0.0%..

Bacterial diseases:

1) Bacterial wilt: *Pseudomonas azadiractae*

Symptoms:

- The bacteria multiply rapidly inside the water conducting tissue of the plant.
- The results in rapid wilt of plant, while the leaves stay green.
- If an infected stem is cut crosswise, it will look brown and tiny drops of yellowish ooze may be visible. In severe cases, falling of leaves takes place.

Etiology:

- Gram –ve bacteria, rod shape, white/yellow colonies, non spore forming, facultative saprophyte, lophotrichous
- Primary Sources of Inoculums: Affected plant debris
- Secondary Sources of Inoculums : Soil and water borne bacterial cells
- Entry: Through wounds

Epidemiology:

- Severe in Sep-Oct
- Temp - 28-320C
- RELATIVE HUMIDITY - 90%
- Neutral pH
- Susceptible host

Management:

- Use healthy planting material and disease free area
- Cut and burn the affected portion
- Regular Pruning reduces the disease
- Maintain NP and increase K application
- Drip irrigation avoids spread of the pathogen
- Chemical: COC 0.3% and Streptocycline 0.05%

2) Angular leaf spot: *Xanthomonas azadiractae*

Symptoms:

- Initially water soaked angular spots on the leaf, later it turns into pale yellow colour oily appearance.
- Later death of the cell takes place. Blightening and dry of leaf and defoliation

Etiology:

- Microscopic, unicellular, binary fusion, monotrichous,
- Motile, Gram –ve, rod shape,
- Primary Sources of Inoculums: Affected plant debris (corky area of the leaves)

Secondary Sources of Inoculums: Rain splash and air borne (spread), bacterial cells

- Entry: through stomata

Management:

- Use healthy planting material and disease free area
- Cut and burn
- Pruning
- Maintain NP and increase K application
- Drip irrigation

- Chemical: COC 0.3% and Streptocycline 0.05%

OPIUM

Papaver somniferum ***L.***

(2n=22)

Uses and importance:

Opium *(Papaver somniferum)* commonly called opium poppy, is an annual herb belonging to the family papavaraceae.

- It grows up to a height of 60-120 cm.
- It is an important medicinal plant.
- The source of over 40 alkaloids including psychoactive agents.
- A great boon to psychiatry for the treatment of mental and nervous diseases and to medical research.
- The commercial product *opium* is an additive narcotic obtained from the seed capsule of the opium poppy, the source of a number of very valuable alkaloids like morphine, codeine, narcotine, papaverine and thebain.
- Other minor alkaloids include aporeine, codamine, cryptopine, guoscpopine, hydrocotarinine, laudanine, narcotoline, neopine, oxynarcotine and papaveramine.
- The seeds are also reported to contain a high % of linoleic acid which lowers blood cholesterol in the human system. The alkaloids, morphine and codeine, are widely used as sedatives to relieve pain and induce sleep, in addition to their use against cough.
- Opium is a very valuable but dangerous drug.

- It should be used in very limited quantities and under the strict supervision of o physician.
- In India, this plant is mainly cultivated for its latex and seeds come as a by product.
- These seeds are quite a rich source of fatty oil and protein and, in many countries of Europe, employed as a major source of cooking oil.
- The seed is also an important culinary item in India.
- It is extremely used in the preparation of native confectionery, pastries and bread. In some places, the young plants are also consumed as a leafy vegetable.
- This is one medicinal plant which is very lucrative.
- A crop raised properly, in one hectare area, fetches about 1 lakh rupees. But its cultivation has to be done under the strict control of the central excise department and it cannot be cultivated everywhere.
- It can be grown only in those areas specified by the government of India.

DISEASES:

Major disease

- Downy mildew – *Peronospora arborescens*

Minor diseases

Fungal diseases

- Damping off – *Pythium dissotocum*
- Root rot – *Macrophomina phaseolina or Fusarium semitectum*
- Powdery mildew – *Erysiphe polygoni*
- Capsule rot – *Embellisia phragamospora*
- Leaf blight –*Helminthosporium papaveris*

Virus diseases

- Poppy mosaic virus
- Cabbage-ring spot
- Beet-yellow
- Bean yellow mosaic

Bacterial diseases

- Soft rot – *Erwinia papaveris*

Major diseases:

Downy mildew -*Peronospora arborescens*(Berk.) de Bary.

SYMPTOMS:

- In India it is noticed during a middle of February,When the crop is fully grown.
- It is also noticed during November-February.It appears on seedling and such affected seedling s are killed out right.
- The leaves near the tips and margins are covered with pale brown spots.
- On the under surface grey-violet fungal growth is seen.
- Under favorable conditions the disease spreads and affected leaves dry up and become papery and brittle.
- In severe cases of attack entire leaf is killed. Infection may spread to inflorescence and stem also. Yield loss from 7-65%.

ETIOLOGY

- Mycelia- Aseptate
- Asexual spores – Barrel shape conidia borne on sporangiophore in asexual fruiting body sporangia
- Sexual spore- Oospores borne in oogonium
- Sporangiophores are erect and very long. They are 7-10 times dichotomously branched and the ultimate branches are fine, curved, sharp, diverging almost at right angles, pointed at the tip.
- At the tip bears a single round –oval conidium .Sporangia are hyaline or pale violet.
- Oospores are round yellow, thick walled surrounded by an irregularly thick and reddish brown wall

MODE OF SPEAD AND SURVIVAL:

Primary source of inoculum: Oospores, affected debris.

Secondary source of inoculum: Zoospores spread through wind, water splash

The fungus infects *Argemone mexicona, A. platyceras Meconosis sp. Papaver dubium, P. argimone* and *P. rhoeas*.

The disease is carried from one season to another by means of thick walled oospores. It is not seed borne. Mycelia fragments on capsule may serve as source of infection

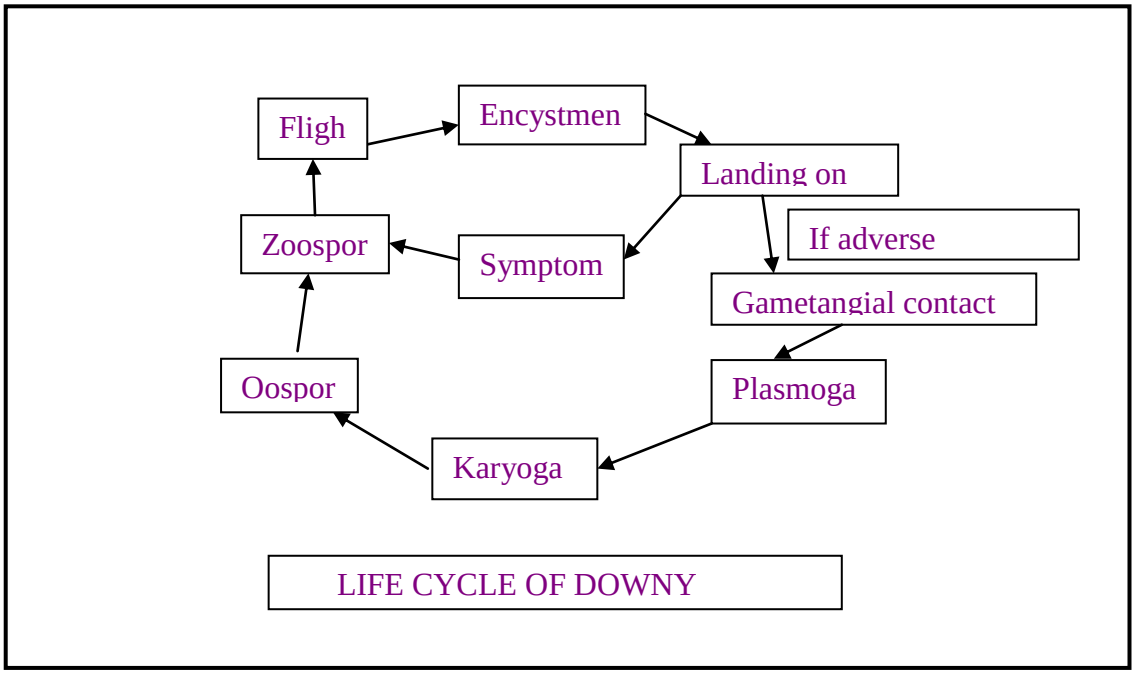
EPIDEMIOLOGY:

- Temperature 22-24^{0}C
- Relative humidity- 90-95%
- Intermittent rain fall
- Susceptible host.

MANAGEMENT:

- All disease plant should be uprooted, collected and destroyed.
- Seed treatment with apron 35SD (metalaxyl) at 5g/kg +3 sprays of metalaxyl (ridomyl 25WP) 0.1% at 20, 60 and 80days of sowing.
- Foliar spraying with mancozeb 0.25% also controls the disease.
- The poppy line Vo.141 is found to be highly resistant to the disease.

LIFECYCLE:



Minor diseases:

Damping Off-

This disease was reported in India from Lucknow during the incidence ranged from 40-60%.

SYMPTOMS:

- Pre-emergence& post-emergence damping off occurs in opium. Severely affected seedlings show decay of root and collar region.
- Diseased seedlings die in 3-5days after attack.
- Mycelium of fungus is white and coenocytic, sporangia are filamentous, slightly inflated with discharged tubes.
- Oogonia may be terminal or intercalary, spherical and 19-24 micrometer in diameter. Antheridia 1-3 micrometer
- Oospores are single, plerotic, 17-20micro meter in size with 1.3micrometer thick walls.

ETIOLOGY: ***Pythium dissotocum*** **Drechsle.**

Mycelia: Aseptate, Asexual spore- Zoospore, Sexual spore- Oospores borne in oogonium

MODE OF SPREAD AND SURVIVAL:

Primary source of inoculum : Oospores, affected debries.

Secondary source of inoculum: Zoospores

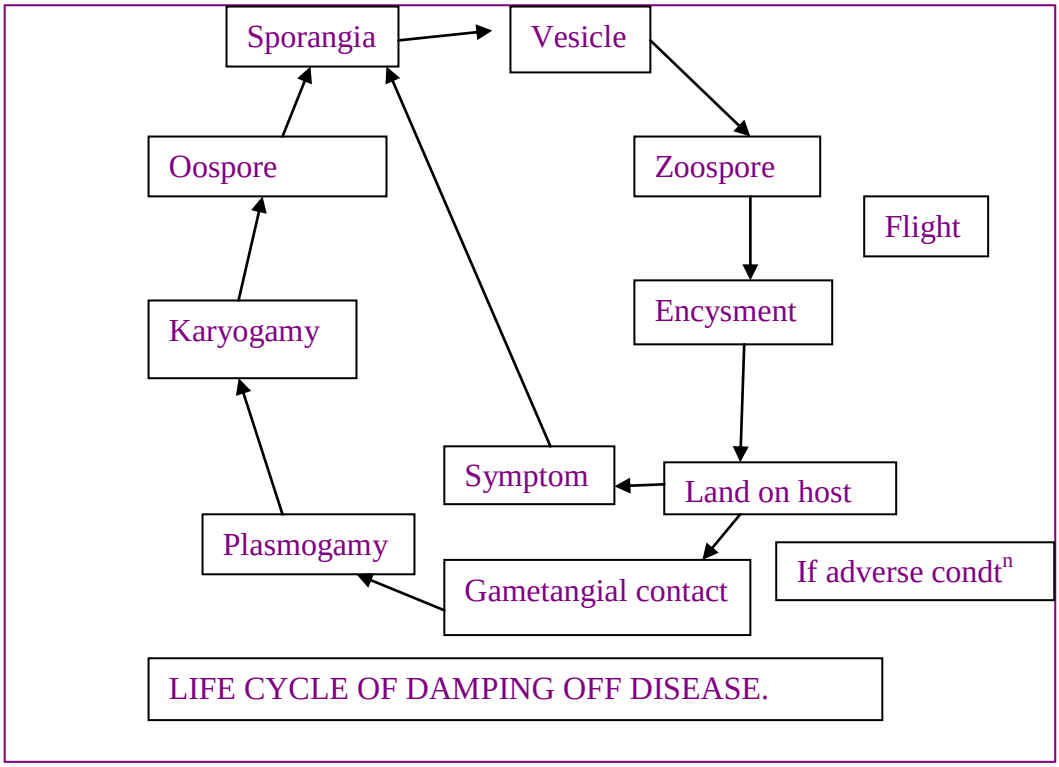
EPIDEMIOLOGY:

- Temparature: 22-24^{o}C
- High relative humidity: 90%,
- High density seedlings
- Low lying areas
- Increased moisture-80-90%
- Susceptible host.

MANAGEMENT:

- Raised methods for sowing, Line sowing with proper spacing,
- Soil sterilization with 4% formaldehyde upto depth of 30cm,
- Seed treatment with captan -2g /kg or Mancozeb-2g /kg of seeds

LIFECYCLE:



Root Rot - *Macrophomina phaseolina* (Tassi) Goid.

It is prevalent in parts of Bihar and U.P.

SYMPTOM:

Affected plant begins to wither and dry up from the base. The stem at the collar region shows blackening and shredding of root barks. The affected plants dry up; the disease is noticed in patches. Large number of minute and black sclerotia can be seen on affected root barks.

MODE OF SPEAD AND SURVIVAL:

Primary source of inoculum : sclerotial bodies

Secondary source of inoculum: Mycelia

ETIOLOGY:

- Mycelia- septate
- Asexual spores: Absent
- Sexual spores : Basidiospores
- Vegetative structures: Sclerotial bodies

- Fungus hyphae are colorless, branched and 8-9micrometer in diameter later they become brown.
- Sclerotia are black and measures 150 micro meter in diameter.

MANAGEMENT:

- Seed treatment with carbendazim 2 g/kg and provision of proper drainage facilities are the important control methods.

Powdery Mildew- ***Erysiphe polygoni*** DC.

Introduction

Powdery mildew is an endemic disease wherever the opium are grown in the world. The disease has been reported from the American continent, Europe, Africa, Australia and Asia.In India, the disease is most common in North India.

Symptoms:

- The fungus attacks all the green plant parts at all stages of plant growth.
- The fungus produces white to grayish powdery patches on the affected plant parts including fruits but young leaves are most susceptible and develop small whitish patches both on upper as well as lower surface.
- These patches grow in size and coalesce to cover large areas on the leaf lamina. Malformation and discoloration of the affected leaves are also common symptom, resulting in distortion.
- Similarly, powdery patches are produced on the stem, tendril, flowers and young fruit branches.
- Diseased vines appear wilted and the stem portion turns brown.
- The infected blossom and berries turn dark in colour, irregular in shape and brittle.
- In advance stage of infection, berries may develop cracks and such berries do not develop and ripe.

ETIOLOGY: *Erysiphe polygoni*

- Mycelia is septate, external thin mycelia, haustoria is sub epidermal, obligate parasite.
- Asexual spores are barrel shape conidia borne on oidiophore in chains asexual fruiting body oidia.
- Sexual spores are ascospores inside the Ascus in the ascocarp Cleistothecium.

MODE OF SPREAD AND SURVIVAL:

Primary source of inoculum : Ascospores, Dormant mycelia.

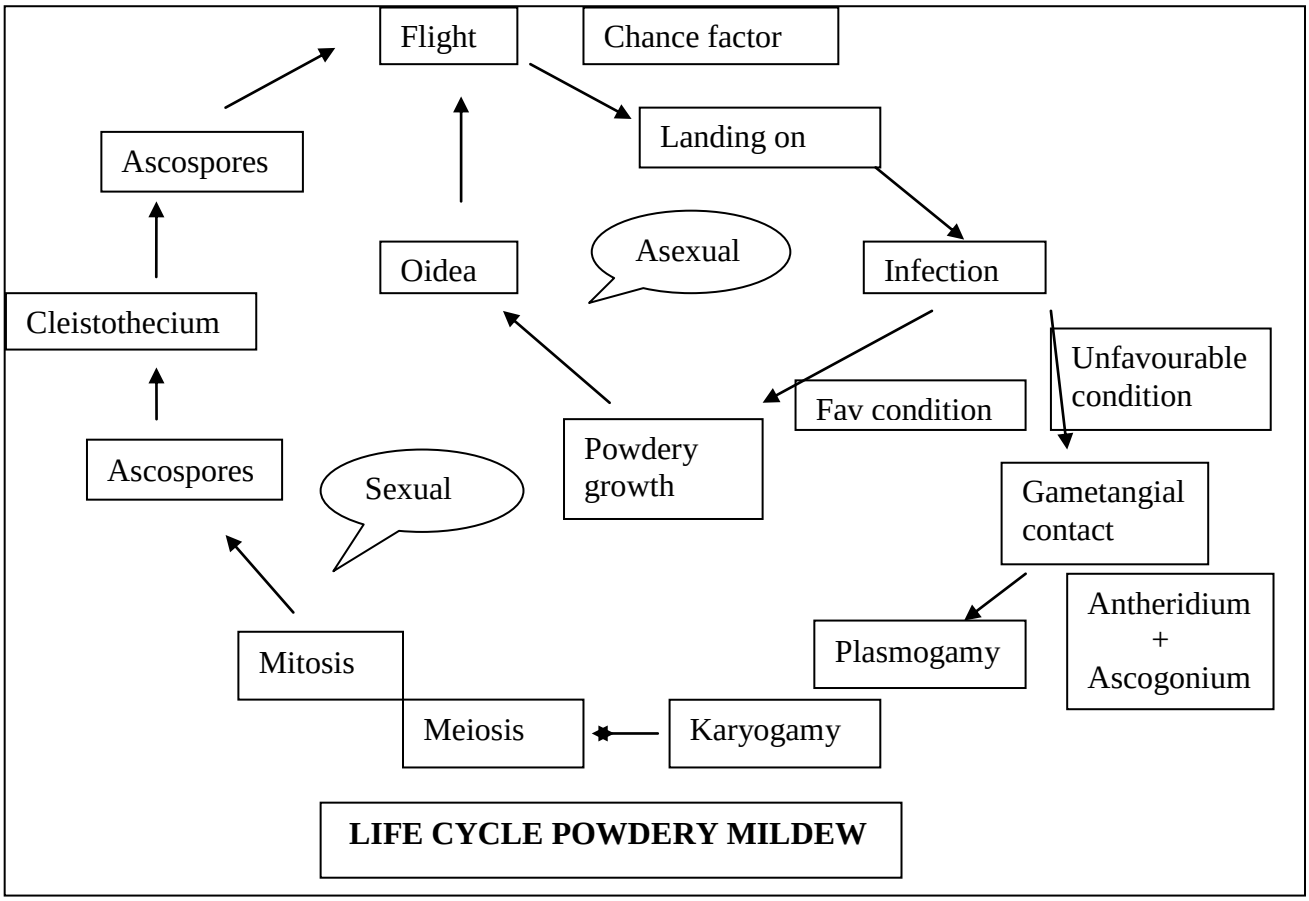
Secondary source of inoculum: oidia

- It survives as dormant mycelia and as Cleistothecia on the shoots and buds from season to season.
- The disease spreads by the air- borne conidia.

EPIDEMIOLOGY:

- The disease occurs in severe from Oct- Nov in North India and Feb- June in South India.
- Disease is favoured by warm sultry weather and retarded by sunshine.
- Warm winter temperature from 20 to 33.50C has been found to be the cause for epidemic in Hyderabad.
- Disease development is adversely affected by rain.

LIFECYCLE:



LIFE CYCLE POWDERY MILDEW

MANAGEMENT:

I. **Cultural practices** :

- The proper air circulation through the canopy and prevent excess shading help in reducing the disease.
- Orchard sanitation is also important in reducing the disease pressure during the growing season.

II. **Chemical control** :

- Fungicides like sulphur, dinocap, benomyl, are used commercially although not as extensively as sulphur, to control the disease.
- The use of fungicides for control of powdery mildew should begin during early stages of development. Spray schedules of 7-10 days are usually required for effective control by sulphur.
- Dinocap has 10-14 days schedule while; sterol biosynthesis inhibiting fungicides are commonly used at 14-21 days schedule.

Capsule Rot- *Embellisia phragmospora*.(Van embess)

SYMPTOMS:

- Symptoms can be seen on mature and tender leaves.
- Large circular, irregular, water soaked lesions, dirty black in color appear on the margins of mature leaves.
- Lesions can be seen in the centre of the leaf on either side of the midrib.
- In some cases, large lesions extending the entire length of the leaf can also be seen. The exposed portions of the tender, unopened leaves may also rot.
- The leaves become shredded and remain attached to the pseudostem.
- Grayish patches of irregular outline and size with brownish margins are found at the base of the leaf sheath.
- The basal portion rots causing the pseudostem to break away at the collar region even at the slightest disturbance.
- The infection spreads to the underground parts and become decomposing mass.
- Small light brown lesion on green, tender fruits which falls off in 3-6 days after infection leaving the small fruits stalk on the bare of inflorescence, finally rotting occurs.

MODE OF SPREAD AND SURVIVAL:

- **Primary source of inoculum :** Chlamydospores, Infected plant debris.
- **Secondary source of inoculum:** Sporodochium, conidia (macro & micro)
- The fungus is soil borne and survives in the form of chlamydospores.
- Soil P^H 6-7 was favoured.

EPIDEMIOLOGY:

- This disease found in MAY-AUGUST coinciding with South -West monsoon.
- Temperature-21-26^0, high rainfall, high soil moisture, more relative humidity.

MANAGEMENT:

- The disease is controlled by spraying with mancozeb 0.2%or zineb0.2%.

Soft Rot: *Erwinia papaveris (Ayyar)* Magrou.

SYMPTOMS:

- The disease is characterized by external blackening and internal disintegration, accompanied by the discoloration of the mid rib of the leaves.
- The disease commences at the apex and extents downwards and the whole plant is turned into a slimy mass.

ETIOLOGY: CO: *Erwinia papaveris*

- It is a gram – ve, single celled, peritrichous bacteria
- The bacterium is rod shaped 0.5-2.5×0.5 micro meter in size, strictly aerobic, , non acid fast,
- Non-Sporulating, Non-capsulated with 2-8 peritrichous flagella.

MODE OF SPEAD AND SURVIVAL:

Primary source of inoculum : Affected debries.

Secondary source of inoculum: Bacterial cells.

EPIDEMIOLOGY:

- Optimum temperature for growth is 30^oC
- Thermal death point lies between 50-60^oC
- The bacterium can retain its viability on poppy seeds for over 20months.

MANAGEMENT:

- Copper oxy Chloride(COC) 0.3%

Poppy Mosaic-*VIRUS*

- The aphid, *Myzus persicae* is the vector which transmits the mosaic disease.
- The minimum acquisition feeding period is one min.
- The minimum inoculation feeding period is also one min.
- Single aphid is efficient in transmitting the virus.
- The virus is non persistent type.

SYMPTOMS:

Yellow + green patches on leaves, stunting, flower drop, yield reduces.

This virus is very sensitive

MODE OF SPEAD AND SURVIVAL:

Primary source of inoculum: Affected host plants, weed host& self sown crops**.**

Secondary source of inoculum: Virus particle

EPIDEMIOLOGY:

- Summer season
- High temperature
- susceptible host
- Improper management leads to development of this disease.

MANAGEMENT:

- Initially spray Dimethoate -0.1% after 15 days and Imidacloprid 0.05% at another 15 daysand neemazol 0.5% later.

Post harvest diseases of aromatic crops

CELERY

1. Early blight

Causal organism: *Curvularia andropogonis*

SYMTOMS:

- The pathogen causes damping off.
- Appearance of symptoms on leaves is seen as severe yellowing and browning of leaf tips initially with circular to oval spot on which in favorable condition become irregular.
- These spots in later stage turn to dark brown surrounded by dark reddish brown borders, Small unclean brown spots scattered over the leaf lamina .
- The minute spot increase in size forming big spherical or irregular patches. Sever in neglected crop

EPIDEMIOLOGY:

Nutritionally poor soil, temp 28-32^{o} C, RH 85-90per cent, cloudy weather, susceptible host.

- PSI: Dormant mycelia
- SSI: Air borne conidia

ETIOLOGY:

Septate mycelia, inter and intracellular haustoria. any one of the conidia or conidiophore is colored Asexual spores-Air borne conidia in conidiaphore,sexual spores- Ascospores, vegetative structure is dormant mycelia.

MANAGEMENT:

- Collect and destroy affected plant parts
- Increased nutritional status
- Reduce plant population

- Mancozeb 0.2% as aerial spray

Late blight: *Septoria petosalanii*

Symptom:

Initially circular to irregular blackish brown spot on leaves, later spot surrounded by yellow hallow. In sevior infestation, the leaves remain small and curled. the dead leaves hang on the stem for some time on the affected part black spots can be visible and are pycnidia of fungus

Aetiology:

septate mycelia inter and intercellular haustoria

PSI: Ascospores(pseudothecium)

SSI: pycnidiophore(pycnidium)

Mode of spread and survival: Infected debris in the soil appear to be primary source of infection carried through suckers

Epidemiology: cool weather 18 to 20 oC, RH=95 – 99%,cloudy weather, intermittent rain fall, susceptible host

MANAGEMENT:

Affected plants should be collect and burn

Irrigation should be regulated

CITRONELLA:

Leaf blight: *Cuvularia andropogonis*

Symptom:

The pathogen causes damping off. Appearance of symptoms on leaves is seen as severe yellowing and browning of leaf tips initially with circular to oval spot on which in favorable condition become irregular. These spots in later stage turn to dark brown surrounded by dark reddish brown borders

ETIOLOGY:

Septate mycelia, any one of the conidia or conidiophore is colored.

Survival – In soil for 3 years.

Spread- through infected corms.

EPIDEMIOLOGY:

Nutritionally poor soil, temp 28-350C, RH 85-90%, susceptible host.

PSI: Dormant mycelia

SSI: Air borne conidia

Management:

- Spray crop with Capton or Zineb at 0.2% or Mancozeb 0.25% at frequent intervals depending on severity of the disease.
- Crop rotation for 3to 4 years, summer ploughing.

Fennel:

Leaf blight: *Cercospora foeinicoli*

Symptoms:

- Light brown zonate spots appear on the leaves.
- Black and elliptic spots appear on the twigs.
- The affected areas in the twigs become flattened and depressed with raised edges. Such infected twigs dry up.
- In severe cases the whole plant dies.

Fungus: *Cercospora foeinicoli*

Conidiophores are olivaceous brown, short fasciculate, sparingly septate and 20 to 40 x 3 µm. Conidia are hyaline to pale olivaceous cylindrical, sub fisoid to sub clavate, septate and 40 to 50 x 3 µm

Mode of survival and Spread: The pathogen survives in affected plant parts as dormant mycelia and spreads through air borne conidia.

Epidemiology: The disease is severe during August to November. When there is high humidity and the temperature between 20 and 27o C

Management:

Clean cultivation, i.e. sanitation, includes removal of weeds. On fallen leaves or affected plant parts, spray nitrogen solution or bleaching powder to enhance degradation. smear with Bordeaux paste or coc paste. Spray thiophonate methyl 0.1% or mancozeb 0.25% or cardendazim 0.1%.

French basil:

Leaf blight: *Colletotrichum capsici*

Symptoms:

Leaf spot:

- The fungus attacks tender shoots and foliage.
- Brown or dark circular or irregular spots are formed on the leaves and such leaves are crinkled.
- The affected portion dry up and fall off and leaf ragged margins.
- Often these leaves are shed leaving the twigs bare.

Etiology: *Colletotrichum capsici.*

- Acervuli developed on diseased parts of the plants.
- They are irregular and appear as brown to black dots.
- Setae are common on twigs but not on fruits.

- The acervuli when mature exude pink masses of conidia under moist conditions. Marginal setae are rare.

- Conidia are borne on hyaline conidiophores.
- The conidia are straight, cylindrical or oval, hyaline with two oil drops and are non-septate with round ends.

Mode of spread and survival:

- Inoculum remains on dried leaves, defoliated branches they serve as primary inoculum.
- Secondary spread is through air borne conidia.
- The latent infection is carried from the field to storage.

Primary source of inoculum: Dormant mycelia

Secondary source of inoculum: Air borne conidia

Epidemiology:

- The acervuli are abundant on the dead twigs and 80% of the spores on them are viable.
- Fresh acervuli continued to appear on dead twigs and persist on the plant.
- The optimum temperature for infection was found to be 25^0c and relative humidity 95-97%.
- The perithecial stage of the fungus is not very common.
- There is no evidence to show that fungus perpetuates through ascospores.

Management:

- Diseased leaves which fall on the ground should be collected and all infected twigs should be pruned and burnt.
- Spraying of Bordeaux mixture 0.6% in the young plants during Feb, April and sept controls the disease.
- Spraying carbendazim 0.1% or thiophanate-methyl 0.1% or chlorothalonil 0.2% at 15days interval until harvest effectively controls anthracnose.

Jasmine:

Laef blight: *Cecospora jasminicola*

Symptoms:

- Light brown zonate spots appear on the leaves.
- Black and elliptic spots appear on the twigs.
- The affected areas in the twigs become flattened and depressed with raised edges. Such infected twigs dry up.
- In severe cases the whole plant dies.

Fungus: *Cercospora jasminicola*

- Conidiophores are olivaceous brown, short fasciculate, sparingly septate and 20 to 40 x 3 µm.
- Conidia are hyaline to pale olivaceous cylindrical, sub fisoid to sub clavate, septate and 40 to 50 x 3 µm

Mode of survival and Spread:

The pathogen survives in affected plant parts as dormant mycelia And spreads through airborne conidia.

Epidemiology:

- The disease is severe during August to November.
- When there is high humidity and the temperature between 20 and 27^0 C

Management:

- Clean cultivation, i.e. sanitation, includes removal of weeds.
- On fallen leaves or affected plant parts, spray nitrogen solution or bleaching powder to enhance degradation.
- smear with Bordeaux paste or coc paste.
- Spray thiophonate methyl 0.1% or mancozeb 0.2% or cardendazim 0.1%.

LEMON GRASS:

Leaf spot: C.O: *Colletotrichum cimbapogoni*

Symptoms:

Leaf spot:

- The fungus attacks tender shoots and foliage.
- Brown or dark circular or irregular spots are formed on the leaves and such leaves are crinkled.
- The affected portion dry up and fall off and leaf ragged margins.
- Often these leaves are shed leaving the twigs bare.

Etiology: *Colletotrichum cimbapogoni*

- Acervuli developed on diseased parts of the plants.
- They are irregular and appear as brown to black dots.
- Setae are common on twigs but not on fruits.
- The acervuli when mature exude pink masses of conidia under moist conditions. Marginal setae are rare.

Conidia are borne on hyaline conidiophores.

The conidia are straight, cylindrical or oval, hyaline with two oil drops and are non-septate with round ends.

Mode of spread and survival:

- Affected dried leaves serve as primary inoculum.
- Secondary spread is through air born conidia.

Primary source of inoculum: dormant mycelia

Secondary source of inoculum: air borne conidia

Epidemiology:

- The optimum temperature for infection was found to be 26- 28^0 c
- Relative humidity 95-97%.

Management:

- Diseased leaves which fall on the ground should be collected and all infected twigs should be pruned and burnt.
- Spraying carbendazim 0.1% or thiophanate-methyl0.1% or chlorothalonil 0.2% at 15days interval until harvest effectively controls leaf spot

Grey Blight/ Grey rot / Pestalotiopsis Leaf Spot: *Pestalotiopsis* sp.

Symptoms:

- Brown spots develops at the margins and tip if the leaf lamina and distributed irregularly on entire leaf.

- Initially the spots are brown and minute and they gradually increase in size and become dark brown.
- Black dots appear at the center of the spots represent the acervuli.

Etiology: *Pestalotiopsis mangliferae* (P.Henn.) Stey.

The fungus produces septate mycelia and acervulus as an asexual fruiting body.

Conidia are5-celled, oblong to clavate or clavate to fusiform, colored cells are 15-16 micro meter long, upper two of them slightly darker than the lowest olivaceaus colored cells, septa and walls sometimes black and will have long pedicel; setulae 3, coarse, widely divergent and 19-26 micron long.

Mode of spread and survival:

- the fungus present in stem is multiplies under favorable conditions.
- It spread through wind- born conidia.

Epidemiology:

- the fungus is capable of growing at temperature between 20-25^{0} c.
- mycelia growth sporulation takes place at pH 5.5-6.0.
- Wounding leads to more disease incidence.

Management:

- Carbendazim 0.1% after heavy rains followed by wettable sulphur 0.2% controls the disease.
- Bordeaux mixture 1.0% can also used for the control.

Palmarosa:

Leaf blight: *Curvularia trifolii*

Symptoms:

- Appearance of symptoms on leaves is seen as severe yellowing and browning of leaf tips, initially with circular to oval spot on which in favorable condition become irregular.
- Then spot in later stages turn to dark brown surrounded by dark reddish brown border.

ETIOLOGY:

Septate mycelia, any one of the conidia or conidiophore is colored.

Survival: In soil for 3 years.

Spread: through infected corms.

EPIDEMIOLOGY:

- Nutritionally poor soil,
- temp 28-35^{0}C,
- RH 85-90%, susceptible host.

PSI: Dormant mycelia

SSI: Air borne conidia

MANAGEMENT:

- Collect and destroy affected plant parts
- Apply recommended dose of fertilizers.
- Reduce plant population.
- Biological agent.
- Mancozeb 0.25% as aerial spray.

Laef spot :*Colletotrichum caudatum*

Symptoms:

Leaf spot:

- The fungus attacks tender shoots and foliage.
- Brown or dark circular or irregular spots are formed on the leaves and such leaves are crinkled.
- The affected portion dry up and fall off and leaf ragged margins.
- Often these leaves are shed leaving the twigs bare.

Etiology: ***Colletotrichum caudatum***

- Mycelium is septate, inter cellular mycelia, intra cellular haustoria and the asexual fruiting body is Acervulus.
- They are irregular and appear as brown to black dots.
- The acervuli when mature exude masses of conidia under moist conditions.
- Conidia are borne on conidiophores.

Mode of spread and survival:

- Inoculum remains on dried leaves serve as primary inoculum
- Secondary spread is through air born conidia.
- Primary source of inoculum: dormant mycelia
- Secondary source of inoculum: air borne conidia

Epidemiology:

- The optimum temperature for infection was found to be 24-28^0 C
- Relative humidity 90-97%.

Management:

Diseased leaves which fall on the ground should be collected and burnt.

Spraying of Bordeaux mixture 1% in the young plants

Rose and Tuberose Grey blight / grey rot:

C.O: *Botrytis cineria : Boytritis elliptica*

Symptoms :

- Infection starts from the sepals as black-brown specks the flower in due course .
- The buds turn brown and decay.
- sometimes partially opened buds are attacked and individual petals turn brown and shrivel.
- In susceptible hybrid tea roses the disease prevents anthesis.
- In cool moist weather the flower is covered with grayish- grey or darkish growth of the fungus.
- Affected flowers mummification takes place and harbor the disease
- winter killed canes harbour infection.

Fungus :*Botrytis cineria*

Etiology :

- conidiophores arise in clusters, brown to dark brown, long, septate, slender, repeatedly branched and thick walled .
- conidia are ovoid to oblong. Disc- shaped .

Management :

- picking and destroying old blooms and overwintered canes help in reducing the disease.
- Avoiding excess irrigation helps to check the disease.
- Fungicidal spray with triphenyl tin acetate(Brestan) 0.05 per cent is effective in its control.
- The disease is effectively controlled by spraying with ferbam 0.2% or capton 0.2% or benomyl 0.1 per cent or mancozeb 0.25%
- The following rose varities viz., Anieval sparks, Bonnienuit, chantare, cahrleston etc. are free from disease.

Post Harvest Diseases of Fruits

Introduction:-The losses due to Post –Harvest diseases of Fruits particularly in subtropics and tropics are enormous. Losses due to Post-Harvest diseases are not exactly known in India. However, there is a colossal wastage under our poor marketing and transit facilities. Keeping in view the importance of fruits in our diet concerted efforts is required to minimize losses which can save at lease 20% of our fruit.

I) Banana

1. Anthracnose : *Collectotrichum musae*
2. Black Tip : *Botryodiplodia theobromae*
3. Cigar-end Disease : *Verticillium theobromae*
4. Pink mould Rot : *Trichothecium roseum*
5. Fusasial Rot : *Fusarium moniliformae*
6. Banana Scab : *Phoma poleyana*
7. Freckle and Blackspot : *Macrophoma musae*

1. Anthracnose:

Symptoms : Fruit – It occurs on the ripened fruit on the ripen fruit small minute black dots and sunken discoloration Ripening stage is susceptible for this disease because of less phenol content and black increased reducing sugar.

Causal organism : ***Collectotrichum musae***

Etiology: -	Mycelia	–	Septate.
	Asexual Spore	–	Conidia bon in acervulus
	Sexual spore	-	Ascospore born in Perithecium

Epidemiology: This organism appears on ripening fruits. Green fruits are free from this Disease. It is common in Sep-Oct month.

Temperature : 28-32^0 C

Relative Humidity : 90-92%

Week and Susceptible Host

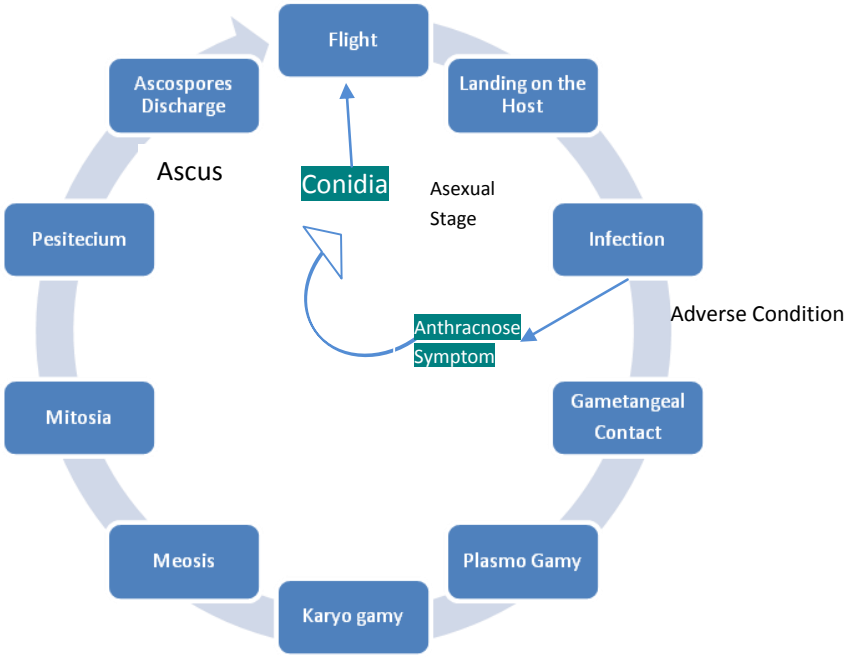
In increased soluble sugar concentration it is a carbon source of organism and will multiplied.

Primary Source of Innaculum: Ascospore born in perithecium Fruiting body.

Secondary source of Innaculum: Conidia born in acervulus.

Spread: Through winds

Life Cycle:



2. Fusarial Rot: *Fusarium moniliformae*

Complete loss, Soil born.

Symptoms of fruits: Produce small sized bunches less number of fingers and fail to ripen.

Etiology: Mycelium – Septate.

Asexual spores: Micro and macro conidia born on sporodochium.

Sexual Spores: Ascospores bon in ascus – Ascocarp is perithecium.

Vegetative Stage: Chlamadospores responsible for long time survival.

Primary source of innaculum: Chlamydospores present in affected debris soil.

Secondary Source of innaculum: Micro and Marco Conidia.

Spread: Through irrigation water through agricultural operations.

Mode of entry: Through wounds – Natural roots one root.

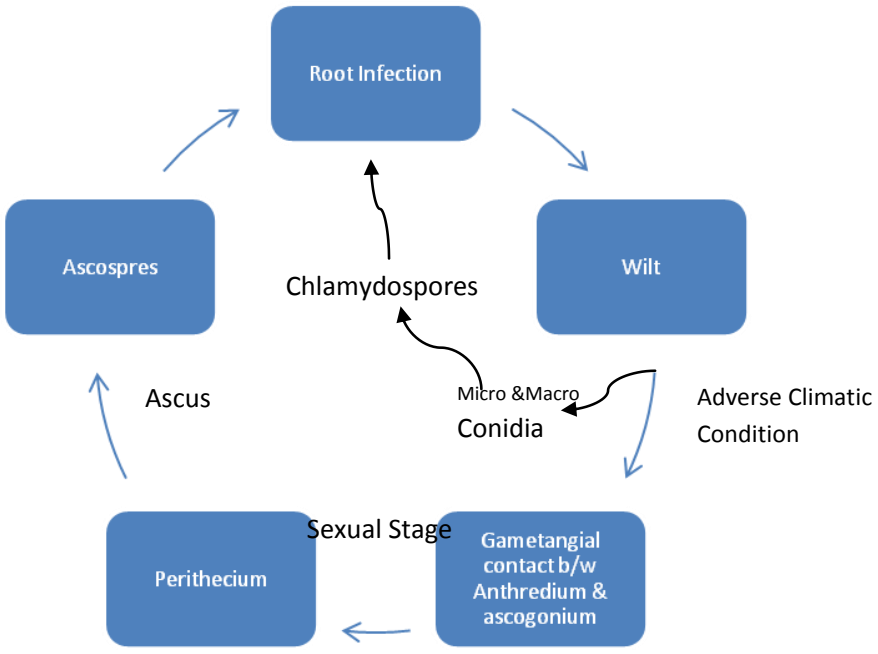
Epidemiology: Temperature – 25-30^{0}C

Soil moisture: - 50%

Soil pH: - Acidic pH 5.5-6.8

Soil type: Sandy loam Congenial for spread of the disease and susceptible host.

Life Cycle:



3. Cigar end Disease: *Verticillium theobromae*

Symptoms : Brackish discoloration is covered by whitish mycelia.

It occurs in green stage in the bunch i.e it occurs on green fruit starting from tip of the fruit.

Grape:

1. Powdery Mildew of Grapes: *Uncinulla necator*

2. Bird eye spot: *Elsinoe amphelina*

1. Powdery Mildew of Grapes :

Leaf : Affect photosynthesis area, affect hinder the photosynthesis, Red sulthana.

Symptom : Whitish powdery growth on young stem.

Flower stalks and on flowe, Flower dropping.

Fruit bunches : whitish powder Cracking of fruits at the time of ripening.

Asexual Spores : Oidium – barrel shaped conidia, Ectophytic.

Sexual spores: Ospores

Etiology: Mycelia – Septate.

Asexual Spores: Barrel Shaped conidia on odium.

Sexual Spores: Ascospores - Ascus – Cleistothecium.

Primary source of innculum: Ascospores present in cleistothecium, dormant mycelia.

Secondary source of innaculum : Air born barrel shaped conidia.

Epidemiology : during warm weather condition,

Temperature : 28-32^{0}C RH 85-90%, Cloudy weather, thick canopy, host.

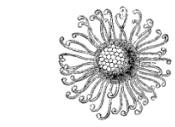
Management: Proper pruning and regulates of thick canopy during kharif season reduces the diseases because of proper aerates and avoid creation of micro climate condition.

* Recommended dose of N:P:K applicants.

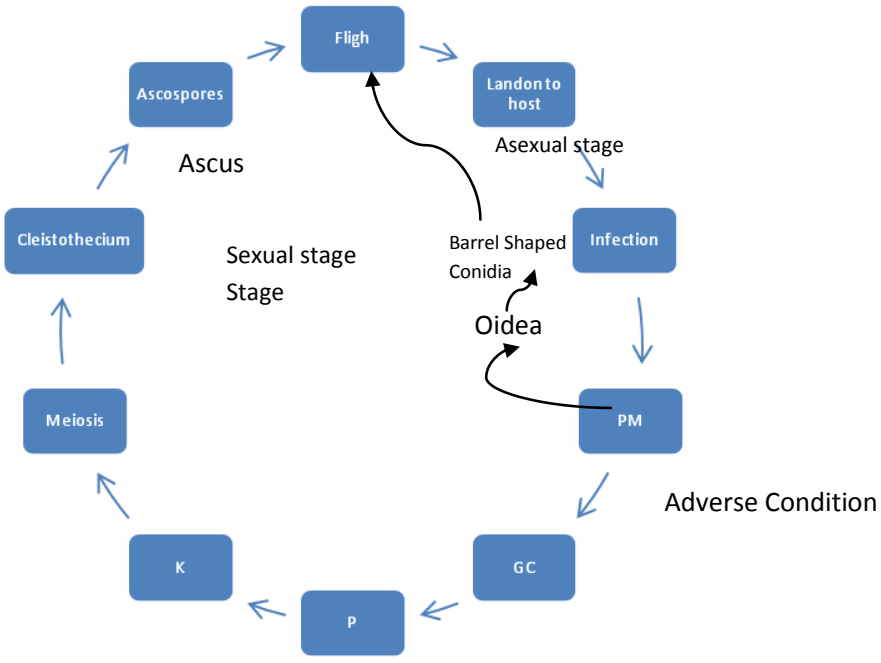
* Enhances resistant mechanism.

* It enhances the disease development, biochemical pathway reduced phenolic content.

Life Cycle:



Curved Uncinulla



2) Bird eye Spot:

Anthracnose of Grapes - *Elsinoe amphelina*

Symptoms :

On Leaf : Necrotic irregular spots.
On stem : necrotic irregular streaks, brownish.
Black Later stage asexual fruiting body acevulus.
Green fruit: Exact circular brown circle – gray colloured brown black ring.

Kharif season severe during sep-oct.
Primary source of innaculum: Dormant mycelia.
Secondary source of innaculum: Air borne.

APPLE:-

1) Apple Scab : *Venturia inaequalis*
2) Bitter Rot : *Glomerella cingulata*
3) Blue Mould Rod : *Penicillium expansum*
4) Grey Mould Rot : *Botrytis cinerea*
5) Alternaria Rot : *Alternaria alternata*
6) White Rot : *Botryosphacria obtiusa*
7) Brown Rot : *Monilinia fructiglna*

1. Apple Scab:

Symptoms: - On leaves : On the lower surface of leaves green colour velvety spots with wavy Appears slowly it will starts showing symptoms on the upper surface i.e. slightly raiseol olive green spot.

On Fruits: Slightly reseal rough corky olive green spot appears later on cracking of fruits taken Place, later mummification may taken place.

Causal organism : *Venturia inaequalies*

Etiology: - Mycelia- It is pseudothecial fungi.

Asexual stage is spilocea.

Primary source of innaculum: Pseudothecium present on the affected taken leaf.

Secondary source of innaculum: Air born spilocea typed conidia.

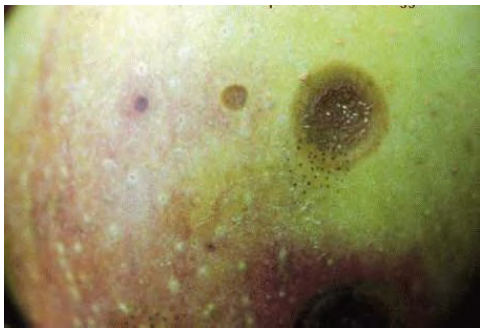
Epidemiology: Moisture condition

Hours	Temperatutre
28	6^0
14	10^0
9	14^0
12	26^0

*High Plant Population

2) Bitter Rot:

Symptoms: On fruits – Small lesion or cipien infection, brown, firm, flat or slightly sunken spots.



Causal organism: *Glomerella Cingulata*

Fruiting body Acervulus

Etiology: Mycelia Septate.

Primary source of innaculum: Dormant mycelia.

Secondary source of innaculum: Air born conidia.

Epidemiology: * Weather is warm and humid during fruit development stages.
*Poor nutrition.

3) Blue mould rot:

Symptoms: on fruits: light colored soft rot and as soon it spreads on the surface and deep into the flesh.

Causal Organism: *Penicilliun expansum*

Epidemiology: High temperature.

4) Grey Mould Rot.

Symptom: On fruit; - Pale brown to brown area on fruit. And may have ash-grey powdery spore masses later it starts to decaying

Causal Organism: *Botrytis cinerea*

5) Alternaria Rot:

Symptoms: Round brown to black, dry firm, shallow lesions around skin breaks at the calyx stem depression. Advanced rots become spongy and the affected flesh is streaked with black.
Causal Organism: *Alternaria alternata.*

Pears :

1) Blue Mould : *Penicillium expansum.*
2) Grey Mould : *Botrytis cinerea*
3) Alternaria Rot : *Alternarea alternata*
4) Mucor Rot : *Mucor piriformis*

Stone fruits: ALMOND, APRFCOTS. CHERIES PEACHSE AND RLUMS.

1) Brown Rot : *Monillnia laxa.*
2) Rhizopus Rot : *Rhizopus stolonifer*

3) Blue mould Rot : *Penicillium expansum*
4) Cladosprium Rot : *Cladosporium harborum*
5) Grey mould Rot : *Botrytis Cinerea*

Management of Post-Harvest Diseases:

1. Harvest the produce at proper maturity.
2. Harvest carefully with out causing any wound.
3. Harvest during cooler hour and immediately shift to cold storage..
4. After harvest grading is must remove affected, misshaped, wounded fruits before cold storage
5. Use sterilized packing material
6. Keep clean around the vicinity of grading area.
7. chemical treatment

Benomyl-1g/lit dip the fruit 5-6 min, dry under shade, pack it and transmit.

8. Oil dipping. olive oil or Neem oil- dip the fruit in this oil 5-6 min and dry under shade
9. Wax coating 0.1% in apple.
10. Trichoderma dipping-10% trichodermal solution dip 5-6 min, and dry it .

Cultural :

* Pruning: early identification of canker affected limbes and prune and wounded area should be pasted with C.O.C to avoid other saprophytic parasites.

* On fallen leaves and flowers spray urea solution of 5% which enhances degradation there by inoculums reduces.

*Maintain optimum population density.

*Go for drip irrigation.

*Remove affected fruit, branches carefully and burn.

*Resistance variety.

*Summer stressed plant is more susceptible.

*Summer Irrigation.

*Proper spacing should be maintained.

*Regulatory Measure – Avoid importing susceptible root sucks from diseased area.

*Pruning should be done properly their by better aeration.

*Uproot and burn.

*Avoid movement of water from infected to healthy plant.

Chemical Management:

1. Benomyl – 1g/lit

2. Thiophanate methyl 0.2%
3. Diphenyl

POST HARVEST DISEASES OF PLANTATION CROPS

COCOA

1. Black pod rot:

Casual organism*: Phytophthora palmivora*

Symptoms:

- First sign of the disease is appearance of brown spot on the pod.
- The brown discolorations rapidly spread in all directions.
- The discolorations spread over the whole pod.
- Internal tissues of diseased pods become brown.
- Infected beans are discoloured.
- It causes further rotting leading to the spoilage of the quality of the produce.

Mode of spread & survival:

- Infected pods serves as source for the spread to the healthy pods in the storage and also during transit.

Management:

- Regular removal & destruction of infected pods at weekly intervals.

- Carefully identify the infected pods and remove them from the lot to the storage.
- Pre-harvest spraying with Benomyl 0.1% to avoid field infections.

2. Charcoal pod rot:

Causal organism: *Botryodiplodia theobromae*

.**Symptoms:-**

- The infection appears as dark brown to black spot on any place on the pod surface & spreads rapidly.

Management:

- Regular removal & destruction of infected pods at weekly intervals.
- Carefully identify the infected pods and remove them from the lot to the storage.
- Pre-harvest spraying with Benomyl 0.1% to avoid field infections.

3) Cherella rot:

Causal organism: *Colletotrichum gloeosporioides*.

Symptom:- 

- Infected stalk becomes shrunken.
- The internal tissues of the pod become discoloured.
- Abundant pinkish slimy mass of conidial is produced on the lesions under high humid conditions.
- Ultimately the diseased pod turns brown to black & remains on the tree as mummified fruit.

Management:

- Regular removal & destruction of infected pods at weekly intervals.
- Carefully identify the infected pods and remove them from the lot to the storage.
- Pre-harvest spraying with Benomyl 0.1% to avoid field infections.

Practical Manual

for the course

"Diseases of fruit Plantation Medicinal and Aromatic crops"

CONTENTS

Exercise 1
DISEASES OF CITRUS

1) CITRUS GUMMOSIS: *Phytophthora citrophthora*
2) CITRUS POWDERY MILDEW: *Oidium tingitaninum*
3) CITRUS SCAB*: Elsinoe fawcetti*
4) CITRUS SOOTY MOULD:*Capnodium citris*
5) CITRUS ANTHRACNOSE: *Colletotrichum gloeosporioides*
6) CITRUS CANKER: *Xanthomanas campestris* pv. *citri*
7) CITRUS TRISTEZA/ QUICK DECLINE- Virus disease
8) CITRUS EXOCARTIS- Viroid disease
9) CITRUS GREENING- Phytoplasma disease
10) CITRUS ROOT KNOT NEMATODE: *Meloidogyne incognita*

1. CITRUS GUMMOSIS/ LEAF FALL/ FOOT ROT

It is a soil borne fungus. Primary colonization is on roots causing discolouration, root decay, bark degradation at collar region and leaf falling.
Exudation of gum like substance from bark of the trunk, which cracks open, dries up and fall down in the later stages.
Causal organism: *Phytophthora citrophthora*

2. POWDERY MILDEW

Whitish powdery growth appears on young leaves & twigs. In infected leaves get distorted and defoliated in severe conditions.
Infected twigs exhibit characteristic die back symptom.
Young fruits are also covered by whitish powdery mass of the fungus and drop prematurely resulting in poor yield.
Causal organism: *Oidium tingitaninum*

3. CITRUS SCAB/ VERRUCOSIS:

Whitish, raised, circular, scabrous growth observed on the fruits, changing to grayish color, decrease in the fruit size, quality and ultimately fruit fall off.
On lower surface of infected leaves whitish scabrous growth corresponding upper surface, concave dippression can also be seen.
Causal organism ***: Elsinoe fawcettii* and *Sphaceloma fawcettii***

4. CITRUS SOOTY MOULD:

Black coloured sooty mass can be seen covering the leaf surface and sometimes on young stems and fruit surfaces.
Black sooty mass contains conidia and mycelia in it affects the normal photosynthesis, process due to which plant growth decreases.
This is purely ectophytic and not a plant parasitic fungi as this fungus develops on the host surface utilizing leaf exudates and honey like substances secreted by insects and also insect excreta.
Causal organism***: Capnodium citris***

5. CITRUS ANTHRACNOSE:

The disease causes defoliation and tip drying of twigs, called whither tip.
Shedding of leaves and dieback of twigs.
Acervuli appear as black dots on the dead twigs. Light green spots appear which later turn brown.
The pathogen also infects the stem-end of immature fruits causing fruit drop.
In severe cases branches also show die back symptoms.
Causal organism***: Colletotrichum gloeosporioides***

6. CITRUS CANKER/ BARK ERRUPTION:

Leaves: Initially water soaked patches appear which slowly turn brown and produce corky raised spots which leads to yellow hallow.
Stem: Same as on leaves but yellow hallow is absent, bark eruption takes place and, we can see bacteria oozing out during warm rainy season from cracks.

Fruits: Brownish corky out growth with cracks and crater like appearance at a later stage is the common symptom. Fruit size is reduced and marketing quality deteriorates.
Fruit rottening is common when stored.
Causal organism: *Xanthomonas campestris* pv.*citri*

7. CITRUS TRISTEZA/QUICK DECLINE
Leaf: Chlorosis is the common symptom followed by leaf size reduction, leaves fall and die back of defoliated twigs.
Stem: Bark eruption and pittings on stem (V shaped depression on the stem and stem twisting occurs.)
Fruits: In the affected fruits, thicknesss of the rind is increases and, mesocarp decreases.
Root stocks are susceptible, phloem necrosis is the common symptom, root discoloration and root decay occurs which leads to sudden leaf dropping.
Causal organism: CITRUS TRISTEZA VIRUS

8. Citrus Exocartis
This disease pertains to the bark, bark discoloration and its removal occurs at the later stage, followed by yellowing of leaf, defoliation and death of the plant.
Causal organism

9. CITRUS GREEENING
Stunting of leaves, sparse foliation and rapid die back symptoms.
Inter nodal length decreases and finally it looks like Witches broom.
Poor crop due to green and worthless fruits, only a portion of tree is affected, foliar chlorosis, infected plants give zinc deficiency appearance.
Causal organism

10. Slow Decline
A tree infected with citrus nematodes may survive for many years after it has been infected.
Main effect of nematode infestation is the "slow decline".
Symptoms include the dieback of small branches, yellowing of leaves and fruits are smaller in size.
Reduced number of feeder roots.
Citrus nematodes are too small to be seen, but the attached roots have a gritty appearance because of the egg masses which cling to them.
Authentic diagnosis must be made in a laboratory with a good microscope.
Growers may expect some citrus nematodes to be present in most of the orchard soils.
Nematodes do not become a problem unless populations are very high (i.e. more than 10,000 larvae per 500g of soil).
Growers planting new orchards must be very careful not to introduce nematodes accidentally, in the soil around roots of seedlings.
If nematodes are already present in the soil in large numbers the best protection is to use resistant rootstocks such as trifoliate orange or Troyer citrange.

Caused by the citrus nematode *Tylenchulus semipenetrans*

11. Citrus Root Knot Disease:
Aerial symptoms: yellowing of leaves, reduction in plant growth and yield.
Below ground symptoms: Formation of galls on roots.
The nematode is sedentary endoparasite, feeds on the affected parts and complete its life cycle on the same gall.
Causal organism: *Meloidogyne incognita*

12. Green / Blue mold rot:
The first symptom is the appearance of soft, watery spots measuring 5-10 mm in diameter. Soft water soaked areas develop on the skin of the fruit which soon become covered with white mould in both the cases. Coloured spores are formed at the centre of the lesions. In green mould rot, whitish margin is generally not more than 2 mm in diameter. These two moulds appear frequently during transportation and storage. But the green mould generally dominates as it grows rapidly at moderate temperature. Insect injury, especially with mediterranean fruit fly when the fruits are still on the trees causing undetectable pre-harvest infection and also the bruises caused during harvesting and handling are the predisposing factors.The decayed fruit becomes soft and shrinked in size. In humid atmosphere, the infected fruit also becomes attacked by other molds and bacteria, which soon turns into a rotten mass.
Causal organism**: *Penicillium digitatum* and *P. italicum***

13.Alternaria rot:
The first symptom of the disease is seen on the fruits as watery rot. The internal damage starts much earlier and which may vary from species to species. In lemon the pulp becomes greyish brown, soft and slimy. In oranges, grapefruits and mandarins, the affected interal tissues turn black giving a common name to the disease as Black rot or Black centre rot. In Mandarin, lesions often develop on the side of the fruit and the infected skin appears brown and hence the name, Brown spot of mandarins. In some cases, the symptoms consist of corky eruptions and pits.
Causal organism: *Alternaria alternata* and *A. Citri.*

14. Black mold or Aspergillus rot:
The rot may be mostly internal. Masses of black powdery spores are observed only when the fruits are cut open. But much soft, sunken, water soaked spots may develop on the skin that later gives rise to black spores resembling “soot”. The decay is accompanied by fermentation odour. Infection is observed when fruits are still on the tree but they look externally healthy.
CAUSAL ORGANISM: *Aspergillus niger*

15. Black spot:
Various types of symptoms are seen due to this disease. Early infection may result in the appearance like “Melanose”. Infection of immature fruits may also leads to “hard spot” or “limited spots” with a hallow centre. “Freckled sot” or “speckled blotch” is seen in fruits nearing maturity which develops further during storage. “Virulent spot” is observed late in the season when temperature goes high and which is characterized by irregular reddish sunken lesions.
Causal organism: *Phyllosticta citricarpa*

16. Brown rot:
Greyish brown spots are seen on the fruits. Infected fruits emit a characteristic pungent odour Under humid conditions, fine white spore bearing mould develops on the peel which spreads to the adjoining fruits. Rotting is very rapid at 25^{o}C.
Causal organism :*Phytophthora* spp.

17. Sour rot:
Appearance of water soaked spots on the fruits is the first symptom of the disease.The surface of the lesion becomes covered with slimy, off - white spores and fruit tissue beneath turns into a sour smelling watery mass which is very attractive to the fruit flies.
Causal organism: *Geotrichum candidum*

18. Grey mold rot:
Rotting may begin at the stem - end or on the side of the fruit. The lesion is mid brown initially and firm but later turns dark,soft. "Nest" of decay develops and a mass of grey brown spores formed under humid conditions.
Causal organism: *Botrytis cinerea*

19. Melanose
Small, raised, reddish brown to black pustules develop on the peel or skin making it rough to touch. The small spots are randomly distributed and exhibit a "Tear Stain" pattern. (Melanose is non=progressive skin blemish). As the fruit develops, the fungus dies back.
CAUSAL ORAGISM: *Phomopsis citri* (*Diaporthe citri*)

20. **Black pit:**
The first symptoms are light brown spots on the skin of the fruits, becoming dark brown and eventually black later with markedly sunken spots. There may be concentric rings of brown colour and on a close examination, a small wound at the centre of each spot may be seen. Under moist conditions, greyish yellow droplets exude from the lesions but tissue below the spot remains firm.
CAUSAL ORGANISM: *Pseudomonas sytingae* pv. *syringae*

Exercise-2

GRAPE-DISEASE

MAJOR DISEASES

Powdery mildew - *Uncinula necator*
Downy mildew - *Plasmopara viticola*
Anthracnose - *Elsinoe ampelina (=Gloeosporium amphelphagum)*
Black rot - *Guignardia bidwellii*
Bacterial canker - *Xanthomonas campestris* pv. *viticola*

Minor diseases

Brown leaf spot - *Cercospora viticola*
Rust - *Phakopsora vitis*
Coniothyrium blight - *Coniothyrium diplodiella*
Alternaria blight - *Alternaria vitis*
Drechslera leaf spot - *Drechslera rostrata*

Fruit rots

Pestalotiopsis fruit rot - *Pestalotiopsis menezesiana*
Grey mould rot - *Botrytis cinerea*
Blue/Green mould rot- *Penicillium digitatum*
Soft rot - *Phomopsis viticola*
Stalk end rot - *Aspergillus niger*
Penicillium rot - *Penicillium canescens*
Rhizopus rot - *Rhizopus nigricans*
Cladosporium rot - *Cladosporium herbarum*
Bitter rot - *Greenaria fuliginea*
Bacterial leaf spot - *Pseudomonas viticola*
Fan leaf - Grapevine fan leaf virus
Little leaf - MLO's (PPLO)

1. **Powdery Mildew of Grapes**
   - The fungus attacks all the green parts of the plant at all stages of plant growth.
   - It produces white to greyish powdery patches on the affected plant parts, including fruits, but young leaves are most susceptible and develop small whitish patches both on the upper as well as lower surface.
   - These patches grow in size and coalesce to cover large areas on the leaf lamina and gets twisted. Malformation and discoloration of the infected leaves are also common symptoms, resulting in distortion.
   - Similarly, powdery patches are also produced on the stem, tendril, flowers and young fruit branches.
   - Diseased vines appear wilted and stem portion turns brown.
   - The infected blossom and berries turn dark in colour, irregular in shape and brittle. In advance stage of infection, berries may develop which do not develop further and ripe.
   - When blossom is infected, flowers may drop. Affected berries become malformed with cracks in the skin causing pulp expose**.**

Causal Organism: *Uncinula necator*

2. **DOWNY MILDEW DISEASE**
   - Symptoms appear on all the aerial parts.
   - disease is initially observed as small, translucent, pale yellow spots with indefinite borders on the upper surface of leaves.
   - Whitish downy growth on the lowering surfaces comprises of tufts of mycelia, sporangiphores and sporangia of the fungus. On the corresponding upper surface, small, round to angular, light green/chlorotic patches is formed.
   - On the under surface of leaves and directly under the spots, a downy growth of fungus appears. The tissue in the spot is traversed by reddish lines.
   - Later, the infected areas get killed and turn brown .The growth on the lower surface becomes dirty grey.
   - Tender vines are also affected. Infected leaves turn yellow, brown and wither. Flowers die and drop. Fruits become greyish, with hardened skin and shrivels forming mummified berries.
   - The necrotic lesions are irregular in outline which enlarge and coalesce to form larger necrotic areas on the leaves, frequently resulting in defoliation.
   - Diseased shoots remain stunted. Infected leaves, shoots and tendrils are covered with whitish growth of the fungus.
   - Flowers and berries are also affected. Flowers may blight or rot.
   - During blossom or early fruiting stage, entire cluster or part of them may be attacked and become quickly covered with downy growth and die.
   - If infection occurs at half-grown stage of berries, the fungus grows mostly internally.
   - The berries become leathery, wrinkled and develop reddish to brown coloration. The fruits shed when attack is very severe.
   - The juice quality of fruit is reduced. Infection of green young shoots, tendrils, stems and fruit stalks results in stunting, distortion and thickening of the tissues which turn brown and die.

Causal organism*: Plasmopara viticola* (Berk. & Curt.) de Bary .

3. **ANTHRACNOSE / BIRDS EYE SPOT DISEASE**
   - The fungus attacks shoots, tendrils, petioles, leaves, stems and also the inflorescence and berries.
   - Numerous spots occur on young shoots. These spots may unite to girdle the stem and cause death of the tips and may also cause die-back symptoms.
   - Spots also appear on new shoots and fruits. Spots on petioles and leaves cause them to curl or become distorted.
   - On berries, characteristic round, brown sunken spots resembling "Birds Eye" appear and hence the name of the disease.
   - On leaves it appears as small, irregular, dark brown spots. The central tissue turn grey and falls. The disease appears as dark red spots on the berry.
   - Later on these spots turn circular, sunken, ashy grey and surrounded by a dark margin which gives it the bird's eye appearance.
   - The spots are 7mm in dia but these may involve about half of the fruit.

   Causal organism*: Gloeosporium ampelophagum*
4. **BUNCH ROT**
   - The disease symptoms appear on all plant parts i.e. leaves, shoots, flowers and berries. Both young and relatively older leaves are infected by the pathogen.
   - The fungus produces irregular, necrotic spots at the centre of the leaves. Under certain conditions, marginal necrosis also occurs.
   - Infected flowers normally do not develop apparent symptoms but necrosis of stamens, the solitary ovary can often be seen covered with tufts of sporulating mycelia.
   - The most prominent symptoms of the disease are found on the berries. Infected berries become dark coloured and show typical greyish, hairy mycelium all over their surface.
   - Tufts of conidiophores and conidia protrude from stomata and peristomatal cracks on the skin of the berry. Under high disease pressure, all the berries in a bunch get affected.

   Causal organism: *Botrytis cinerea* Pers. ex. Fr.
5. **BLACK ROT**
   - The disease appears on fruits as light, brownish, soft, circular spots which increase in size and the entire berry is discoloured.
   - The decaying berries begin to shrivel within a week and transformed into hard, black, shrivelled mummies.
   - On the leaf, circular red spots appear and later the margins become black. Minute black dots representing fruiting bodies of the fungus are arranged in a ring near the outer edge.

   Causal Organism: *Guignardia bidwelli* (Ell.) Viala & Ravaz.
6. **Brown Leaf Spot**
   - The pathogen is normally prevalent in neglected gardens, during July- Dec in the grape growing areas.
   - Dark brown, angular spots appear on leaves and young shoots. Sometimes young shoots get dried.
   - The disease spreads through wind- borne conidia.
   - High humidity favours the disease.
   - Maintaining the garden in a healthy and vigorous conditions through proper manuring and cultural operations keeps the disease away.

- Mancozeb (0.25%) or Bordeaux mixture (1.0%) or benomyl (0.05%) spray is quite effective.
- Varieties like Australia No.2, Champach and Champion are resistant.

Causal organism: *Cercospora viticola* (Ces.) Sacc (Perfect stage; *Mycosphaerella personata* Higgins

7. RUST

- In Tamil Nadu, this disease has been reported from Salem, Dharmapuri, Nilgiris and Coimbatore districts.
- Generally the variety, Black Prince is affected, besides attacking some wild species of *Vitis*.
- This disease is generally observed during winter season.
- The fungus produces numerous orange coloured sori on the lower surface of leaves. In severe cases of infection, entire leaf surface is covered by
- the orange coloured sori followed by defoliation occurs.
- Uredospores are binucleate with hyaline or coloured walls. These are echinulated and borne singly on pedicels .
- Teliospores found in several layers. Which are sessile and not echinulate. These are single celled with one germ pores and wall is pigmented
- The fungus attacks only the blue coloured grapes than green ones
- The disease can be controlled by spraying Zineb (0.2%) or wettable sulphur (0.2%) or dusting sulpur at 25 kg/ha.

Causal organism: *Physopella vitis* Syd.

8. CONIOTHYRIUM BLIGHT

- Isolated, reddish brown, irregular spots appear along the margins of the leaf. Affected leaf shows reddening from the margin towards the centre.
- Later, the lesions become cinnamon brown and bear pycnidia in dark encrustations.
- Leaves curl downward, wither and fall prematurely in dry weather.
- In damp weather conditions, they curl upwards and remain in the branches for longer time as compared to healthy leaves.
- Dark brown, circular shrunken areas are seen on twigs, petioles and tendrils.
- Fungus produces pycnidia. Conidia are single celled, light amber- coloured when young and dark brown when old .

Causal organism*: Coniothyrium diplodiella*

9. ALTERNARIA BLIGHT

- Characteristic symptom of the disease is the appearance of patches mostly along the margin of the leaves.
- In the initial stage, minute, yellow spots appear on the upper surface of leaves. These spots later enlarge and form brownish spots with concentric rings in them.
- In severe cases of attack, the leaves become dry defoliat.
- Causal Organism *Alternaria vitis* Cavara.

10. **DRECHSLERA LEAF SPOT**

- Produces leaf spot symptoms. Infected leaves show marginal lesions of light brown colour and gradually change to reddish brown .
- Infected portions become brittle and get detached showing shot-holes.
- Causal Organism *Drechslera rostrata* (Drechs.) Richardson & Fraser.

FRUIT ROTS

11. **PESTALOTIOPSIS FRUIT ROT**:

- The infection starts just near the peduncle or tip of fruits which spreads rapidly and covers the upper part of the fruit.
- Lesions on fruits become brownish black and leathery.
- The fungus also attacks leaves and twigs.
- Causal Organism *Pestalotiopsis menezesiana* Bres. & Torr.

12. **BLUE MOULD ROT**:

- The disease infects fruits before or after the harvest.
- It is characterized by scanty growth of the pathogen that turns bluish-green later.
- The pathogen enters through wounds or cracks in the skin. In storage and transit, the fungus decays the berries.
- The infected tissues become soft and watery. They develop a mouldy flavour also.
- In Vinifera grapes, fumigation with sulphur dioxide disease reduces the rot in storage.
- Causal Organism *Penicillium digitatum* Sacc.

13. **PENICILLIUM ROT**:

- Shallow, pinhead size, water-soaked lesions appear on the fruits. They become larger and deeper in advance stages of infection.
- The decaying fruits emit fermented, mouldy smell.
- Heavily infected fruits under humid conditions are partially or completely covered by mycelium, conidia and conidiophores.
- The fungus produces conidia which are aseptate, small and globose.
- Causal Organism *Penicillium canescens* Sopp.

14. **SOFT ROT**:

- Berries develop small brown spots. Later they become round with distinct dark brown margins. Infected tissues becomes pulpy and white mycelial growth appears after 4 to 5 days.
- The berries get completely rotten within 10 to 12 days and emit a fermented odour.
- Black pinhead-like fruiting bodies (pycnidia) develop over the entire surface of the fruit after about 12 days .
- Mycelium of the fungus is inter and intra-cellular in the host tissue. It is branched, septate and hyaline.
- Two types of conidia are present – elliptical fusoid, acute at one or both ends, generally two guttulate and hemate or flexuous and filiform types.
- Avoiding injuries to the ripe berries helps controlling soft rot.

- Bhokri(Nasik Green), a South Indian grape variety was found to be more resistant than Thompson Seedless and Kali Sahebi varieties.
- Causal Organism *Phomopsis viticola* Sacc.

15. **STALK END ROT (Black mould rot)**:
- Infected berries show brown rot at stalk end. The rotten begins as small, circular to oval, water- soaked spot. Which enlarges and turns brown.
- White mycelial growth of the fungus develops and black conidial head of the fungus is seen. Infected tissues become soft and emit bad odour.
- Diphenyl a protectant and eradicant when sprayed on cushions is effective at 1g per pack in protecting the fruits upto 15 days in storage.
- Causal Organism *Aspergillus niger* van Tiegh.

16. **RHIZOPUS ROT**:
- Round to irregular, light brown and water-soaked lesions appear on the fruits.
- These lesions enlarge and engulf the entire fruit. When diseased fruits are stored in moist chambers, white sporangiophores with black sporangia are found on the surface.
- Typical symptoms of soft, watery rot are also observed. Diseased fruits become unattractive and unfit for consumption.
- Causal Organism *Rhizopus nigricans* Ehrenb.

17. **CLADOSPORIUM ROT:**
- Black, firm and shallow decay is found localized in one side of blossom end . The fruits become wrinkled on the infected side. Sparse growth of grey-green fungus may be seen on the fruits.
- The infection occurs through uninjured skin or wounds or cracks at the blossom end.
- The disease can be controlled by sulphur fumigation( ) and by cooling and storage of fruits at a temperature range of 0.55 to 0.00°C.
- Causal Organism *Cladosporium herbarum* (Pers.) Sacc.

18. **BITTER ROT**:
- Ripe and unripe berries just near the peduncle are affected. It causes light brown to dark, fuliginous full of dense acervuli.
- Brown, hard depressed patches on the berries which subsequently bear numerous black, dot- like fructifications.
- Grapes harvested with small lesions develop typical rot symptoms which deteriorate in transit and storage.
- Causal Organism *Greenaria fuliginea* Scribner & Viala.

19. BACTERIAL CANKER
- Small irregular water soaked spots appear on leaves, that translucent to light and have a necrotic pinhead sized centre.
- Numerous spots coalesce to form large patches.
- Severely infected leaves defoliated.

- On the stem disease starts as brown black spots around nodes. In advance stage girdling and cracking of nodes occurs.
- Finally it leads to break down of the plant.

Causal Organism: *Xanthomonas campestris* pv. v*iticola* (Nayudu) Dye.

20. BACTERIAL LEAF SPOT

The spots on the leaves are dark brown . Sometimes they coalesce to form larger spots.

- Vein infection is also common. Petioles and stems show elongated cankers.
- The infected leaves after drying are firmly attached to the stem. These leaves crumpled very easily.
- The bacterium is non- capsulated, gram negative and lophotrichous.
- Old, dry leaves attached to the grapevines and the stem cankers act as primary sources of inoculum.
- The bacterium infects neem and *Phyllanthus maderaspatensis*.
- Rain water disseminates the bacterium. The disease is severe during rainy season.

Causal Organism *Pseudomonas viticola* Patel *et al*.

21. FAN – LEAF

- Infected young leaves show variegated mottling.
- The malformed leaves have open petiolar sinuses. Widening of the petiolar sinuses and reduction of areas between the veins give the impression of a half-closed fan.
- Affected leaves stand upright along the axis of young shoots and become cup-like.
- The dark green areas in the mottled leaf bulge upward and leaf surface become rough.
- The characteristic symptom of the disease is the underdeveloped leaves.
- The infected leaves turn light yellow and show cupping.
- The distance between internodes is reduced and nodes and internodes become thin and weak. Growth becomes zig-zag at the nodes.
- Few lateral branches are produced and axillary branches proliferate to produce small, thin and weak, secondary branches.
- Infected plants do not produce flowers and fruits even at the age of three years.
- Plants become stunted and produce very few and weak rootlets.

Causal organism: Grapevine fan leaf virus (GFLV).

22. LITTLE LEAF

- The leaves on infected vines become extremely small and develop light yellow colour.
- Internodes and stems are reduced to a great extent and develop in zig-zag fashion.
- Axillary buds proliferate. Flower and fruits do not develop on infected vines.
- Roots become stunted and only a few weak rootlets develop.

Causal organism: Phytoplasma like organism .

Exercise-3

DISEASES OF PAPAYA

Diseases of papaya:

(A) FUNGAL DISEASES:
(1) Powdery Mildew: *Odium indicum* Kamat, Odium caricae Noack, *Leveillula taurica* (Lev.) Arnauld
(2) Leaf- Blight: *Corynespora cassiicola* (Burk and Curt).
(3) Damping-Off : *Pythium aphanidermatum* Nirvan; *Rhizoctonia solani* Subramaniam.
(4) Foot Rot : *Pythium aphanidermatum* Nirvan.
(5) Anthracnose: *Colletotrichum gloeosporioides* Penz.

(B) VIRAL DISEASES
Papaya Mosaic
Leaf Curl of Papaya
Papaya Ring Spot Virus (PRSV) disease
(C) POST HARVEST DISEASES OF PAPAYA:
(A)FRUIT ROT OF PAPAYA:
(1). Macrophomina Rot: *Macrophomina phaseoli* (Maubl).
(2) Rhyzophus Rot or Soft Rot: *Rhizophus stolonifer* (Ehr.)
(3) Phomopsis Rot: *Phomopsis caricae* (Pterrak and Cif)
(4)Anthracnose: *Colletotrichum gloeosporioides*

Powdery Mildew disease

CAUSAL ORGANISM :(*Odium indicum*, Odium caricae, *Leveillula taurica*):

- The disease appears 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.
- In more severe cases dieback symptoms develop.

Leaf- Blight

Causal organism: (*Corynespora cassiicola*):

- The disease causes severe damage to leaves.
- It first appears as small, discoloured lesions, 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 may die.
- A considerable reduction in the yield is observed.

Damping-Off of Seedlings

CAUSAL ORGANISM : (*Rhizoctonia solani;* *Pythium aphanidermatum* Nirvan):

It is also one of the serious diseases caused by fungi.

- This is a disease of young seedlings. On collar region discoloration takes place initially.

- Lesions are seen on the stem at or just above soil level.
- The stem becomes watery and shrinks, followed by death of the plant.

Damping off; Foot Rot
Causal organism:(*Pythium aphanidermatum*)

- In case of nursery plants, damping off symptoms are produced, whereas in adult plants foot rot, collar rot symptoms are produced.
- Foot rot is characterized by the appearance of water-soaked patches on the stem near ground level.
- These patches enlarge rapidly and girdle the stem, causing rotting of the tissues, which then turn dark brown or black. The affected internal tissues give a honey comb like appearance.
- Simultaneously, the terminal leaves of infected plants turn yellow, start drooping and fall off.
- The infected plants cannot withstand strong wind and topple down to die.
- If the disease attack is mild, only one side of the stem rots and the plants remain stunted.
- Fruits if formed are shrivelled and malformed. Gradually the plant dies.

Anthracnose Disease
CAUSAL ORGANISM :(*Colletotrichum gloeosporioides*):

- The disease prominently appears on green leaves and also on green immature fruits.
- The symptoms appear 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 become soft, watery and which spreads to the entire fruit.
- Small, irregular-shaped, water-soaked spots on leaves may also be seen. These. spots eventually turn brown.
- On fruits, 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 enlarge to form water soaked lesions.
- The flesh beneath the infected portion becomes soft and starts rotting.

Papaya Mosaic Disease
CAUSAL ORGANISM: PMV

- The disease attacks 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 first on the top young leaves
- 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.
- Infected plants show a marked reduction in growth.
- Fruits borne on diseased plants develop water soaked lesions with a central solid spot. Such fruits are elongated and reduced in size.

Leaf Curl Disease of Papaya:

The disease effects yield and quality of fruits and serious losses are caused in terms of production and productivity.

- The disease is transmitted by the vector white fly (*Bemisia tabaci)*.
- Severe curling, crinkling and deformation of leaves characterize the disease and mostly the young leaves are affected.
- Apart from curling, leaves also exhibit vein clearing and thickening of the veins.
- Sometimes the petioles are twisted. In severe cases complete defoliation of the infected plant is observed.
- The infected plants show stunted growth with reduced fruit yield.

Papaya Ring spot Virus Disease

- Yellowing and vein-clearing of young leaves are the earliest symptoms on papaya.
- It is followed by a very conspicuous yellow mottling of 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 fruits. It consists 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 dark 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.
- Other key symptoms are the intense yellow mosaic on leaf lamina and numerous "oily" streaks on petioles.
- The leaf canopy becomes smaller as the disease progresses due to development of smaller leaves and stunting of the plant.
- Fruit yield and levels are markedly lower than fruit from healthy plants. Leaf and fruit symptoms are most intense during the cool season.
- Leaves often develop a shoe-string appearance caused by the extreme reduction of leaf lamina similar to that caused by broad mites.
- Papaya trees of all ages are susceptible and generally will show symptoms two to three weeks after inoculation.
- Trees infected at a very young stage never produce fruit but rarely die because of the disease.
- There are, however, some strains which cause wilting and sometimes death of young trees.

POST HARVEST DISEASES OF PAPAYA:

Fruit Rot of Papaya:

Causal Organism: Caused by *Macrophomina phaseoli*

(1). Macrophomina rot: Caused by *Macrophomina phaseoli*

Macrophomina rot appears as small, water soaked spots on fruit surface. Gradually, such spots become deeper and sunken causing rotting of inner tissues. Subsequently, small sclerotia develop

on these spots. The inner tissues of such fruits develop brownish black colour having dark mycelial growth.

(2)Rhyzophus rot or soft rot: Caused by *Rhizopus stolonifer*

Rhizopus fruit rot or watery fruit rot develops on injured fruits producing irregular, water soaked lesions. These lesions are in due course, covered with whitish fungal growth which later turns dark brown. The fruit becomes watery and emit foul smell. Infection spreads quickly to the adjoining fruits.

Causal Organism: The sporangiophores are produced on arching stolons, usually borne on opposite tuft of rhizoids and typically unbranched sporangiophores.

(3)**Phomopsis rot**:

Causal Organism: *Phomopsis caricae*

Initially water - soaked spots appear which become sunken and dark brown to black in advance stages. Some times such spots are surrounded by white raised tissues on the side. The whole area becomes soft and pulpy giving the typical appearance of soft rot.

(4). Phytophthora rot:

Causal organism: *Pytophthora palmivora*

Phytophthora rot appears as small, water soaked lesions on fruit surface. Gradually, such lesions become deeper and sunken causing rotting of inner tissues. Subsequently, it produces white coating that comprising of sporangio phore and sporangia and covers all external surface of the ripened fruits.

Exercise-3

DISEASES OF APPLE (*Malus domestica*)

Apple scab	*Venturia inaequalis*
Powdery mildew	*Podosphaera leuchotricha*
Cedar rust	*Gymnosporangium juniper- verginiane*
Fire blight	*Erwinia amylovora*
Crown gall	*Agrobacterium tumefaciens*
Black Rot	*Botryosphaeria obtuse*
Sooty blotch	*Leptodontium elatius*
Flyspeck	*Zygophiala jamaicensis*
Phytopthora Crown Rot, Collar Rot, and Root	*Phytophthora* sp

1. Apple Scab

Causal organism: *Venturia inaequalis* (Cooke) Wint.

- Infections are most obvious on leaves and fruit
- When infection first occurs on leaves, it is visible as a lighter shade of green
- As the fungus leaf tissue in that area die inner portion of the lesion become grey - brown
- Under severe conditions, the whole leaf give a velvet appearance, a phenomenon known as scab, this condition lead to premature defoliation.
- Foliar lesions which are formed in the autumn appear on either surface of the leaf as a small, round, tan or black spot that closely resembles other fungal lesions which can affect apple leaves.
- Early infection of the fruit often results in large lesions which deform the fruit and may cause its dropping.

2. FIRE BLIGHT

Causal organism: *Erwinia amylovora* (Burrill) Winslow

- Blossom blight symptoms most often appear within one to two weeks after bloom and usually involve the entire blossom cluster which wilts and dies
- When weather is favourable for pathogen development, globules of bacterial ooze can be seen on the blossoms.
- The tips of young infected shoots wilt, forming a very typical "shepherd's crook" symptom.
- As the infection spreads down the shoot axis, the leaves first show dark streaks in the mid veins, that wilt and turn brown
- As with blossom infections the pathogen often invades and kills a portion of the limb supporting the infected shoot.
- In addition, the petioles and mid veins of the basal leaves usually become necrotic before those at the shoot tip.
- Depending on the cultivar and its stage of development at the time of infection a single blossom infection can result in the death of entire limb and where trunk of the tree is invaded, a major portion of the tree can be killed in just one season.

4. Powdery Mildew

Causal organism: *Podosphaera leucotricha* (Ell. and Eva.) Salmon

- Symptoms of powdery mildew infection may appear on the primary leaves, buds, shoots, blossoms, and fruits.
- On leaves the symptoms most often are seen as whitish, felt-like patches of fungal mycelium and spores.
- These most commonly appear first on the lower surface of the leaves.
- Lesions may also appear on the upper surface as chlorotic spots, or cover the entire leaf with powdery white spores and mycelium.
- Curling and crinkling of leaves can occur as a result of infections along the leaf margin.
- Leaves infected severely by the disease may defoliate buds which are infected with powdery mildew can become more susceptible to winter injury.
- Fruit infections on certain cultivars may result in a netlike russeting.

5. Cedar apple rust Disease

Causal oragnism: *Gymnosporangium juniperi virginianae*.

Infection first appears on apple as bright yellow-orange lesions on the upper surface of leaves, petioles, and young fruit. Lesions may be bordered by a red band or a chlorotic halo. Lesions that occur on fruits are superficial and do not extend more than 1/16 inch into the flesh. They occur most often on the calyx end of the fruit. On cedar the fungus produces brown to reddish brown leaf galls.

6. BlackRotdisease

Causal organism: *Botryospaeria obtusa* (Schwein)Shoemaker

- Signs of leaf infection usually appear 1-3 weeks after petal fall and become visible as small, purple flecks that enlarge to form circular lesions.
- The margins of the lesions remain purple while the centers become tan to brown.
- This disease is often called "frogeye leaf spot" due to these symptoms.

7. Sooty blotch disease of apple

Causal organisms: a complex of fungi which includes *Leptodontium elatius* (G. Mangenot and *Geastrumia polystigmatus* Batista

- Colonies of the fungal pathogen on the fruit resemble sooty or cloudy olive green blotches on the surface of the fruit.
- The fungus grows superficially on the fruit surface which can be easily wiped out.
- 7.Flyspeck Disease
- Causal organism: *Zygophiala jamaicensis* E. Mason

8. Flyspeck appears on the fruit as well-defined groups of shining black dots which grow on the surface of the fruit. Areas of these dots are usually less than an inch in diameter. Fungi grow superficially on the fruit which can be wiped out from the surface easily.

9. Phytopthora Crown Rot, Collar Rot, and Root Rot of Apple

Causal organisms: fungi in the genus Phytopthora

- Rottening of may be seen at or below the ground line and may extend from the original site of infection into the root system and up the trunk to the bud union and above the bud union if the scion is also susceptible. Infected bark is brown and often slimy when wet.

- When infected bark is pulled, the cambium and phloem will be seen as an orange, reddish brown color.
- The rottening of tissues caused by the fungus girdle the tree resulting in poor vegetative growth of the tree with chlorotic foliage that may turn purple in the autumn.
- A severely infected tree may die. Trees may be killed in one growing season or may survive for a number of growing seasons.

Exercise-4

DISEASES OF JACK FRUIT

Diseases of jack fruit

Major Diseases

1. Die back (*Botryodiplodia theobromae*)
2. Fruit rots
    a. *Rhizopus artocarpus*
    b. *Rhizopus nigricans*
    C. *Phytopthora palmivora*

Minor Diseases

a. Leaf spot- *Phyllosticta artocarina*

b. Pink disease- *Botryobasidium salmonicolor* & *Corticium Salmonicolor*

1. Die back

C.O (*Botryodiplodia theobromae*

- Discoloration and darkening of the bark from the tip downwards.
- It advances and young green twigs start withering from the base towards veins of leaf edges.
- Infected leaves turn brown with their margins rolling upwards.
- Infected twigs or branches shrivel due to necrosis and fall down, there may be exudation of gum from affected branches which may then attacked by shoot borers causing internal discoloration of the twigs.
- On infected twigs, erumpent aceruvuli of *Colletotrichum gloeosporioides* can be seen.

2. Fruit rots

C.O: *Rhizopus artocarpi*

- Young fruits & inflorescence are badly attacked by the fungus and only a fruits reach maturity. Female inflorescence and mature fruits are generally not infected.
- It is a soft rot disease causing dropping of a large no. of affected fruits.
- Initially the fungus appears as a greyish growth with abundant mycelia that gradually become dense forming a black growth.
- The fungus advances slowly until the whole fruit or entire inflorescence become rotten and drop.

3. Phytophthora rot

C.O: Phytopthora palmivora

- Infection takes place through bruised or wounded skin in rough skinned varieties and through wounds in smooth skinned verities.
- Water socked lesions appear within 48-78 hours of inoculation. These become enlarged to form light brown spots with sporulating hyphae near the edge. Infected fruits develop soft rot.
- The damage caused to the bark of crown roots or bark of the trunk is called as Phytophthora gummosis, collar rot or foot rot.

1. Leaf spot

C.O: (*Pestalotiopsis clostica*)

- It produces white spots with broad dark margins on the leaves which can be controlled by spraying Bordeaux mixture (1.0%).
- Another fungus *Pestalotiopsis clastica* also causes leaf spots. It is characterized by dark brick red spots on both the leaf surfaces in mature spots and the centres become grayish with erupted dark acervulus (*colletotrichom gloeosporioides).* The margins of the spots turn dark brown.

  2.Pink disease

  C.O: (*Botryobasidium salmonicolaor* & *Corticium Salmonicolor*)
- It is widespread in tropical and subtropical areas.
- Disease appears as a pinkish powdery coating on the stem.
- Pink colour represents profuse conidial production of fungus.

- Young woody branches of the affected trees lose their leaves & show die back symptoms. Pink encrustation is seen on the lower shaded side.

DISEASES OF PEAR

Diseases	Causal organisms
1.Pear scab	: *Venturia inaequalis*
2.Powdery mildew	:*Podosphaera leucotricha*
3.Pacific Coast Pear Rust	:*Gymnosporangium libocedri*
4.Fire blight	:*Erwinia amylovora*
5.Crown gall	:*Agrobacterium tumefaciens*
6.Fabraea Leaf Spot	:Fabraea maculata
7 .Pear decline	*:*Phytoplasma like organism

8.Phytophthora Crown Rot, Collar Rot, and Root: *Phytophthora* sp.

1. Powdery mildew disease of pear

Casual organism- *Podosphaera leucotricha*

- On leaves- White powdery growth appears on upper and lower side comprising of oidia
- On stem- whitish powdery growth
- On fruits- whitish powdery growth but in dry condition

2. FIRE BLIGHT DISEASE OF PEAR

Causal organism*: Erwinia amylovora*

- Infected parts appear to be scorched by fire. A watery ooze may exude from infected plant parts. The disease may kill entire trees. Fruits infected early remain small, appear shrivelled, dark and 'water soaked'. They remain attached to the cluster.
- Fruits infected late are less tasty

3. Pacific Coast Pear Rust Disease

Causal organism: *Gymnosporangium libocedri*

- Leaf: Spots on the leaf fade and darken as the leaf matures or falls from the tree. Green shoots and leaves also are attacked but not so frequently.
- Fruit: Pear fruits are malformed while young and drop from the tree. Bright yellow to orange spots with numerous cup-shaped pustules (aecia) develop over the fruit surface.
- Oriental and european cultivars are susceptible. 'Winter Nelis' is severely infected where as 'Bartlett' is resistant.

4. Fabraea Leaf Spot disease

Causal organism: *Fabraea maculata*

- Leaf :spot can be found on petioles, leaves, shoots and fruits. Initial lesions on leaves are tiny, round, purplish-black spots which quickly enlarge to $1/8^{th}$ - $1/4^{th}$ inch in diameter and usually have a blackish-brown center (photo 2-46).
- Spots coalesce and severely infected leaves fall to the ground prematurely. A small black acervulus may develop at the centre of each lesion,from which conidia ooze out in a creamy, white mass in wet weather.
- Fruit :lesions (photo 2-47) are larger than those on leaves and cause the fruit to crack and drop.
- Lesions on current season's shoots may be observed as small inconspicuous, purplish-black spots.
- Some lesions develop into superficial cankers, but most are walled-off during the next growing season, as the cankers rarely persist in two-year-old wood.

5. Phytopthora Crown Rot, Collar Rot and Root Rot disease

Causal organism: *Phytopthora* spp.

- Cankers may be seen at or below the ground level which may extend from original site of infection to the root system or up the trunk to the bud union level and above it if the scion is also susceptible. Infected bark is brown and often slimy when wet.
- When the bark is pulled out, the cambium and phloem show an orange, reddish brown color.
- The cankers caused by the fungus girdle the tree, resulting in their poor vegetative growth and chlorotic foliage that may turn purple in the autumn.
- A severely infected tree may die. Trees may be killed in one growing season or may linger for a number of growing seasons

6. Pear –decline

Casual organism: Phytoplasma like organism

- Pear decline is characterized by two phases: quick decline and slow decline.
- Trees may wilt, scorch, and die in a few weeks or lose vigor over several seasons during which foliage gets sparse with little or no terminal growth and leaf size reduced.
- An abnormal early red leaf coloration has been observed generally on infected trees.
- Examining the graft union reveals a brown line on the cambial face of the phloem tissue. (Use a pocket knife to expose the cambium.)

7. Pear scab

Casual organism: *Venturia pirina*,

In spring, sooty spots with soft velvety look appear on young fruit, stems, calyx lobes, or flower petals.

- Fruit :Young infected fruit frequently drops or misshapen. Scab spots expand with growth until stopped by dry weather or sprays. Old fruit infection often, cause crack.
- Cracks are surrounded by russeted, corky tissue and then an olive-color ring of active fungal growth.
- If when fruit is infected late in the season, about two week before harvest, pinpoint scab spots often show up in storage after a month or more.
- On leaves: olive-black spots expand with the leaf growth but often cause the leaf to twist abnormally.

- Infected twigs show small blisterlike infections, the size of a pinhead and develop a corky layer. Many twig infections are sloughed off during the summer season.

8. Crown gall

C.O: *Agrobacterium tumefaciens*

- The disease first appears as small overgrowths or galls on the roots, crown, trunk or canes.
- Galls usually develop on the crown or trunk of the plant near the soil line or on underground roots.
- Above ground or aerial galls may form on canes of brambles of highly susceptible cultivars of pear. Aerial galls are not common on fruit trees.

Exercise-5
DISEASES OF POMEGRANATE

A) MAJOR DISEASES

1. Cercospora leaf spot - *Cercospora punicae*
2. Bacterial blight -*Xanthomonas axonopodis* pv. *punicae*
3. Leaf spots - *Colletotrichum gloeosporioides*
   -*Sphaceloma punicae*
   - *Fusarium fusaroidies*
   -*Phomopsis aucubicola*
   -*Drechslera rostara*

B) Minor diseases

1. Canker -*Ceuthospora phyllosticta*
2. Leaf and fruit spot -*Coelophoma empetri*
3. Flower and fruit spot -*Phytophthora nicotianae*
4. Fruit Spots -*Beltaraniella humicola*
   -*Pestalotiopsis versicolor*

5. Fruit rots

a. Cladosporium fruit rot- *Cladosporium oxysporum*
b. Aspergillus fruit rot -*Aspergillus spp.*
c. Mild softrot- *Penicillium chysogenum*
d. Soft rots- *Rhizopus arrhizus & R. stolonifier*
e. Dry rot- *Syncephalastrum racemsum*
f. Fusarium rot- *Fusarium equiseti*
g. Phomopsis rot- *Phomopsis sp.*

6. Root knot nematode- *Meloidogyne incognata*

1.Cercospora leaf spot

Causal organism: *Cercospora punicae* P.Henn.

- Light brown zonated spots appear on leaves and fruits.
- Black , elliptic spots appear on the twigs.
- The infected areas in the twigs become flattened and depressed with raised edges.
- Such infected twigs become dry and in severe cases the whole plant dies.

2. Bacterial blight:

Causal organism: *Xanthomas axonopodis* pv. *punicae*

- Small, irregular, water soaked spots appear on the leaves.
- Spots vary from two to five mm in diameter with necrotic centre of pin-head size.
- Spots are translucent which turn light brown to dark brown after sometime and are surrounded by prominent water-soaked margins. Spots coalesce to form large patches.
- Severely infected leaves defoliated.
- The bacterium attacks stems, branches and fruits also.
- On stem, the disease starts as brown to black spots around the nodes .It further causes girdling and cracking of nodes. Finally the branches get broken.
- Brown to black spots formed on fruits which are raised and oily in appearance.

3. Leaf spots:

Causal organism: *Colletotrichum gloeosporioides*

- The disease appears as small, regular to irregular, dull violet or black spots on the leaves.
- These spots are surrounded by yellow margins.
- The infected leaves turn yellow and defoliate.

4. Leaf spot disease

Causal organism*: Sphaceloma punicae* (Bitancourt and Jenkins)

- The disease attacks leaves, shoots, calyx and fruits.
- Rusty spots appear on leaves. Infected leaves turn yellow and die, Rusty colored pustules appear on fruits.
- Drizzling rains and abundant dew favour disease development and spread.

5. Fusarium wilt:

Causal organism: *Fusarium fusarioides* (Farg &Cif)

- The disease appears as minute specks towards the leaf margin.
- The spots are brown, circular to irregular in shape which coalesce and form big dark brown necrotic blotch at a later stage.

6. Canker

Causal organism: *Ceuthospora phyllosticta*

- Elliptic black spots are formed on twigs.
- Infected areas become flattened and depressed with raised edge.
- Later the bark becomes dry which cracks and the wood below show abnormal, dark brown to black discoloration.
- Twigs beyond the cankerous spots turn dry and in severe cases the infected trees become dead.

7. Leaf and fruit spot:

Causal organism: *Coelophoma empetri* (Rostrup)

- On leaves the spots appear as circular, reddish and brown to dark brown in colour.
- These spots coalesce to form bigger sized lesions which are necrotic and dark brown.
- The infected leaves turn pale yellow and drop at a later stage.
- Numerous minute, circular, tan brown spots appear on fruits which turn brown to black later.
- The spots coalesce to form irregular, depressed and hard necrotic lesions.
- Lesions are restricted to epidermis baring black, spherical pycnidia.

Flower and fruit spot

Causal organism: *Phytophthora nicotianae*

- Diseased spots on flower result in premature shedding.
- Lesions are also formed on fruits.
- Twigs in the trees are also infected.

4. Fruit Spots Disease

Causal organism *:Beltaraniella humicola*:

- Black, circular spots appear that gradually enlarge and coalesce to form big spots and cause necrosis.
- The margin of spots varies from reddish to brown in colour.
- Infection is restricted to rind of the fruit and undesirable of the pulp.

Causal organism*: Pestalotiopsis versicolor* (Speg.)

- The disease manifests its symptoms as minute, brown to rust coloured spots on the fruits.
- The spots coalesce with the disease development and cause necrotic patches.
- The central portion of the lesion is depressed inwards with raised margin and in case of severe infection, tear open the rind.
- In several cases infection penetrates deep into the fruits and causes discoloration of seeds.

5. Fruit rots:

(a)Cladosporium fruit rot disease

Causal organism: *Cladosporium oxysporum*

- The diseased fruits develop orange-red to dull-brown circular spots which become olive-brown. In advanced stage of the disease, the entire fruit rots. Hyphae of the fungus are septate.
- Light olive-green, 2.5 - 30 µm in width; conidiophores are light brown and simple; conidia light brown to olive green, 1-celled, fusoid and 1 - 20 x 3.5 - 4.5 µm.

(b)Aspergillus fruit rots:

Causal organism: *Aspergillus flavus* (Link)

- It causes brown discoloration which gradually becomes blackish and slimy.
- Later, it gets slightly depressed and covered by green conidial heads of the fungus.
- The disease causes soft rot of fruits and emit fermented odour.

(c) Mild soft rot:

Causal organism: *Penicillium chrysogenum* (Thom)

Symptoms

- Soft, watery spots of two to four cm diameter appear on the fruits. They increase in size and coalesce together. The spots are found covered with white mycelia and bluish green spores.

(d) Soft rots:

Causal organism: *Rhizopus arrhizus & R. stolonifer (Fisher)*

- Small spots appear on fruits which increase in size and coalesce. Infection is restricted to rind, but the entire internal content decays into a pulpy mass.
- Under dry conditions, cracks originate from the point of infection. Packing straw should be treated with sulphur dioxide.
- Treatment of fruits with linseed oil or mustard oil or castor oil protects them from rotting.

(e) Dry rot:

Causal organism: *Syncephalastrum racemosum (Cohn)*

- Small, isolated dark patches are formed on surface of the fruits which turn dry and covered with mycelium and spores of the fungus.
- Inner pulp rots.

(f) Fusarium rot:

Causal organism: *Fusarium equisetti (Corda)*

- Circular and depressed lesions appear on the fruits. Lesions are surrounded by concentric wrinkle.
- These lesions increase in size and cover almost the entire fruit.

(g) Phomopsis rot:

Causal organism: *Phomopsis* sp.

- The disease starts from calyx end and gradually spreads over the entire fruit. Pycnidia appear on infected areas.
- One spray with copper oxychloride (%) checks the spread.
- Copper oxychloride (0.5%) spray, three times at ten days interval, controls the disease.

6. Root knot nematode*:*

Causal organism: *Meloidogyne incognita*

- Gradual yellowing of plant; stunting, root discoloration, formation of knots on the roots, root decay and finally plant collapse, are the major symptoms.

Exercise-6

Disease of BANANA (*Musa paradisiaca*)

Major diseases of banana

1. PANAMA DISEASE- *Fusarium oxysporum* f.sp. *cubense*
2. MOKO WILT / DISEASE (Bacterial wilt)-*Ralstonia solanacearum*
3. SIGATOKA LEAF SPOT- *Cercospora musae*
4. ANTHRACNOSE- *Colletotrichum musae*
5. BUNCHY TOP- *Banana bunchy top virus*
6. STEM END ROT- *Ceratocystis paradoxa*
7. BURROWING NEMATODE- *Radopholus similis*
8. BLACK SPOT- *Phyllosticta musarum*
9. INFECTIOUS CHLOROSIS- *Cucumber mosaic virus*

Minor diseases on banana

1. CROWN ROT – Several fungi
2. BLACK SPOT/BLACK TIP/SPECKLE/PIN SPOT/ - *Deightoniella torulosa*
3. FINGER ROT – *Botryodiplodia theobromae*
4. PITTING DISEASE OR JOHNSON SPOT – *Pyricularia grisea*
5. DIAMOND SPOT – *Cercospora hayi* and *Fusarium* spp.
6. CIGAR END ROT – *Trachysphaera fructigena* and *Verticillium theobromae*
7. SQUIRTER DISEASE – *Nigrospora sphaerica*

1. PANAMA DISEASE of Banana

Causal organism: *Fusarium oxysporum* f.sp. *cubens* (E.F SMITH)

- Fungal pathogen blocks the vascular system and causes wilting.
- Older leaves yellowing is the Initial symptom
- The infected plant shows yellowing of leaf blades, developing as a band along the margin spreading towards midrib
- The leaf wilts and the petiole buckles
- The leaf hangs between the pseudostem while the middle of lamina is still green.
- After four to six weeks, only the pseudostem remains, with dead leaves hanging round it. The cut stem smells like rotten fish
- Pseudostem splitting is common in Fusarium affected plants
- The plants emerged from suckers growing out of diseased corms also wilt and die.

2. MOKO DISEASE (WILT)

Causal organism : *Ralstonia solanacearum* (Yubucchi *et al.*)

- Yellowing of younger leaves is the primary symptom.
- Yellowing progresses downward gradually leading to drooping and drying of leaves
- Fruit bunch size gets reduced with immature and irregular ripening of fruits. Infected fruits show cracking with bacterial ooze
- Vascular browning of the fruit along with light coloured vascular discolouration is common

3. SIGATOKA DISEASE

Causal organism: *Cercospora musae* (Zimm.)

Symptoms

- Light yellow or brownish green narrow streaks which enlarge in size developing into linear, oblong, muddy brown to black spots.
- In central portion necrotic circular spots appear on older leaves. The spots lead blight formation and splitting of leaf lamina, complete leaf drying followed by defoliation.

4. ANTHRACNOSE/ FRUIT ROT disease

Causal organism : *Colletotrichum musae* (BERK AND CURT)

- Symptoms can be seen at the distal end of banana. The skin turns black, shrivels and covered with characteristic pink colored asexual fruiting body,the acervulus.
- As the disease advances, it spreads to entire finger, and entire bunch resulting in premature fruit ripening.
- The shrivelled fruits use covered with pink spore masses which finally rot. Ripe fruits are more susceptible than unripe fruits
- Latent Infection: Usually originates in the field on uninjured fruits. When fruits approach maturity, the fungus resumes activity and causes typical lesions on ripe fruits.
- Non-latent Infection: It usually begins during or after harvest as small, peel wounds and continue to develop without dormancy.

5. BUNCHY TOP DISEASE

Causal organism: *Banana bunchy top virus*

- The infected leaves show green streaks on the secondary veins on the under side of lamina, midrib and petiole
- The powdery bloom covers midrib and petiole, the dark green lines with ragged edge appear if rubbed
- Leaves remain dwarf, they also show marginal chlorosis and curling. The leaves are brittle in texture and petioles incompletely elongated
- The leaves become smaller and eventually the crown of the plant become composed with stunted growth, the rosette or bunchy leaves
- Fruit bunches are reduced, lower hands of the bunch often die down

6. STEM END ROT DISEASE

Causal organism: *Ceratocystis paradoxa* (DADE)

- Brown or water soaked patches formed on the rhizome.
- The stalks decay rapidly, the tissues become soft and blackened and have a characteristic sweet smell.
- The fungal pathogen spreads to the fruit where it causes uneven black discoloration of the skin. The pulp is reduced to a dark brown soft wet mass and premature ripening of fruits.

7. BURROWING NEMATODE:

Causal organism: *Radopholus similis*

- Show yellowing of leaves and root discoloration, forms tunnels on suckers, followed by root decay and finally complete plant colla

8. BLACK SPOT DISEASE

Causal organism: *Phyllosticta musarum*

- Minute black spots appear on leaves and fruits
- The spots are brown to dark brown initially
- Spots are abundant on the upper surface which are raised
- Leaf turns yellow in colour in advance stage of infection
- On fruits the pathogen is confined to the skin.

9. INFECTIOUS CHLOROSIS

Causal organism: *Cucumber mosaic virus*

- Chlorotic or yellow green lands on leaves, upward curling of leaves, mottling of young leaves.
- Sometimes heart rot symptoms also appear.
- Diseased plants are unable to reach maturity.

1. CROWN ROT:

Causal organism*: Botryodiplodia theobromae, Colletotrichum musae, Botryodiplodia theobromae, Fusarium roseum, Verticillium theobromae and Acromonium sp.*

- The disease is implicated in the more severe form in the main stalk rot in which splitting of stem occurs.
- The disease is a problem when shipment is done in boxes only and not in bunches. Softening and blackening of crown tissue during ripening of fruits are the first symptoms.
- The fungus also extends through cushions and causes finger stalk rot and finger dropping.
- It is some times associated with fruit spots and blemishes.
- The infection originates in or immediately below the decayed perianth or styles and spreads uniformly along the fruit and cause a progressive brownish black discoloration and softening of the pulp.

2. CIGAR END ROT

Causal organism: *Verticillium theobromae* (TURC) and *Trachysphaera fructigena*

- It attacks even the immature fruits. In some bunches only some fruits are infected where as in others each and every finger shows the disease symptoms.
- The initial infection in the perianth slowly spreads along with the finger causing blackening of the skin, shrinkage and folding of tissues.
- The corrugated diseased portion becomes covered with powdery conidiophores and conidia of the fungus that resembles the ash on a cigar end and hence the name cigar end disease.

3. BLACK SPOT/BLACK TIP/SPECKLE/PIN SPOT

Causal organism: *Deightoniella torulosa*

- The fungus causes complex symptoms. It causes black spot on leaves, black tip or black end and hand speckle on fruit and also causes rottening of leaves and pseudostem.
- Fruit speckling or spotting are the most common symptoms and which use reddish to black in colour with dark green halo around each spot
- Finger tip or black tip are associated with injury to the tip. Black discolouration appears just below the flower i.e. fruit tip.

4. FINGER ROT

Causal organism*: Botryodiplodiplodia theobromae*

- The fungus invades the fruits through wounds or injuries and the pulp turn rapidly turns into a black, watery mass. It spreads more rapidly as the fruit ripens and may affect the whole finger. Greyish black mycelia on the surface is the characteristic symptom of the disease.

5. PITTING DISEASE OR JOHNSON SPOT

Causal organism*: Pyricularia grisea*

- It begins as small, reddish spot on the skin of the green fruits nearing maturity. These develop into typical black pits of 4 to 6 mm diam. Spots on bunch stalk.

6. DIAMOND SPOT

Causal organism: *Cercospora hayi* and *Fusarium* spp.

- Raised, yellow spots of 3-5 mm on the peel is the first symptoms. The infected cells are unable to expand as the fruit develops and as a result, a longitudinal crack develops, surrounded by a yellow halo. These spots then show characteristic diamond necrotic spots. Pulp may be exposed in some cases.

7. SQUIRTER DISEASE

Causal organism*: Nigrospora sphaerica*

- This pathogen penetrates through broken stem ends and converts the inner pulp into a dark watery fluid. When a badly infected banana is squeezed, the contents are ejected and hence the name, SQUIRTER DISEASE which is common on singles

Exercise-7

DISEASES OF PINEAPPLE –*Ananas comosus*

MAJOR DISEASES

1. Heart rot: *Phytopthora cinnamomi* and *Phytopthora parasitica.*
2. Base rot: *Ceratocystis paradoxa*
3. Wilt: pine apple wilt virus
4. Pink disease: -*Pantoea citrea*

MINOR DISEASES:

1. Fruit let core rot: *Penicillium spp.*

Bacterial fruit rot: *Pantoea ananas* pv. *ananas.*

1. Heart rot

Causal organism*: Phytopthora cinnamomi* and *Phytopthora parasitica.*

- In the field, heart rot disease of young plants can be suspected where there is a change in the colour of leaves from normal green to yellowish green and browning of the leaf tips.
- The bases of the leaves shown yellowish white rotten area bordered by distinct and characteristic brown margin.
- The chlorophyll region commences?
- The affected area gives a odour due to secondary bacterial invasion.
- The rot extends the stem of the plant producing a soft cheese-like rotting condition.
- The roots of plants are largely destroyed with the result that the plants remain stunted and fruit formation is delayed or dose not form at all.

2. Base rot

Causal organism: *Ceratocystis paradoxa*

- It is typically the black rot of butt of the plant.
- The soft tissues are destroyed and only stringy fibers decay of the butt is followed by wilting of the foliage and the diseased plants break off at low level
- The leaves show grey spots with dark margin which turn olive brown or white. With advancement of the diseases tissues become dry and leaves are destroyed.
- Finally the skin flesh and core get disintegrated.
- The fruit decay is accompanied by a sweetish smell and the fungus can be found on the rotting tops and suckers left lying in heaps in damp situation.

3. WILT

Causal organism: Pine apple Wilt Virus

- Leaves develop characteristic bronzing symptoms starting from third or fourth whorl on words.
- The leaves show bright pink colour browning of the tips with downward curling of the margin.
- The pink colour becomes more pronounced and leaves become dry from the top downwards
- Finally the tips become completely dried.
- The bright pink colour becomes dull and root system collapses.

4. PINK DISEASE

C.O :Pantoea citrea

- Pink disease symptoms are difficult to observe in the field since external symptoms are not apparent.
- Infections of the foliage is not detectable. Under severe invasion of the fruit by *P. citrea*, a translucent appearance in the sub-dermal fruit tissue occasionally can be observed.
- The symptoms become observable when infected fruit preparations are heated during canning process.
- Heating causes formation of red to rusty brown coloration of the golden yellow tissue of a healthy fruit.

DISEASES OF STRAWBERRY: *Fragaria chiloensis*

1. Powdery mildew disease of strawberry

Casual Organism – *Sphaerotheca fragariae*

- Whitish powdery growth appear on upper surface of the leaf and young stem. Defoliation fruit cracking reduction in fruit size and fruit yield are the common effects of the disease.
- Occasionally a powdery or surface mildew causes some damage to the plants.

2. LEAF SPOT DISEASE OF STRAWBERRY:

Casual Organism – *Mycospharella fragariae*.

- Leaf spot is most frequently evident on the blades of the leaflets, but may appear on the petioles, fruit and fruit stems.
- The lesions may be seen first on the upper surface as small, deep-purple, somewhat indefinite areas.
- As the spot enlarges, the central area becomes brown, which soon turns to a definite white spot in older leaves or light brown in young tender leaves. An indefinite, dark purple zone surrounds the central light area, giving the hole a bird's-eys effect.
- On the undersurface part of the leaf, symptoms are much the same as on the upper, but coloring is less intense.
- Here the prominent veins which are touched by any of the spots take on a reddish-purple color that extends some distance beyond the infected spots.

3. Strawberry Leaf Scorch disease

Causal Organism – *Leptothyrium fragariae*

- Leaf scorch lesions appear not only on leaf blades but also on the petioles, fruit pedicels, and sepals of the calyx.
- In early stage, leaf scorch lesions resemble those produced by the leaf spot organism as the small dark purple spots appear scattered over the upper surface of the leaflets.
- It is not difficult to distinguish the two after the spots have developed.
- In mature condition the leaf scorch spots are large and irregular in outline and never show the white central area which is characteristic of the leaf spot disease.
- On the contrary, black fruiting bodies which develop in the central area give the leaf scorch disease a "tar spot" appearance.

4. Leaf Blight Disease of Strawberry:

Causal organism – *Dendrophoma obscurans*

- The disease is most prominent on the leaves, although at times it appears on the calyx. Usually the spots on the single leaflet are limited to one to five or six.
- The initial young spots are uniformly reddish purple and almost circular in outline., The spots near one of the main veins are elliptical.
- Later three zones viz., normal green of the leaf, a light brown zone about 5 mm width, and, finally, a dark brown central area 2 to 3 mm in diameter are formed.
- The white central area characteristic of leaf spot is never present.
- The spots appearing on a prominent vein, and especially if on the midrib, the typical V-shaped lesion is formed, with the purple coloured tissue extending in a fanlike manner to the border of the leaflet.

5. **Cortical Root Rot (Black Root) of Strawberry**
   Causal organism:

- A plantation affected by root rot presents an uneven "patchy" appearance due to dwarfing of the diseased plants and the gaps caused by complete death of the severely infected plants. It is generally agreed that certain definite concerned.
- Under certain environmental conditions some of these organisms are considered much more virulent than others.

6. **Gray Mold of Strawberry**
   Causal Organism– *Botrytis Cinerea.*

- The disease often regarded as a fruit rot, starts early in the season as a blossom blight. In the cluster of blossoms on the main fruit stalk, one or more will show blast condition, with the disease extending partly down the pedicel.
- Later, as the berries enlarge, disease may be observed on tips of the calyx lobes, often confined to one or two lobes only.
- Infection on the berries may appear at any point.
- Often rotting on half-grown fruit starts from the base of the fruit and originates from the infected calyx.

7. **Angular Leaf Spot (Bacterial Blight) of strawberry**

Causal organism: *Xanthomonas fragariae*.

- Typical symptoms of angular leaf spot appear initially as minute, water-soaked lesions on the lower leaf surface.
- These lesions enlarge to become angular spots, usually delineated by small veins.
- An important distinguishing characteristic of this disease is that lesions are translucent when viewed in transmitted light, but dark green when viewed in reflected light.

Exercise-8

DISEASE OF SAPOTA

1. Leaf spot disease

C.O: Phaeopleospora indica , Pestalotiopsis versicolor

- *Phaeopleospora indica*: Initially circular spots pinkish in colour appear which gradually turn brownish in colour. Centre of the spot is whitish grey coloured and number of spots are more on leaves.
- *Pestalotiopsis versicolor*: In this case spots , circular and brownish and bigger in size. Later one can see the black dots on centre of the spot. These black dots are the asexual fruiting bodies of the fungus (Acervulus).
- In advanced stage of the disease defoliation is common.

2. Flat limb

C.O: *Botyodiploidia theobromae*

- In young stems instead of normal growth flattening takes place as a result of infection. On this flattened stem small sized leaves with small petioles can be seen.
- This is a sporadic disease. In plant 1 or 2 branches in whole plantation, 1 or 2 plants are affected.

3. Sooty mould

C.O: *Capnodium versicolor*

- Disease severity increases with the increased population of leaf hoppers, aphids and other insects. Black superficial growth of the fungus appears on entire surface of leaves, fruits and twigs. The Fungus responsible is not a parasite, but it grows on the excreta and honey secretions of insects.
- Under dry spell, the infected leaves curl & shrivel. At flowering time the disease results in reduced fruit set.
- Sooty mass is a superficial growth of the fungus which multiplies on insect secretions. The mould hampers the photosynthesis activity and yield decreases.

5. Red rust of sapota

C.O: *Cephaleuros versicolor*

- The disease is initially characterized by green coloured, circular patches with marginal serrations.
- The upper surface of the spot consist of numerous, unbranched filaments which project through the cuticle.
- As the disease advances the organism forms red, rusty spots on the leaves and young twigs.
- Mature spores fall and leave cream to white velvet texture on the surface of the leaf.

Exercise-9

DISEASES OF GUAVA (*Psidium guajava* L.)

Major diseases

1. Wilt :*Fusarium oxysporum* f. sp. *psidii*,
2. Fruit canker : *Pestalotiopsis psidii*
3. Stem canker: *Physalospora psidii*
4. Anthracnose : *Gloeosporium psidii* (=*Collectotrichum psidii*)
5. Red rust :*Cephaleuros virescens*

Minor diseases

1. Leaf spot :*Cercospora psidii*
2. Phomopsis fruit rot: *Phomopsis psidii*

1. Fusarium wilt

Causal organism: *Fusarium oxysporum* f.sp. *psidii* Prasad, Mehta and Lall. *F.solani* (Mart.) Sacc.,

- The disease is characterised by yellowing and browning of leaves, discolouration of stem and death of the branches along one side. Sometimes the infection girdles the stem and whole plant may wilt. Leaf necrosis die and the twig barks split.

2. Fruit canker

Causal organism*: Pestalotiopsis psidii*

- Infection generally occurs on green fruits.
- Minute, brown or rust- coloured, unbroken, circular, scabby lesions of 2 to 4 mm dia appear on the fruit which later tear the epidermis open in a circinate manner.
- The margin of the affected area market value highly reduced.

3. Stem canker

Causal organism: *Physalospora psidii* Stev. & Pier

- Infected twigs show wilting and death.
- Cracks and lesions are formed along the stem, arresting translocation of nutrients.
- Infected fruits turn dark brown to black and resulting in die-back symptoms.
- Fruit rotting takes place, blighting of leaves to enlargement
- Perithecia is glabrous with a fleshy wall. Ascospores are hyaline, narrow, ellipsoid and one celled.
- Conidia are single celled, ovoid with a rough wall and measure 20 to 26 x 9 to 12 µm. Pycnidia are formed in stroma on the stems and fruits.

4. Anthracnose/Die-back/Fruit spot/Twig blight

Causal organism: *Gloeosporium psidii* Delacr. (Perfect stage: *Glomerella psidii* (Del.) Sheld.)

- The disease attacks all plant parts except roots.
- Severity of the disease may show die-back of the main branches resulting in death of plants.
- The most characteristic symptoms appear as small pin-head sized spots on the unripe fruits during the rainy season.
- The spots gradually enlarge to form sunken,circular, dark brown to black spots.
- The infected area of the unripe fruits become harde and corky.
- Acervuli are formed on fruit stalks.

5. Red rust:

Causal organism*: Cephaleuros virescens*

- The alga produces specks or big patches on the leaves. These may be crowded or scattered.
- The pathogen extends between cuticle and epidermis and penetrates the epidermal cells.
- Fruit infection by alga is not common on fruits. Fruit lesions are usually smaller than leaf spots.
- They are dark green to brown or black in colour.

1. **Leaf spots**

Causal organism: *Cercospora psidii*

- The disease appears as water-soaked, irregular patches which look brown on the lower surface of the leaves.
- Old leaves are mostly infected and the severely affected ones curl and subsequently drop.
- Affected leaves show round or light irregular spots, brownish-red in colour.
- The central portion of the spot turns white. These spots coalesce to form large irregular, white patches surrounded by a brownish margin.
- These leaf spot diseases are checked by spraying with copper oxychloride (0.3 per cent).

2. **Phomopsis fruit rot:**

Causal organism: *Phomopsis psidii* Camara.

- The symptoms appear on unripe fruits at the blossom-end.
- Infected fruits show small, conspicuous, white or light brown and circular spots. Some of the infected fruits shed prematurely.
- As the fruits ripen, the spots extend and cover the fruit surface. The infected tissues become soft and emit an undesirable odour.
- Weekly sprays with Bordeaux mixture (1.0 per cent) or copper oxychloride (0.3 per cent) are required for controlling of fruit rot.
- Six monthly sprays with Mancozeb (0.2 per cent) during fruiting stage are helpful in controlling fruit rot.

3. **Sooty mould:**

Causal organism: *capnodium psidii*

- It is an ectophytic fungus and not the parasite. Black superficial growth appear on entire surface of leaf and twigs. Under dry spell such infected leaves curl & shrivel.
- At flowering stage the disease causes reduced fruit set and fruit fall. Blackish powder like fungal conidial structures covere the leaf surface.
- The fungus develops on the excreta and honey secretions of insects as black sooty mass of spores and will not invade plant tissue.
- Disease severity increases with the increase in population of leaf hoppers, aphids and other insects. This disease effects the photosynthesis activity and decrease in yield.

Exercise-10

DISEASES OF PEACH

Major Disease of Peach

1.Leaf curl –*Taphrina deformans*
2.Rust – *Puccinia pruni* – spinosae
3.California peach blight- *Stigmina carpophila*
4.Scab – *Venturia carpophila*

Minor Diseases of Peach

1.Powdery mildew –*Sphaerotheca pannosa* var. *persicae*
2.Frosty mildews – *Cercosporella persicae*
3.Target leaf spot – *Phyllosticta persicae*
4.Bacterial leaf spot: *Pseudomonas syringae* pv. *persicae*
5.Gummosis: Prunus dwarf virus
6.Mosaic Virus disease-Peach Mosaic Virus
7.Necrotic Leaf spot: Necrotic Leaf Spot Virus .
8.Peach- X : Phytoplasma like organism
9.Peach yellows : Phytoplasma like organism

1. PEACH LEAF CURL DISEASE:

C.O: *Taphrina deformans*

- The disease first appears in the early spring as the leaves begin to unfold
- The leaf blade thickens and midrib turns yellow and curl
- Finally infected leaf turns to reddish purple tint
- The reddish velvety surface of lamina is soon covered with a whitish grey bloom of the fungus on the upper surface
- Both the leaves and petiole may curl
- Affected leaves die and drop immaturely
- Twigs become pale green to yellow, swollen, stunted and exude gummy material
- Flowers and fruits are also infected & drop prematurely

2. PEACH RUST

C.O: *Puccinia pruni-spinosae*

- Pale yellow spots appear on both the surfaces of leaves.
- These spots become bright yellow at a later stage.
- Numerous brown dusty pustules are seen on the under surface of leaves.
- Pustules cover under surface area of the leaves.
- Defoliation occurs.
- The fruit is rarely attacked.

3. CALIFORNIA PEACH BLIGHT /shot hole / pustular spot

C.O: *Stigmina carpophila*

- The pathogen attacks twigs, blossoms, leaves, fruits and unopened buds.
- Small, circular, deep purple spots appear on the fruit.
- The spots become raised and rough.
- Dark brown, scattered lesions enlarge rapidly on the leaves.
- The diseased buds become dark in colour.
- Small, purplish, raised spots appear on twigs and they expand in to necrotic cankers.

4. SCAB /FRECKLE /BLACK SPOT:

C.O: *Venturia carpophila*

- The disease occurs on fruit, twigs and leaves.
- Circular and dark –olivaceous lesions appear on fruits.
- In severe infection, the individual spots merge and form a uniform, dark olivaceous, velvety blotch.
- A thick or corky layer of cells is produced below the surface of the scabbed region.
- The fruit becomes abnormal in shape and cracks.
- On the twigs, light brown oval lesions are formed which enlarge and turn dark brown.
- Dark brown, long and narrow lesions are noticed on the midrib.

1. POWDERY MILDEW of PEACH

C.O: *Sphaerotheca pannosa* var. *persicae.*

- Whitish powdery growth of fungus appear on leaves, young shoots and fruits.
- The young leaves are coated with a thick layer of mycelium and as a result they become narrow and curled.
- Terminal portion of the shoot is covered by white powdery mass.
- White powdery growth later turns in to pinkish and finally dark brown in colour.
- Epicarp of fruit becomes leathery and hard.

2. FROSTY MILDEW of PEACH

C.O: *Cercosporella persicae*.

- It produces pale green areas on the upper leaf surface and creamy white fungal growth on lower surface.

3. BACTERIAL LEAF SPOT

C.O: *Pseudomonas morus-prunorum*.

- Small, circular green spots occur on the leaves.
- Later spots become angular, deep purple to black.
- The spotted area falls and shot holes are formed.
- Severe disease infection leads to defoliation which devitalizes the tree.
- Circular spots are noticed on fruits. These are water-soaked initially and become black.
- Due to intense spotting on the fruits, pitting or cracking occurs in the vicinity of spots.
- Twig canker results in the death of branch.

4. BACTERIAL CANKER / GUMMOSIS:

C.O: *Pseudomonas syringae* pv. *syringae* vanHall.

- The disease attacks trunk, limbs, shoots, fruit spurs, blossoms, dormant buds, leaves and fruits.
- The bark and outer sap wood show circular to elongated, water –soaked lesions.
- Bark becomes brown and gummy.
- The girdled branches die.
- Blossom blight occurs and purple lesions appear on leaves.

5. MOSAIC DISEASE OF PEACH

C.O: Peach Mosaic Virus

- Leaves emerging during spring and summer show light green mosaic and ring spot mottle.
- Leaves become small and deformed.
- Stunting growth of the plant and short inter nodes.
- Yellow mottling are seen on new growth flushes during spring.

6. NECROTIC LEAF SPOT DISEASE

C.O: NECROTIC LEAF SPOT VIRUS (NLSV)

- Initially ring- spots are observed on the leaves which later become necrotic.
- Necrotic tissues later fall down leaving holes in the leaves.

7. PEACH "X" DISEASE

C.O: PHYTOPLASMA –LIKE ORGANISM

- The trees show varying degree of anthocyanosis, die-back twig and shoots and general tree decline.
- Infected leaves roll upwards on affected branches.
- Premature defoliation.
- Fruits remain small, malformed and abort without proper ripening.

8. PEACH YELLOWS / PAJA ROSETTE

C.O: PHYTOPLASMA –LIKE ORGANISM

- Trees show numerous upright branches growing from the main stem.
- The branches are numerous and the tree looks bushy.
- The leaves are small but the basal 1 or 2 leaves are abnormally long.
- Most of the leaves show light green to yellow mottling and have irregular margins and clearing of veins.
- The trees are stunted, inter - nodes are short and appear bushy.
- Premature unfolding of leaf bud is common.
- The leaves on infected trees continue to grow even after the fall of normal leaves.
- The larger leaves on infected trees are also mottled.
- Wilting and die back symptoms appear later resulting in the death of plant.

Exercise-11

DISEASES OF PLUM

Diseases	causal organism
1. Plum pocket	- *Taphrina maculans*.
2. Wilt	-*Verticillium albo-atrum* (Reinke & Berth)
3. Leaf curl	-*Taphrina deformans* (Berk & Tul)
4. Bacterial canker	-*Pseudomonas syringae* pv.*syringae* (van Hall)
5. Bacterial leaf spot	-*Xanthomonas syringae*
6. Line pattern	-Plum American line pattern virus.
7. Plum mosaic	-Plum line pattern virus & ring spot virus
8. Creamy-white spot	-Creamy white spot virus.

1. PLUM POCKET*:*

C.O*: Taphrina maculans*

- The symptoms are more prominent on fruits
- The infected fruits having whitish circular spots on the fruits are completely covered
- Infected fruits develop into double their size.
- Infected fruits fail to produce seeds
- On leaves whitish coat will form in rare cases and defoliation occurs.

2. WILT

C.*O: Verticillium albo-atrum.* (Reinke & Berth)

- The infected limbs get defoliated in early summer.
- The declining symptoms are first seen on the lower branches.
- Roots of infected plants turn brown and die.
- No partial wilt but lower leaves show yellowing symptoms that occurs at flowering and fruiting stage.
- Complete loss depending upon seveitrty of infection.
- V – Shaped yellowing of leaf margin.

3. LEAF CURL

C.*O: Taphrina deformans* (Berk & Tul)

- The disease first appears in early spring as the leaves begin to unfold.
- The leaf blade thickens, midrib turns yellow and curls.
- Finally the infected leaf turns to reddish purple tint.
- The reddish velvety surface of lamina is soon covered with a whitish grey bloom of the fungus on the upper surface.
- Both the leaves and petiole may curl.
- Infected leaves die and drop immaturely.
- Twigs become pale green to yellow, swollen, stunted and exude gummy material.
- Flowers and fruits are also infected and drop prematurely.

4. BACTERIAL CANKER / GUMMOSIS

C.*O: Pseudomonas syringae pv.syringae* (van Hall)

- The disease attacks trunk, limbs, shoots, fruit spurs, blossom, dormant buds, leaves and fruits.
- The bark and outer sap wood show circular to elongated, water –soaked lesions.
- Bark becomes brown and gummy.
- The girdled branches die.
- Blossom blight occurs and purple lesions appear on leaves.

5. BACTERIAL LEAF SPOT

C.*O: Xanthomonas syringae pv.pruni vauterin.*

- It is most commonly observed in nursery stages.
- The disease appears on leaf surface as angular dark brown spots of 0.5to 3.0 mm diameter.
- The lesions are bordered by light, yellowish green halo.
- In severe condition, leaves turn yellow and drop.

6. LINE PATTERN

C.O: Plum American line pattern virus.

- Yellow vein banding in part or whole of the leaf lamina.
- Chlorosis of the entire leaf with stunting of plants.
- Some times green stamen petiole show chlorosis.
- Old branches exhibit aerial rotting.
- Chlorotic spots on ripened fruits.

7. PLUM MOSAIC

C.O: Plum line pattern virus & ring spot virus.(Kennedy et – al)

- Leaves emerging during spring and summer show light green mosaic and ring spot mottle.
- These remain small & deformed.

8. CREAMY-WHITE SPOT

C.O: CREAMY WHITE SPOT VIRUS

- Small, pale yellow to white spots on the leaves.
- These spots coalesce and form large white areas.
- The virus is restricted to plum only.

9. BLACK KNOT

C.O: *Apdiosporina morbosum*,

- Pathogen infects Plum and cherry plants throughout the states having temperate climate.
- First year symptoms include light green swellings on twigs.
  Next spring these become enlarged and turned velvety black

Exercise-12

Post Harvest Diseases of Fruits

Banana

- Anthracnose :*Collectotrichum musa*e
- Black Tip :*Botryodiplodia theobromae*
- Cigar-end Disease : *Verticillium theobromae*
- Pink mould Rot :*Trichothecium roseum*
- Fusarial Rot : *Fusarium moniliformae*
- Banana Scab : *Phoma poleyana*
- Freckle and Blackspot :*Macrophoma musae*

1. Anthracnose:

Causal organism : *Collectotrichum musae*

- It occurs on the ripened fruits on which small, minute, black spots appear sunken discolorations.
- Ripening stage is most susceptible to this disease because of its less phenol and increased reducing sugar content.

2. Fusarial Rot:

Causal organism: *Fusarium moniliformae*

- Small sized fruit bunches with less number of fingers are formed which fail to ripen.

3. Cigar end Disease:

Causal organism: *Verticillium theobromae*

- Brackish discoloration is covered by white mycelia.
- It occurs on green fruits in a bunch starting from tip of the fruit

Grape

1. Powdery Mildew of Grapes

   Causal organism: *Uncinulla necator*

2. Bird eye spot

   Causal organism*: Elsinoe amphelina*

- Powdery Mildew of Grapes :
- Leaf : Hinder the photosynthesis activity, Red sulthana
- Whitish powdery growth appears on young stems, flower stalks and flowers, causing their dropping.
- Fruit bunches : Appearance of whitish powder and cracking of fruits at the time of ripening

3. Anthracnose of Grapes

   Causal organism: *Elsinoe amphelina*

- On Leaf : Necrotic irregular spots.
- On stem : necrotic irregular brown streaks that changes to black at a later stage and asexual fruiting body acevulus.
- On green fruits : Circular brown spots with – grey coloured brown, black ring are formed.
- Kharif season - severe during sep-oct.
- Primary source of inoculum: Dormant mycelia.
- Secondary source of inoculum: Air borne.

APPLE

- Apple Scab : *Venturia inaequalis*
- Bitter Rot :*Glomerella cingulata*
- Blue Mould Rod : *Penicillium expansum*
- Grey Mould Rot : *Botrytis cinerea*
- Alternaria Rot : *Alternaria alternata*

- White Rot : *Botryosphecria obtiusa*
- Brown Rot : *Monilinia fructiglna*

1. Apple Scab

Causal organism: *Venturia inaequalies*

- On leaves : On the lower surface of leaves green coloured velvety spots appear slowly starts showing symptoms on the upper surface with slightly raised olive green spots.
- On Fruits: Slightly raised rough, corky, olive green spots appear followed by cracking of fruits and mummification.

2. Bitter Rot:

Causal organism: Glomerella *Cingulata*

On fruits – Small lesion appear from incipient infection which is brown, firm, flat or slightly sunken spots.

3. Blue mould rot:

Causal Organism: *Penicilliun expansum*

Light coloured soft rot appear soon which spreads on the surface and deep into the flesh.

4. Grey Mould Rot.

Causal Organism: *Botrytis cinerea*

- On fruits Pale brown to brown area develop on fruits with appearance of ash-grey powdery spore masses which starts decaying.

5. Alternaria Rot:

Causal Organism: *Alternaria alternata.*

- Round, brown to black, dry firm, shallow lesions appear around skin that breaks at the calyx stem causing depression. Advanced infected fruits turn spongy and flesh streaked with black.

Pears

- Blue Mould :*Penicillium expansum.*
- Grey Mould : *Botrytis cinerea*
- Alternaria Rot : *Alternaria alternata*
- Mucor Rot : *Mucor piriformis*

Stone fruits: ALMOND, APRICOT. CHERRY, PEACH AND RLUMS.

- Brown Rot : *Monillnia laxa.*
- Rhizopus Rot : *Rhizopus stolonifer*
- Blue mould Rot : *Penicilliun expansum*
- Cladosprium Rot : *Cladosporium harborum*
- Grey mould Rot : *Botrytis Cinerea*

Practical observation: Record the main symptoms of the given specimen and take free hand thin sections of the fungal affected host tissue and note down the microscopic observations.

Exercise-13

DISEASSE OF ARECANUT (*Areca catechu* L.)

DISEASES OF ARECA NUT

(A) Major diseases

1. Mahali disease -*Phytophthora meadii (=P. arecae)*
2. Bacterial leaf stripe: *Xanthomonas campestris* pv. *Arecae*
3. Anabe roga (disease): *Ganoderma lucidum*
4. Yellow leaf disease: Phytoplasma-like organism
5. Bud rot - *Phytophthora arecae*
6. Stem bleeding -*Thielaviopsis paradoxa*
7. Inflorescence die back –*Colletotrichum gleosporioides*

(B) Minor diseases

a. Red rust -*Cephaleuros* sp.
b. Yellow leaf spot: Fungal complex
c. Root rot -*Fusarium* sp.
d. Leaf blight – *Phomopsis palmicola* var. *arecae*

1. MAHALI/KOLEROGA/FRUIT ROT/NUT ROT

C.O: *Phytophthora meadii (=P. arecae)*

- Characteristic symptoms include rotting and excessive shedding of immature nuts from the trees.
- The first sign of the disease is on the nuts, on which water soaked lesions usually develop towards the base. Because of this watery rot, the disease is locally called as "Neerugole".
- Later leads to discoloration, discoloration starts browning then leads to deep browning, later dropping of nuts takes place..
- The fallen nuts show the felty, white mass of mycelium of the fungus which soon envelops the entire surface. Infected nuts loose their luster. This type of symptoms with boost like growth of the fungus , as also locally called as "Busurugole".
- The disease gradually spreads among the bunch ultimately covering the entire bunch wherein they rot and shed from the bunches.
- Fruit stalks and rachis of inflorescence are also affected. They are lighter in weight which deteriorate and become unsuitable for chewing.

2. BACTERIAL LEAF STRIPE

- The initial symptoms include 1-4 mm diameter wide, dark green water soaked, translucent, linear lesions or stripes along side and parallel to the mid rib of the leaf let of its other main veins.
- The lesions may develop from any point on the lamina, but more commonly from the base or towards the tip of the leaf let.
- The margin of the lesions is usually straight and well defined, but occasionally it may appear wavy.
- The lesions are covered with abundant bacterial exudates on the lower surface. The exudate is creamy white and slimy.
- On drying, it forms a waxy film or creamy white or yellowish flakes or fine granules or irregular yellowish masses.
- In the advanced stages, the lesions may measure 1cm or more wide and several centimeters long involving the midrib also.
- The affected midrib and veins of the leaflet get discolored and turn black.

3. ANABE ROGA/ROOT ROT/ROOT WILT/TANJAVUR WILT/GANODERMA WILT

Causal organism: *Ganoderma lucidum*

- Yellowing and browning of outer whorl of leaves. As the disease advances the inner whorl also exhibit the same symptom.
- Leaf dries at later stage of the disease, droops and hangs around the stem.
- The impact is the flowers, and nut size reduction and dropping.
- In severe or advanced stages, drooping of all the leaves and their dropping leaving only the stem with out leaves. Discolouration of vascular bundles can be seen.
- Stem bleeding and oozing of gum takes place upto the height of 5m as the disease advances.
- The roots of the infected plant become brittle, discololured and dry.
- Sporophores and fruiting bodies can be seen on the stem portion at the collar region mostly after the death of the tree which gives the name "Anabe Roga (Mushroom like)".

4. YELLOW LEAF DISEASE

Causal organism: Phytoplasma-like organisms

- Symptoms include yellowing of leaves and shedding of both mature and immature nuts. Endosperms of diseased nuts are soft, blackish and not suitable for consumption.
- Yellowing at the tips of leaf lets in 2or3 leaves of the outermost whorl is the first visible symptom.
- Brown, necrotic streaks run parallel to lamina in unfolded leaves, with the development of leaves, yellowing starts form the tips of leaflets, gradually extending to the middle of the lamina.
- One or two leaflets in any of the crown or the entire foliage may be affected by the disease. Tips of the chlorotic leaves eventually dry up.
- In advanced stages, leaves are reduced in size, become stiff and pointed, closely bunched and puckered. Finally the crown falls down leaving the base trunk.
- Root tips turn dark and gradually rot. Production of lateral root is reduced.
- Affected fruits fall down. Some of the palms exhibiting foliar yellowing may produce normal nuts and all nuts in the bunch may not show kernel discoloration.
- Blocking of xylem vessels of older leaves of diseased palms, degeneration of cortex and presence of tyloses in xylem are also noticed in diseased roots.

5. BUD ROT

Causal organism*: Phytophthora palmivora*

- The fungus *Phytophthora palmivora*. *P meadii* causing koleroga in bunches also pass on to the buds and cause rotting.
- The first symptom of the disease is the discoloration of the spindle from the natural light green color to yellow and then brown.
- Infection spreads to young leaves which rot rapidly. As the infection spreads inside the bud the growing point of the stem also rots resulting in the death of the palm.
- The spindle slumps and can be drawn out with a gentle pull.
- The outer leaves then become yellow, droop and drop off one by one leaving a bare stem. Secondary organisms colonize the rotting bud and convert it into a slimy mass which would emit a foetid smell.

6. STEM BLEEDING

Causal organism: *Thielaviopsis paradoxa* (de Seyenes) Hohn.

- Both the young and old plants are affected but young palms are highly susceptible. Symptoms appear on the basal portions of the stem as small discolored depression during initial stages.
- Later the spots coalesce and cracks develop on the stem which eventually produces hollows upto varying depths along the infected portion.
- Crown of affected adult palms get reduced in size followed by reduction in yield. Finally a dark brown liquid oozes out from cracks.
- Primary source of inoculum: Dormant mycelia .
- Secondary source of inoculum: Air borne conidia.
- Epidemiology: More serious in kharif season and also more serious in case of poor drainage areas.

8.Inflorescence die-back and button shedding:
Causal organism: *Colletotrichum gloeosporioides* Penz

- Die back of inflorescence is associated with low fruit set. About 60% of palms in the state of Karnataka and Kerala are infected by this disease causing severe shedding of buttons.
- Disease appears on the rachillae of the male flowers, then in the main rachis as brownish patches which soon spread from tip downwards covering the entire rachis causing it wilting.
- The female flowers of the infected rachis are shed.
- The fungus also infects the developing embryo inside the female flowers, which eventually shrivels up showing a brown discoloration.
- Under severe conditions the fungal infection proceeds from tip downwards producing the condition known as die-back.

1.Red rust:
Causal organism: *Cephaleuros* sp.the alga,

- *Cephaleuros* sp. produces circular spots with sunken centers and yellow haloes on the foliage.
- Lesions are irregular on the stem. Infection destroys the epidermis.
- It affects photosynthesis, yield as well as reduces quality is highly reduced.
- Management:
- Early identification & destruction so as to reduce further infection.
- Provide proper irrigation and recommended N, P, K application.
- Trimming with better aeration.
- Spray of systemic fungicide Benomyl (1.5g/litre).

2. YELLOW LEAF SPOT
C.O: *Curvularia* sp., C*olletotrichum* sp., *Phyllosticta* sp., *Helminthosporum* sp.and ***Alternaria tenuis*** have been reported to cause leaf spot of seedlings.

- Yellow specks measuring 3-10mm diameter appear on the leaves.
- These spots coalesce to form larger lesions surrounded by yellow haloes.
- Infected seedlings are stunted and in severe cases they die.

3. Root rot or collar rot

- Causal organism: *Fusarium* sp. and *Rhizoctonia* sp
- The fungi infect roots and cause wilting of seedlings.
- Sometimes bacteria enter the stem through the collar region and rotting of bud also.
- The severity of the disease can be minimized by providing good drainage in the nursery and drenching the soil with Bordeaux mixture or cheshnut compound.

4. Leaf blight:

- The disease is characterized by reddish brown spots which blight the leaves.
- Later black crusty appearance will form which is little hard.
  causal organism :*Phomopsis palmicola* var.*arecae* Causal organism: *Pestalotiopsis palmarum* (Cooke), *Phomopsis palmicola* var. *arecae.*

Exercise-14

DISEASES OF COCOA

l. **Major disease:**

1) Seedling die - back : *Phytophthora palmivora*.
2) White thread blight : *Marasmius scandens*
3) Black pod disease : *Phytophthora palmivora*
4) Charcoal pod rot : *Botryodiplodia theobromae*
5) Witches broom : *Crinipellis pernicios*

II. **Minor diseases:**

a. Pink disease: *Pelicularia salmonicolor*
b. Stem canker: *Phytophthora palmivora*
c. Cherella rot : *Colletotrichum gloeosporioides*
d. Vascular streak: *Oncobasidium theobromae*.
e. Cacao swollen shoot virus. (CSSV)

1) Seedling die –back

Causal organism: *Phytophthora palmivora*(Butler)

- Die back disease is severe on young seedlings during rainy season. It has been observed in the cocoa nurseries in Karnataka, Kerala & Tamilnadu.
- This disease is more severe on one month old cocoa seedlings though it is noticed in 1 to 4 month old seedlings.
- Infection may start from tip of the stem or cotyledon stalk or from the collar region.
- The disease appears as dark brown to black, water soaked and linear lesions.
- The lesions extend to leaves through the petiole resulting in wilting and subsequent defoliation of the seedlings.
- Defoliations and die back of the seedlings are noticed during advanced stages of the disease.

2) White thread blight

Causal organism: *Marasmius scandens*

- The young branches of the infected plants contain white mycelial threads of the fungus which spread longitudinally and irregularly along the surface of the stem.
- On the leaf lamina it spreads in the form of much branched fine threads.
- The fungus invades the cortical tissues which eventually turn dark brown to black. The diseased leaves also turn dark brown.
- The dead leaves in a branch eventually get detached from the stem but are found suspended by the mycelial thread in a row.
- The extensive death of the young branches & suspended leaves in a row are the common field symptoms of white thread blight

3) Black pod disease

Causal organism : *Phytophthora palmivora* (Butler)

- Appearance of brown spots on the pod.
- The discoloration and brown spots spreads over the whole pod.
- Internal tissues of diseased pods become brown.
- Infected beans become discoloured.

4) **Charcoal pod rot:**

Causal organism: *Botryodiplodia theobromae*

- The disease is severe during summer months.
- The infection appears as dark brown to black spot on any part of the pod surface & spreads rapidly.
- The beans may not develop fully & get mummified.

5. **Witche's broom**

Causal organism: *Crinipellis perniciosa*.

Excess of axillary bud production with Pale yellowing.

- Broom like appearance.

Minor Diseases

1) Pink disease
Causal organism: *Pellicularia salmonicolor*

- The first visible symptom is the appearance of salmon pink encrustation of fruiting bodies of the fungus on the bark of the stem.

2) **Stem canker**
Causal organism: *Phytophthora palmivora*.

- Reddish brown liquid oozes out from the lesion which later become dry and form a rusty deposit.
- Tissues beneath the lesion appear as reddish brown
- The cankers girdle the main stem or branches & the pods in them wilt the leaves are discoloured.

3 Cherelle rot
Causal organism: *Colletotrichum gloeosporioides*.

- Infected stalk becomes shrunken.
- The internal tissues of the pod get discoloured. Abundant pinkish slimy mass of conidia is produced on the lesions under high humid conditions.
- Ultimately the diseased pod turns brown to black and remains on the tree as mummified fruit.

4. Vascular streak die-back
causal organism : *Oncobasidium theobromae*.

- In India, VSD disease has reported only from Kerala state
- The first visible symptom of VSD is the yellowing of a single leaf in the second or third flush from the twig with sets of green patches scattered over the yellowish lamina.
- Affected leaves defoliate prior to the older leaves of the same branch.
- The bark in the leaf detached part of the branch becomes rough due to swelling of lenticels.
- The auxillary buds of the fallen sprout and then rapidly die.
- Later die back symptom appears on these branches due to infection and the xylem vessels turn brownish which appear as streaking within the vascular tissues.
- Hence the disease is called as vascular streak disease.

5. Cocoa swollen shoot
C.O: Cocoa swollen shoot virus

- Some of recommendations for controlling disease are:
- Give proper spacing of to ft between
- Weeding may be done regularly
- Cut down and remove the diseased trees.
- Keep the infected area fallow for three years then clean it back up and the Capsid was gone.

Exercise-15
DISEASES OF COFFEE PLANT

LEAF RUST/ORIENTAL LEAF DISEASE

c.o*: Hemilia vastatrix*

- Rust affects the berry yield in many ways, by reducing the photosynthetic area, by occupying leaf area, inducing defoliation and reducing vigour of the plants due to altered physiology.
- Depending on the severity of disease not only fewer flowers are formed but the flowers and fruit fall prematurely and the remaining berries do not develop to their maximum size.
- In severely infected cases, the pathogen may causes losses up to 50% foliage and 70% loss of coffee berries.

BLACK ROT/KOLEROGA/THREAD BLIGHT

Causal organism: *Pellicularia koleroga*

- The black rot pathogen infects leaves, developing berries and young shoots.
- The most striking symptoms are the blackening & rotten of infected leaves, developing berries and young twigs.
- Infected leaves get detached from branches & remain hanging within slimy fungal strands.
- On green berries characteristic blackening starts from one side and spreads gradually in a narrow band.
- Close examination reveals the presence of characteristic threads of mycelia running along the twigs, petioles and spreading mostly on the lower surface of the leaves.
- When infected leaves and berries become dry, they reveal the presence of white web consisting of closely interwoven mycelium.
- Defoliation and berry drop from the infected branches occur in advanced stage of the disease.

PINK DISEASE

Causal organism: *Corticium salmonicolor*

- Infected branches show a pink encrustation, hence the name pink disease.
- On the brown wood of infected branches longitudinal cracks develop through which pinkish encrustation bursts.
- In advanced stage, entire branch may show a pinkish encrustation.
- Cobweb like mycelial strands are seen on infected branches.
- Infected branches loose their leaves & die.

ANTHRACNOSE

Causal organism: *Colletotricum gloeosporioides*

- The disease affects the leaves, twigs and berries. It is a bark inhabiting fungus, a weak pathogen but under certain conditions of the host & the environment becomes virulent.
- The fungus causes three different diseases of coffee viz., twig die back, stalk rot of berries & leaves & brown blight of leaves.

a. Twig die-back or summer die-back

- This disease occurs during dry weather from Oct-May and reaches to its peak level after blossom showers.
- Yellowing or blighting of leaf on the green wood.
- Yellowing, necrosis of nodes & internodes towards the tip.
- Infected twig wilts and kills necrosis of tissues towards the apex and depict a die-back appearance.
- Floral buds on infected branches fail to open.
- Infected plants put on new vegetative growth on the primary & secondary near the main stem.
- Infected plants in the exposed area bear new leaves which are small, crinkled, chlorotic, thick and leathery.
- Internodes are short and give fan shape appearance

b. Stalk rot of berries & leaves

- Stalk rot of berries and leaves is generally noticed on Arabica and also on robusta coffee during Jul-Aug under the heavy pours of South-Western monsoon conditions.
- Necrosis of nodes & internodes from the junction of brown & green wood to wards the apex followed by berry drop and defoliation.
- Berries and leaves drop down due to necrosis & decay of the stalk portion. Generally, the rotting stalk remains on the branch while berries are dropped.
- One or two nodes at the tip of the infected branches may show total berry drop.
- The infected hanging berries remain lighter in weight and show premature ripening towards the end of Sept or Oct.

Brown blight of leaves

C.O: *Colletotricum gloeosporioides*.

- Round necrotic spots measuring up to 25 mm in diameter appear on leaves.
- Two or more such spots may coalesce & the entire or a portion of leaf may look blighted.
- Necrotic spots are brown in colour hence the name brown blight.
- Fructifications of the fungus appear as black dots on the spots on upper or lower surface of leaf.

ROOT DISEASES

- There are four types of root diseases infecting coffee plants viz., brown root disease, red root disease, black root disease and santavery root disease.
- Brown, red & black root disease are observed both on Arabica & Robusta, while santavery root disease is noticed only on Arabica.

Brown root disease

C.O: *Fomes noxius*

- Infected plants show gradual yellowing of leaves and defoliation followed by death of the entire plant.
- Stem near the ground level becomes spongy and soft. Root system shows development of thick brown encrustation adhered with small stones.
- The brown fungal encrustation gives the name brown root disease.
- Interior of the roots show dark brown to black wavy lines.

Red root disease

C.O: *Poria hypolateritia* Berk

- Gradual yellowing of leaves and defoliation followed by death of the above ground parts are the aerial symptoms as in case of brown root disease.
- Root system of dying or dead plants show red encrustation covered with soil & gravel adhering to it.
- The red encrustation is nothing but the fungal rhizomorph.
- The infected root appears deep red in colour when washed in water which is a good diagnostic symptom of this disease.

Black root disease

Causal organism :*Rosellinia bunodes* (B. & Br.) Sacc & *Rosellinia arcuta* Petch

- Aerial symptoms are almost the same as described under brown root disease. On affected roots, black fungal rhiozomorph or black woolly mycelium are seen.
- In transverse section, thread like black lines or dots can be seen clearly.
- On the stem near the ground level, fan shaped black fungal mat with pellet like fructifications are also seen.

Santavery root disease

Causal organism :*Fusarium oxysporum*

- Sudden wilting, yellowing of leaves followed by defoliation and death of aerial parts.
- Roots show, brown to pinkish discoloration of the inner portion in transverse section. Scrapping the bark of the stem near ground level shows internal discoloration.

BERRY BLOTCH

Causal organism: *Cercospora coffeicola* B. & Cke.

- Dark brown, irregular, slightly sunken, necrotic spots appear on exposed surface of the green berries.
- Necrotic spots enlarge in size & cover a major portion of berry surface.
- Skin of the infected berries show a purple halo around the necrotic spots.
- Infected tissues turn brown to black, shrivel, become dry and stick fast to the parchment.

FUSARIUM BARK DISEASE

C.O*: Fusarium stilboides (*syn. *Gibberala stilboides)*

- The pathogen infects the collar region of the stem and produce bark canker. Bark scaling is the most common but least damaging symptom.
- The fungus grows beneath the bark layer that becomes flaxy in texture.
- Cankers are then produced which can girdle the trunk and kill the tree.
- Damage is also caused due to young suckers, where a necrotic brown lesion develops at the base, usually close to the junction with the main stem.
- The sucker may get killed or survive to have a constricted ‘bottle neck’ appearance at the base, which leaves the new stem weakened & liable to break when heavy crop is borne.

NURSERY DISEASES

C.O: *Rhizoctonia solani* Kuhn

- The pathogen attacks seeds & seedlings both in the following two stages.

Pre-emergence damping off:

- Embryo & endosperm are invaded by the fungus before germination and the radical during germination resulting in seeds rot and disintegration.

Post-emergence damping off:

- Seedlings show brownish discoloration on the stem near the ground level leading to rotting of the tissue.
- Growing apex wilts, the seedlings collapse and die.

Brown-eye-spot

C.O: *Cercospora coffeicola* Botrytis & Cke.

- Disease has been reported from all the known coffee growing countries.
- Mostly the seedlings in nursery & young plants in the new clearings suffer to a large extent when proper over head shade is lacking.
- Leaves show circular necrotic spots with dark brown margin & light brown or pale centre.
- Necrotic spots increase in size, central portion turns light grey due to sporulation by the fungus and collapses leaving a hole at the centre.
- Infected leaves turn yellow causing pre-mature defoliation.

a. Grey blight of leaves

C.O: *Pestalotiopsis clavispora*

- Brown or grey necrotic spots, up-to 1-2 cm in diameter appear on mature leaves. These spots enlarge & coalesce and the leaves appear brown or grey.
- Black fructifications on both sides of leaves in concentric rings are irregularly distributed on necrotic spots.

b.Black leaf

C.O: *Cylindrocladium illicicola*

- Small, circular, water-soaked, necrotic black spots appear on the leaf blade mostly on the margin of upper or lower surface.
- Spots enlarge in size and the entire leaf or half of it turns black & rot hence the name black leaf.
- Infected leaves drop.

Target leaf spot

C.O: *Myrothecium advena*

Brown circular or irregular necrotic spots are formed on leaves.

- Concentric zonation visible on the upper surface of the leaves, give a characteristic target board appearance, hence the name target leaf spot.
- Severe infection may cause defoliation.
- Mostly leaves near or touching the soil are infected

d. Tip burn

C.O: *Myrothecium roridum*

- In nursery, 5-6 months old plants show infection at first internode & also on tip pair of leaves.
- Water soaked, brown to grey discoloration of the internodes from the tip defoliation and death as in case of die-back disease.
- On necrotic tissues cushion shaped fructifications with shiny black centre and white margins are seen.

e. Sclerotium disease

C.O: *Sclerotium coffeicola*

- Small circular necrotic spots appear on leaves.
- These spots gradually increase in size up to 25mm in diameter & show concentric rings of light & dark brown shades.
- Rhizomorphs of the fungus are seen on the necrotic spots.
- Mustard like sclerotia are formed on the necrotic spots.

f. Coffee blight

C.O:*Phoma costarricensis*

- The disease infecting leaves of *Coffee arabica* was noticed in Karnataka.
- Severity of the disease leads to heavy defoliation.
- Wet weather, high humidity, low temperature and wounds caused by the insects under field condition are favourable for development of disease.
- Defoliation noticed was up to 30-35% and seen at higher elevations.
- Young & mature leaves get affected.
- The disease appears to extend up to the tip portion of the tender twig when all the leaves on a tender branch get infected completely.

g. Sooty mould

C.O: *Capnodium braziliense* puttom.

- Sooty mould of coffee is seen whenever there is heavy attack of aphids & scale insects. The fungus responsible is ectophytic and not a pathogen
- The fungus feeds on excreta and secretions of the insects & indirectly hinders the normal leaf functioning.
- The leaves & shoots are covered with black sooty fungal growth, affecting photosynthetic activity of the plants.

FLOWERING PARASITES

a. shoot parasite

- *Cuscuta reflexa* (dodder) or strange vine is generally observed on coffee plants either in nursery or in the estate near the fence hedge, if the latter is not kept free from the parasite.
- Dense strand of leafless yellow vines twining the plants.
- Produce white flowers & form seeds during dry weather from Nov-Jan.
- Primary infection comes from seeds & secondary spread occurs through neighbouring infected plants.
- This parasite gradually weakens coffee plants as it draws nourishment through haustoria and as a result the host vigour is lost.

Root parasite

C.O: Balanophora indica,

The root parasite belongs to the family Balanophoraceae, occurs on roots of coffee plant growing at higher elevations above 1000 m MSL. Infected plants gradually decline in their vigour.

- The parasite occurs in the form of root stock composed of tuberous out growths on the lateral roots of coffee plants during the South-west monsoon.
- In the early stages of development the tubers are small round bodies hidden inside the soil.
- Flower heads begin to appear by November.
- The infected coffee bushes do not show clear cut symptoms of attack externally except for general unhealthy appearance & low productivity.

STEM WASTING DISORDER (KONDLI)

- Symptoms become apparent from Aug-Oct on 6-8 months old plants.
- Infected plants show a constriction at the first or second node from the base.
- The stem portion above the constriction becomes swollen with gradual thinning of the stem below the constriction.
- The tip pair of leaves of the infected plants show copper bronze or pale yellow coloration.
- The plants become lean & lanky.
- It easily snap off at the constriction.

Nematodes (*Pratylenchus coffeae)*

- 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.
- Infected bearing plants show thinner stem and inadequate foliage to support the crop.

Exercise-16

DISEASES OF BEETLE VINE

- LEAF ROT :*Phytophthora parasitica* f. *piperina***(Dastur)**
- PYTHIUM FOOTROT :*Pythium vexans* (De Bary)
- LEAF SPOT :*Colletotrichum capsici* (Petch)
- POWDERY MILDEW :*Oidium piperis* (Uppal, Kamat and Patel)
- BACTERIAL LEAF BLIGHT *:* *Pseudomonas betlicola* **(Patel, Kulakarni and Dhande)**
- FUSARIUM WILT : *Fusarium oxysporum* **(Scchlecht)**
- ROOT-KNOT DISEASE :*Meloidogyne incognita*

1. LEAF ROT

Causal Organism: *Phytophthora parasitica* var.*piperrina*
P. nicotianae var. *parasitica* f. *piperina* **(Dastur)**

- Symptoms appear only during rainy season when both the temperature and atmospheric humidity are high and favorable.
- Initially brown to black spots appear which and then it becomes soft & deliquescent in appearance under the continuous humid conditions.
- When disease advances spots rapidly increase in diameter under moist condition and extends to the major part of the leaf causing soft rot.
- The rot may extend to the petiole and in some cases to the stem also.
- In wet conditions, a white cottony growth appears on the lower side of the infected leaf at the light colored margins of the spots is due to the presence of sporangia & sporangiophores of the fungus coming out through the stomata by disintegrating the lower epidermis.
- With intervening dry warm periods, the diseased areas develop concentric zones of development.
- One or more than one spots may be found on a leaf within the plant part 2-3 feet of the ground level are more commonly affected than others leaves.
- It also infects root system and causes root rot or wilt.

2. PYTHIUM FOOT ROT

Causal organisms:
Pythium vexans **(de Bary)**
P. piperinum **(Dastur)**
P. splendens var. *hawaianum*

- Infected Plants droop, the upper succulent parts of the vines wilt.
- The green parts turn pale yellow and then brown, leaves shrivel and plant dies.
- The basal part becomes rotten and can easily be pulled out due to the rottening of roots.

3. LEAF SPOT

Causal Organism: *Colletotrichum capsici* ***(Petch)***

- The spot on the leaf is irregular in shape & size, light to dark brown surrounded by diffused chlorotic yellow hallow, marginal leaf tissues become black, necrotic and gradually spread to the leaf centre.
- Occasionally diffused yellow halo may also be seen.
- Fungus produces Acervulus, the asexual fruiting body where the circular, black lesions that occur rapidly increase in size and girdle the stem culminating in the death of the vine.
- Later on the fungi move to the spikes of individual plants.

4. POWDERY MILDEW DISEASE

Causal organism: *Oidium piperis* ***(Uppal, Kamat and Patel)***

- Early leaf infection symptoms consist of the formation of circular light greyish white powdery patches or spots which gradually enlarge and turn powdery mass of fungal growth.
- Under ideal conditions both the leaf surfaces get covered by the white floury mass of fungal growth.

- It is followed by yellowing of the leaves which become brittle resulting in early leaf falls.
- The growing shoots are also affected in severe cases and whole crop may be destroyed.
- Photosynthesis process is reduced and yield reduction occurs.

5. **BACTERIAL LEAF SPOT**

Causal Organism: *Xanthomonas campestris* pv. *beticola* **(Asthana and Mahmud)**

- The first symptoms of the disease in affected orchards are diminutive.
- Pale yellow spots, rapidly turning dark purple appear along or between the veins on either leaf surface.
- The spots in former positions are roughly circular or angular while in latter, they are irregularly elongated or branched like fern leaves.
- Only in case of advanced decay, the lesions are visible on both the surfaces.
- The infected leaves gradually turn yellow and fall.

6. **BACTERIAL LEAF BLIGHT**

Causal Organism: *Pseudomonas betlicola* ***(Patel, Kulakarni and Dhande)***

- Water soaked area appears on the lower surface, where as yellow halo appears on the corresponding upper surface of the leaf.
- Elongated brown spots of variable length appear on the vine.
- In severe infection, by stem canker large areas of leaf lamina are covered causing blight followed.

7. **FUSARIUM WILT**

Causal Organism: *Fusarium oxysporum* (Scchlecht)

- Initially infected crop shows yellowing symptoms. Later the vine is severely infested turns brown in colour.
- Further browning of leaves and drying of vines occurs ultimately which results in death of the plant.

8. **SCLEROTIUM WILT**

C.O: *Sclorotium rolfsii* (Sacc)

- Beetle vine of all ages are vulnerable to infection particularly at the collar region.
- White cottony mycelial growth creep over the infected root or the stem and soon minute mustard like sclerotial bodies appear in the soil near collar region of the vine.
- The vine wilts, dries off and leaves droop. Decay of stem occurs at and below the soil level, where dense, white cottony, mycelial mass are found at the site of entry causing wilting of the aerial parts.
- Numerous sclerotial bodies develop on the rotting stem and the soil around the infected plants. There is abundance of mycelia near the infected tissue.
- The mycelium inside the host is both inter and intra cellular that destroys the middle lamella resulting soft rot. The plants are susceptible at all the stages of their growth.
- The sclerotia are produced in plenty and are responsible for perpetuation and dissemination of the pathogen.

9.NEMATODE DISEASE

Causal organism: *Meloidogyne incognita*

- Root-knot disease symptoms caused by *Meloidogyne incognita* and *Meloidogyne javanica* are most common.
- The infected plants show growth reduction, yellowing and abnormal thickening of leaves with necrosis symptoms on the tip and margins of leaf that extends inwards.
- The disease causes reduction in quality and quantity of leaves. Serious wilt disease sometime greatly affects the growth of plants and produce causing heavy losses to the farmers.
- Because of the heavy losses due to root knot disease it requires chemical method of control.

Exercise-17

DISEASES OF RUBBER PLANT

- Bird's eye spot: *Helminthosporium heveae* Petch.
- Powdery mildew: *Oidium heveae*
- Leaf fall, Seedling blight and stem canker : *Phytophthora palmivora* Butler
- Seedling blight: *Rhizoctonia solani* Kuhn
- Pink disease: *Corticium salmonicolor*
- Root rot disease- *Phellinus noxious*
- Sooty mold: *Meliola* sp.
- Leaf and seedling blight and wilt :*Fusarium oxysporum* f. sp. *vasinfectum*

1. **Bird's eye spot**

C O: *Helminthosporium heveae* Petch.

- Affected rubber leaves have numerously-scattered small, circular spots with transparent centers and distinct brown borders which look like bird's eye.
- Young leaves are blackened and wrinkled, older leaves have necrotic lesions that result formation of shot holes caused due to falling down of tissue.

2. Powdery mildew

C.O: *Oidium heveae*

- White, cottony, hairy or powder-like borders are seen along the lesions.
- The shiny filamentous colonies of *Oidium* are clearly visible on both sides of the affected, freshly-fallen leaves.
- Severity of powdery mildew disease is commonly seen during and after over wintering or during flushing of the tree.

3. Sooty mold disease

C.O: *Tripospermum* sp.

- Sooty mold disease on rubber foliage is seasonal and depends largely on excreta and honey secretions of scale insect and other insects. Honey dew like excreta are favorable for the growth of the fungus.

4. Leaf and seedling blight and wilt

C.O: *Fusarium oxysporum* f.sp. *vasinfectum*

- Culture appears cottony white to yellowish with conidiophores simple and branching.
- Clusters of single-celled micro conidia in chains are also abundant.
- It infects both budded rubber and seedlings in nurseries and trees in plantations.
- Early symptoms include presence of irregular, brown lesions, which enlarge later.
- As the diseases progresses, the infected leaf eventually withers and a pinkish, shiny, cottony growth is evident on the infected area beneath the leaf surface.
- In young budded seedlings the pathogen causes seedling/shoot tip blight.
- Macro conidia are several-celled, slightly curved or bent at the pointed ends, multi septate (3-7), typically canoe shaped,hyaline, measuring 25-50 x 4-6 mm under 100x.

5. Seedling blight, black stripe, and stem canker

C.O: *Phytophthora palmivora* Butler

- Seedling blight caused by *Phytophthora palmivora* is noticeable especially during rainy season in nursery.
- Typical symptom of seedling blight shows leaf blades with few blotches that soon enlarge and coalesce.
- In severe cases, yellowing with defoliation occurs and eventually dieback takes place.
- *Phytophthora* leaf blight is initiated by the chlorosis at leaf margin which eventually advances until a brown colored lesion develops that becomes water soaked. It is more commonly observed in field plantations.
- Black stripes, stem canker and bark splitting are also frequently observed in rubber plantations.

- The typical symptoms of black stripe are sunken with slightly discolored areas on the tapping panel.

6. Seedling blight

C.O: *Rhizoctonia solani* Kuhn

- This disease infects mostly the seedlings.
- Symptoms start from the tip of the leaf with a chlorotic lesion. Mycelial growth of the fungus can be easily seen at the lower or undersurface part of the leaves.
- Seedling blight of rubber is caused by a complex of possibly *R. solani* (hyphal strands below right) associated with the nematodes present inside infected stem of budded rubber seedlings. Discoloration and rotting of the vascular tissues has also be noticed.

8. Pink disease

C.O: *Corticium salmonicolor*

- The symptom shows fungal salmon pink incrustations on the fork region of the tree or branches where moisture is easily trapped.
- The white silky threads (mycelia) of the fungus appear and, under favourable conditions, spread around the branch giving a thick cobweb effect which is more visible during rainy season.

9. Root rot disease

C.O: ***Phellinus noxious***

- Brown root rot disease caused by *Phellinus noxius*, have rhizomorphs found in the infected roots that form a continuous fungal skin, tawny brown, becoming almost dark with age.
- The diseased roots develop a very rough and irregular surface through a thick layer of soil adhering to them.
- In early stage, the rot is pale brown but later, brown zigzag lines appear. At a fairly advanced stage, the brown network of lines can also be seen on the wood surface beneath the bark.
- The fruit body is a hard, dark brown bracket fungus which is dark grey on the underside.

Exercise-18

POST HARVEST DISEASES OF PLANTATION CROPS

COCOA

1. Black pod rot disease

Causal organism*: Phytophthora palmivora*

- First sign of the disease is the appearance of brown spots on pod.
- The brown discoloration rapidly spreads in all directions and it also spread over the whole pod.
- Internal tissues of diseased pods become brown.
- Infected beans are discoloured.

It causes further rotten leading to the spoilage of quality of the produce.

2. Charcoal pod rot

Causal organism: *Botryodiplodia theobromae*

- The infection appears as dark brown to black spot on any place on the pod surface and which spreads rapidly.

3) Cherella rot

Causal organism: *Colletotrichum gloeosporioides*.

- Infected stalk becomes shrunken.
- The internal tissues of the pod become discoloured.
- Pinkish slimy mass of conidia is produced abundantly on the lesions under high humid conditions.
- Ultimately the diseased pod turns brown to black and remains on the tree as mummified fruit.

Exercise-18

Diseases of Coconut

- Bud Rot - *Phytophthora palmivora*
- Trunk and Root Rot Or Ganoderma-Wilt -*Ganoderma lucidum*
- Fruit Rot Or Mahali - *Phytophthora palmivora*
- Stem Bleeding - *Thielaviopsis paradoxa*
- Leaf Blight Or Grey Leaf Spot - *Pestalotia palmarum*
- Red Ring Disease - *Rhadinaphelenchus cocophilus*
- Crown Choking
- Cadang- Cadang
- Lethal Yellowing
- Linking MLO a Lethal Yellowing in coconut palms
- Leaf scorch decline

1.BUD ROT

C.O: (*Phytophthora palmivora*)

- The first symptom is the discoloration of youngest leaf, withering of central spindle of the crown, rolling and death of growing point
- The tender leaf bases degenerate into a soil mass of purified material, emitting foul smell that attracts flies.
- When the base of the bud is badly affected, the palm finally succumbs.
- Bud rot is highly infectious and is spread by the wind during rainy season.

2. TRUNK AND ROOT ROT OR GANODERMA-WILT

C.O: Ganoderma lucidum

- Although the seat of infection is the base of the trunk/root, yet the characteristic symptom is visible on the crown followed by withering and drooping of the older leaves which remain hanging around the trunk for several months.
- The new leaves are reduced in size and yellowish in colour, the inflorescences become suppressed and palms remain barren.
- Bleeding patches occur at the base of the trunk which slowly extend to the stem and ultimately kill the plant.

3. STEM BLEEDING

C.O: *Thielaviopsis paradoxa*

- The first symptom is the **exudation of a dark reddish-brown fluid** through cracks of outer tissue or wounds of lower parts of the trunk.
- The tissue inside the trunk gets decayed and the epidermis destroyed.
- The fluid turns black in colour as it dries up on the bark.
- The crown becomes smaller.
- This disease covers palms of all ages but the spread is more rapid in young palms
- Bleeding of the stem is associated with fungal infection.
- The fungus associated with the disease is *Thielaviopsis paradoxa*, which is a wood parasite, isolated from infected stem tissues.
- This parasite establishes itself inside tissues of the trunk after getting entry through cracks and wounds on the trunk.

4. FRUIT ROT OR MAHALI

C.O: (*Phytophthora palmivora*)

- Fruit rot also called 'Mahali' is used by the fungus *Phytophthora pulmivora* during monsoon period.
- It affects immature as well as mature nuts.
- Dropping of buttons becomes more common after the rains when the atmospheric humidity is high with low temperature.
- A water-soaked area develops near ,the fruit stalk during the monsoon.
- The fruit appears dark green at first and in the fruit rot may extend to the' husk and further into the kernel cavity.

5. **GREY LEAF BLIGHT OR GREY LEAF SPOT**

C.O: (*Pestalotia palmarum*)

- The incidence of the disease is usually influenced by the nutrient· status of the soil and the palm as well.
- Young palms are mostly susceptible when the soil is deficient in potash and rich in nitrogen content.
- Leaf spot symptoms develop only on the mature leaves in the form of small yellowish-brown spots on the leaflets which gradually become oval in shape with a greyish band.
- In advance stage, the infected portion of the leaflets shows a burnt or blighted appearance.

6. RED RING DISEASE

C.O: (*Rhodinophelenchus cocophilus*)

- This disease is caused by the nematode, *R. cocophilus* which is an endo-parasite, mostly confined to the Western Tropics.
- However, this disease is not prevelent in India.
- The leaflets of the outer turn yellow, starting from the tips causing browning and death of leaves.
- The young palms (4 to 7 year old) are more susceptible to infection.
- The infection spreads through the soil under wet conditions when the root system comes in contact with the adjoining infected palm trees.

7. CROWN CHOKING

- The first symptom is the emergence of shorter leaves with deformed and crinkled leaflets which are associated with severe tip necrosis.
- The deformed leaflets fail to unfurl and ultimately give a choked appearance to the frond. Hence, this deformity of the' palms is known as "crown choking".
- In case of young palms, peripheral leaves crown around the bud and prevent normal unfurling of the flag leaf.
- In acute cases, necrosis of the primordial tissue occurs and the crown dies, but not suddenly.
- The infected palm slowly looses vitality and succums finally within 3 to 4 years.

8. **CADANG- CADANG**

- The symptoms and its spreading nature have been generally accepted indicating its virus origin and the involved organism has been identified as viroid.
- The first visible symptom is the decrease in size of nuts, fibrous layer becoming thinner and thinner.
- Irregular yellow translucent spots appear in the pinnate of young leaves and turn orange-yellow mottling as the leaves mature and size and number of spots increase.
- On the lower surface of the leaves, a peculiar 'water-soaked' type of spot appears.
- Young leaves become short, brittle and frond as a whole become smaller and tend to remain in upright position in the crown.
- Both male and female flowers remain dwarf and the flower production usually ceases
- As the disease progresses, roots generally deteriorate and rotting becomes extensive.

9. LETHAL YELLOWING

C.O: (Phytoplasma Like |Organism)

- The first symptom of lethal yellowing in mature coconut palms is the premature dropping of most of the nuts regardless in size.
- Next symptom is the necrosis of new inflorescence with blackening of tips and most of the male flowers become dead and thereby no fruit set on such' flower stalks.Next, the lower fronds turn yellow which spreads gradually to younger leaves.
- However diseased yellowed leaves are found turgid and not flaccid as in case of root wilt disease.
- These leaves become yellow, ultimately turn brown, desiccate and hang down.
- Finally, the newly emerged spear leaf collapses and death of the terminal bud occurs resulting in fall of the top of the palm within 6 months after appearance of the symptoms.
- Lethal Yellowing spreads not only but it kills rapidly.

10.LEAF SCORCH DECLINE

- Necrosis of lower whorl of fronds of grown up palms and downwards curling of leaflets are the main characteristics of Leaf Scorch Decline.
- After a short period, crown is reduced in size and the trunk begins to tap and as result the formation of inflorescence may cease completely.
- Extensive damage of root system and root decay are found to be common in infected palms.
- This malady is often associated with cracking of heavy clay soil and visible magnesium deficiency symptoms on leaves.

Exercise-19

DISEASES OF TEA (*Camellia sinesis*)

(A) MAJOR DISEASES

1. Root rot diseases
   a. Brown root disease — *Fomes lamoensis*
   b. Black root disease — *Rosellinia arcuata*
   c. Red root rot — *Poria hypolateritia*
   d. Armilariella root rot — *Armiilartella mellea*
   e. Interroot disease — *Botryodiplodia theobromae*
2. Blister blight — *Exobasidiun vexans*
3. Grey blight — *Pestalotia theae*
4. Black rot — *Corticium invasum, C.theae*
5. Red rust — *Cephaleuros mycoidea*

B)Minor diseases

a. Pink disease — *Pellicularia salmonicolor*
b. Sooty mould — *Capnodium* sp.
c. Leaf spot — *Cercospora theae*
d. Branch canker — *Macrophoma theicola*
e. Thread blight — *Pellicularia koleroga*
f. Stump rot — *Ustulina zonata*

1. Root rot diseases

a. Brown root disease:

C.O: *Fomes lamaoensis* (Murrill) Sacc. & Trott.

- The disease appears on the decaying slumps of jungle and shade trees that have been cut and left in the soil It is widely distributed in the tropics occurring in Java, Malaysia, Sri Lanka, Sumatra, East and West Africa.
- The roots of the tea bush are encrusted with a mass of earth and small stones cemented to the root by the mycelium.
- When aged, the mycelium acquires a black covering, sometimes with a brown powdery outer layer.
- Between bark and the wood, there is usually a thin layer of white or brownish mycelium.
- The fructification is rarely formed on cultivated plants killed by this fungus.
- The disease spreads through root contacts.
- This is a faster killer than stump rot and more common on sandy soils than clayey soils.

b. Black root disease:

C.O: *Rosellinia arcuata* Fetch.

- It is a common disease of tea occurring in India and Sri Lanka.
- It spreads rapidly in the form of strands
- The black strands closely adhere to the roots as loose cob-webby mass.
- The fungus enters the bark and spreads out into the star- like sheets of white mycelium
- The attack usually begins at the collar region.
- The mycelium penetrates inside and ramifies between bark and wood.

- The pathogen has two types of fructifications, a conidial stage and a perithecial stage.
- Disease spreads to other parts of the field through conidia dispersed by the wind.
- Consequently, a swollen ring of tissue is formed round the stem above the dead patch and below the latter.
- The conidia are borne on short bristle-like stalks.
- The perithecia are black, Spherical bodies about 0.5 to 1.0 mm in diameter. They bear asci which in turn bear ascospores.

The disease spread by wind.

c. Red root rot disease:

C.O: *Poria hypolateritia* Berk.

- The fungus is confined to the underground parts. When bark is lifted, characteristic flat, black rhizomorphs ars exposed
- These strands form branched markings on the surface of the wood.
- The strands vary in colour from pink to brown or black according to age.
- The root has generally a mottled appearance of red and white.
- Plants of one to two years age are killed more speedily.
- The bark is softened and wood may be discoloured as bluish black.
- On the bark the conidial stage appears in the form of reddish tufts at the collar region.
- The conidia are of two types, thin and thick walled.
- Perithecia appear on the bark at a later stage.
- Perithecia are small, dark red bodies, round shaped at the bottom and drawn into a short conical neck above.
- Each perithecia contains numerous asci without paraphyses.
- The fungus lives as a saprophyte on the pieces of fallen wood of several trees.
- It spreads mostly through the rhizomorphs present in soil.

d. Armillariella root rot:

C.O: *Armillariella mellea*.

- It occurs in all the temperate region but limited to tropics in Africa and Asia where it is more predominant in mountain areas, but it also occurs in lowland areas in Central and West Africa.
- Usually the disease becomes apparent after it has severely damaged the root system of bushes as the foliage begins to wilt, turn chlorotic and falls, 'Death of the whole plant then follows.'
- As the parasite spreads up to the roots and reaches the collar region, of the tissue beneath the bark often cracks.
- Sheets of creamy coloured mycelium appear beneath the bark accompanied by flattened brown rhizomorphs.
- Rhizomorphs are also found on outside of roots where they often grow epiphytotically in advance of infection.
- The characteristic sporophores are usually produced on the collar region of the host in advanced stage of the disease? They occur in clumps, are pale brown and mushroom - shaped.
- Old tree stumps large root pieces or other woody material that has been colonized by the fungus act as the main sources from which the pathogen invades tea bushes or other

perennial crops. Rhizomorphs can grow through the soil to reach potential hosts Basidiospores from the sporophore are able to initiate saprophytic growth which can colonise wood.

e. Inter root disease:

C.O: *Botryodiplodia theobromae* Pat.

- The disease usually appears within six weeks to three months after pruning.
- The mycelium runs within the tissues of the plant.
- The fructifications of the fungus are minute, black, spherical bodies embedded in the bark.
- The fungus enters through the fine rootlets and attacks the tap root also. Soil fumigation is the best method to control it, though it is expensive.

2. Blister blight

C.O: *Exobasidium vexans*

- The first symptom is the appearance of small, pale or pinkish spots on the leaves.
- These spots are round from the very beginning and enlarge upto about an inch in diameter.
- Young shoots are very much affected.
- On the upper surface of the leaf, spot becomes light green in colour and depressed into a shallow cavity while the under side bulges correspondingly forming a blister like swelling. The lower bulged surface is covered by white growth of the fungus.
- Later the blister turns dark brown and shrinks to flattened patch.
- Old leaves of four weeks and above are immune as only the young leaves are circular in shape but become elongated along the midrib.
- The infection passes on to the petiole and young succulent stem which results in serious damage.
- The fungus eventually penetrates and damages the stem.
- The leaf yield may be reduced and vitality of the tea bush is affected finally.
- Under severe attack, the bush may be permanently injured and growth impaired.

3. Grey blight disease of tea

C.O: *Pestalotia theae*

- The disease appears as minute, brownish spots on older leaves which soon turn grey.
- The spots are mostly irregular and several of them may coalesce to form irregular grey patches. The spots have fine concentric lines.
- Fructifications of the fungus appear as black dots in older leaves on the upper surface.
- The fungus infects plucking points and causes die-back. Generally grey blight attacks older leaves of the tea plant.
- If young leaf is infected, the leaves are blackened and frequently the attack takes place even before the leaf is unfolded.
- It sometimes attacks the ends of plucked shoot and kills them back upto a short distance and repetition of this process results in production of a bush of dead shoots.

4. Black rot disease of tea

C.O: *Corticium invasum*, Fetch and *C. theae* Bernard

- Small dark brown irregular spots appear on leaf.
- They coalesce to form a dark brown patch which eventually covers the whole leaf and causes dropping it before leaf turns black, the lower surface assumes a white powdery appearance.

5. Red rust disease of tea:

C.O: *Cephaleuros mycoidea* Karst

- On leaves the alga may sometimes exist as parasite or sometimes as epiphytes while in the stem it is normally in parasitic form producing cankers and killing the tissues.
- The leaf infection can be seen throughout the year in an acute condition while the stem infection may escape at certain periods.
- The leaf infection of red rust does little damage, but it is important in that it serves as a source of stem infection.
- The alga occur as orange yellow, roughly ciruclar patches on the upper surface of the leaf. The patches may be few or numerous, crowded or scattered and may occupy any part of the leaf. They are rare on the petiole.
- Under favourable conditions the algae penetrates the leaf tissues
- The penetrating filaments may extend laterally between epidermis and adjacent layers and also downwards between palisade cells.
- The filaments never penetrate leaf cells but get nourishment through osmosis.
- The host cell that comes in contact get killed and their contents turn brown and become dry. Ultimately the alga itself ceases to grow, cells die and a crater-like depression is left surrounded by an elevated ring.

1. Pink disease

C.O: *Pellicularia salmonicolor* (Berk. & Br.) Dastur

- A number of fine, silky threads packed into a thin film appear first on stem. It is found on leaves. Fungus forms pink fructifications over infected stems.
- Young branches on the outside of the bush lose their leaves and die-back.
- The pink concentrations crack into small fractions at right angles.
- They are generally confined to lower side of branches. Bark killed in patches.
- When the branch increase in thickness, it grows only in areas where bark is dead. So branch becomes irregularly swollen.Pink tissue becomes white when old.
- Basidiospores are wind-borne.
- The disease first appears on border was adjacent to jungles. Addition of potash in the soil promotes recovery. Very difficult to eradicate by removing of infected plants.

2. Sooty mould

C.O: *Capnodium sp*.

- A black film of mould sometimes appear on stem or upper surface of leaves.
- The film is superficial and its appearance is usually related to the presence of scale insects.

3. Leaf spot/Bird's eye spot

C.O: *Cercospora theae* Van Breda.

- This is a minor leaf disease causing the so called “bird's eye spot” on young leaves.
- The spots are 3.5 mm in diameter, brown in the centre and reddish or dark brown at the edge.
- The disease has been reported to cause severe attack after heavy rains.

4. Branch canker

C.O: *Macrophoma theicola* Fetch.

- This is a disease that infects stem and produces characteristic cankered appearance.
- The disease appears during early part of the monsoon as small, slightly sunken, oval patches on the bark of young branches.
- These patches grow in the cambium, spreading rapidly between bark and the wood.
- The barks above the infected cambium quickly dies, turns black and fall.
- The black patches of dead bark crumbles off and the unaffected white wood underneath is exposed.
- In minor attacks, the infected patches are completely callused within a few months and after one or two only a sight scar remains.
- During the attack, the pycnidia or small fruiting bodies are produced under the bark which is covered over by callus.
- Where the callus formation is incomplete, spores from these pycnidia may give rise to subsequent attacks.
- Repeated attack of stems result in encircling the stem and finally killing them out. Prolonged drought condition renders the bark susceptible to Macrophoma.

5. Thread blight

C.O: *Pellicularia koleroga* Cke.

- Sterile, white threads or strands pass along the branches and spread into a fine web like film on the under surface of the leaves.
- It may cause browning and death of the leaf cells.

6. Stump rot / Charcoal rot

C.O: *Ustulinia zonata* (Lev.) Sac.

- It is prevalent in most of the tea growing areas.
- It attacks cocoa, coffee, rubber and other woody plants.
- The disease causes tea bushes to die in patches.
- The diseased bushes become dry as if suffering from drought.
- The leaves wither, turn brown and drop. Generally the bushes die slowly turning in to thin canopy due to fall of the leaves and sometimes they become suddenly dry with leaves intact.
- New shoots rarely arise from lower side once wilting sets in.
- The disease spreads to the surrounding bushes in wide circles.
- The roots do not show any external mycelium. Brownish or white mycelium with fan shaped fructifications can be seen when the bark is removed.

Practical observation: Record the main symptoms of the given specimen and take free hand thin sections of the fungal affected host tissue and note down the microscopic observations.

Exercise-20

DISEASE OF BELLADONNA – *Atropa belladonna L*

- Root rot wiltt :*Fusarium solani*, *Pythium butleri* and *Phytophthora nicotianae* var. *nicotianae*
- Leaf spot :*Cercospora atropae*
- Damping off :*Pythium ultimum*, *Rhizoctonia solani* and *Phytophthora parasitica*.
- Downey mildew :*Peronospora* spp.
- Leaf necrosis :*Ascochyta atropae*
- Mottlevirus :virus

1. Root rot wilt of Belladonna

C.O*: Fusarium solani, Pythium butleri* and *Phytophthora nicotianae* var. *nicotianae*

- All the stages of the Plant are affected.
- In young seedling stage the fungus causes pre and post emergence damping off of seedlings.
- Drooping and yellowing of older branches and leaves. In the advance stage whole epical portion of the plant get died.
- The tissue at collar region above and below the soil surface become brown and appear quite distinct from healthy tissue
- Older plants when affected invariably wilt .

2. Damping off of Belladonna

C.O: *Pythium ultimum*, *Pythium debaryanum*, *Rhizoctinia solani* and *Phytophthora parasitica.*

- Roots of affected seedlings or sprouts show water soaked lesions at the base below soil level and exhibit rottening, reddening, drooping down and falling of leaves.

3. Cercospora leaf spot disease

Causal Organism: *Cercospora atropa*

- Round to angular, brown spots with chestnut colored margins appear on both sides of the leaves. The conidiophores produced on the spots are olive brown and tuft whip like. Multicellulars conidia can be seen on the conidiophores.

4. Downy mildew disease

C.O: *Peronospora parasitica*

- Initially small dots like structure are seen on the lower surface of leaves that later develop into pustules which further increase in size and produce downy growth.
- In advanced stage the leaves wither away.
- Whitish downy growth consisting of enormous amount of sporangiophores, sporangia and mycelia..

5. Leaf necrosis disease:

Causal Organism: *Ascochyta atropae*

- Greyish, white irregular spot with slight depression on the upper surface of leaves.
- The spots coalesce and become necrotic causing defoliation and death of the plants.

6. Belladonna mottle disease

C.O: Mottle Virus

- The characteristics symptoms are the slight clearing of veins and crumpling of leaves, followed by a light or dark green mottle, together with blistering and distortion of leaves and stunting of the plants.

Exercise-21

DISEASES OF DATURA

List of Fungal diseases

1. Wilt of datura ***: Sclerotium rolfsii***
2. Root & foot rot : ***Corticium solani***
3. Leaf spot : ***Alternaria tennuissima***

Viral diseases

1. Distortion mosaic
2. Rugose leaf curl
3. Mosaic
1. Little leaf of datura caused by phytoplasma

1. LEAF SPOT

C.O*: Alternaria tennuissima*

- Concentric round spots on the leaves.
- Spot size increases and covers the entire leaves.
- Blightening of leaves.

2. Mosaic

Causal organism : Mosaic virus.

- Young growing leaves & inflorescence show mosaic symptoms.
- Leaves become yellow from the veins.
- Finally the leaves roll & falls off.
- Epidemiology
- Severe in summer due to high insect vector population.

3. Wilt

C.O: *Sclerotium rolfsii*

- The organism colonizes at epidermal layer at collar region of plant, discoloration of collar region, girdling
- The infected plants start drooping and drying then and finally rottening occurs.

4. Root & Foot rot

C.O*: Corticium solani*

- Brownish black discoloration of infected leaves which completely get detached from the stem.
- Rottening of the roots is the final symptom
- It also colonizes and cause foot rot symptoms.

5. Little leaf

C.O: Phytoplasma

- Leaf size reduction is the major symptom
- The number of lveases Internodal length decreases.
- Floral parts converted into foliage parts or leaves.
- Stunting of plants. Leaf hoppers act as Vector

Exercise-22

DISEASES OF MINT

1. PODERY MILDEW: *Erysiphe cichoracearum*
2. **WILT**: *Verticillium albo-atrum*
3. **RUST**: *Puccinia menthae*
4. **LEAF SPOT** *:Curvularia lunata*
5. **LEAF BLIGHT**: *Alternaria* spp
6. **STOLON ROT**: *Rhizoctonia bataticola*

1) **POWDERY MILDEW**

C.O: *Erysiphe cichoracearum*

- Small chloratic spots appear on the upper surface of leaves.
- The corresponding lower surface shows brownish discolouration prior to the appearance of powdery patches.
- White /grey colour powdery growth appears on both upper &lower surface of leaves at a later stage which leads to heavy defoliation

2) **Rust**

C.O: *Puccinia menthae*

- Brown rusty pustules appear on the lower surface of leaves.
- The spots are initially circular ,slightly elevated which later coalesce to form irregular spots.
- Chlorotic streaks on the upper surface, telial stage is characterized by swellings on the upper portion of the stem.
- Defoliation and death of the leaves can be seen in severely affected plants (Leaf bligh)

3)**LEAF SPOT**

C.O: *Curvularia lunata*

- Small, unclear and scattered brown spots scattered over the leaf lamina.
- The minute spots increase in size, forming big spherical or irregular patches.
- Infection is severe in neglected crops

4) **LEAF BLIGHT**

C.O: *Alternaria alternata*

- Lower most leaves are the first to be infected &disease later develops on the upper leaves.
- The infected leaves shows round to oval to irregular or slightly irregular dark brown spots on the upper surface of the leaves with concentric rings.
- Spot size increases and covers the entire leaves. Later on blightening & detaching of leaves takes place.

5) **Stolon Rot**

C.O: *Rhizoctonia bataticola & Sclerotium rolfsii*

- Initially there is yellowing of leaves & stunted growth. In advance stage the plants wilt followed by death of the above ground parts.
- Initially stolons exhibit pinkish brown lesions which gradually turn into dark brown lesions.
- These lesions turn into dark brown to black patches that increase in size resulting in soft decay.

6) **WILT**

C.O: *Verticilium albo-atrum*

- There can be complete loss of the crop due to this disease
- Initially lower leaves show V shape yellowing symptoms Dwarfing and unilateral development of the branches. Etiolation of the leaves leading to wilting and death.
- Light tan coloured discolouration of vascular bundles.

Exercise-23

DISEASES OF PYRETHRUM

MAJOR DISEASES

- **PYRETHRUM FUSARIUM WILT : *Fusarium oxysporum* f.sp.*solani***
- **LEAF SPOT/BLTOCH*: Septoria chrysanthemella***
- **ROOT ROT*; Sclerotinia minor***

MINOR DISEASE

- **RAY BLIGHT; *Phoma ligulicola* var. *inoxydablis,***

1. PYRETHRUM FUSARIUM WILT

Causal organism*: Fusarium oxysporum* f.sp.*solani*

- Initially the older leaves start showing yellowing and as the disease advances the yellowing progresses to upper leaves.
- If the organism produces enough of toxin then leaf margin necrosis takes place.
- Infected roots show black to brown discolouration, blocking of the vascular bundle by fungal mycelia and the chlamydospores, micro and macro conidia may cause drooping of the plant.

2. Leaf spot\blotch:

C.O: ***Septoria chrysanthemella***

- Initially circular to irregular blackish brown spots are formed.
- Later the spots are surrounded by yellow hallow.
- In severe infestation, the leaves remain small and curling takes place
- The dead leaves hang on the stem for some time

3 .ROOT ROT

C.O: ***Sclerotinia minor***

- The organism colonizes at epidermal layer at collar region of the plant causes discoloration and thinning at collar region which leads to girdling
- The plant starts drooping, drying and then finally rotting takes place **.**

Ray Blight

C.O*: Phoma ligulicola* var. *inoxydablis,*

- Necrosis of ray florets of the flowers
- Distortion of the developing stems of plants followed by necrosis in the growing tips are symptoms of a severe form of ray blight caused by ***Phoma ligulicola* var. *inoxydablis***
- The disease affects all above ground parts of the plant.
- The disease does not affect roots, but the pathogen is able to survive as epiphytic mycelium around root cuttings

Exercise-24

DISEASES OF Camphor (*Cinnamomum camphora*)

- **POWDERY MILDEW :***Microsphaera alphifoides* (Griff) *:*
  :Erysiphe cinnamomi
- **Verticillium wilt :***Verticillium* spp.
- **Leaf spot :***Pseudomonas* spp.
- **Leaf blight** *:Alternaria* spp. (kuntze: Pers)

1. POWDERY MILDEW OF CAMPHOR

Causal organism: *Erysiphe cinnamomi*

- Whitish grey coloured powdery growth seen on upper surface of leaf which slowly spreads.
- In severe conditions it may move to lower surface of the leaf.
- Leaf slowly cupping, later leaf dropping takes place.
- Powdery growth appear on stems and it consists of oidia and mycelial strands.
- The stem and petioles are also affected at later stages and are covered with dirty white mycelia and oidia.
- With the advancement of the disease, complete or partial chlorosis of leaf lamina occurs and the affected leaves eventually dry up

2. VERTICILLIUM WILT

Causal organism: *Verticillium* spp.

- Affected plants are stunted in growth, leaves develop dark green patches followed by interveinal and marginal yellowing.
- Leaves wilt, dry and eventually fall.
- A brown discoloration can be seen in the xylem vessel on cutting through the stem and roots .
- Partial wilt but lower leaves show yellowing symptoms and V shaped yellowing of leaf margin.
- Epinasty not seen but lower leaves get dried.

3. LEAF SPOT DISEASE

Causal organism: ***Pseudomonas* spp.**

- Disease affects the aerial parts of the plant.
- Spots on the leaflets are water soaked, round, oval or irregular.
- Several such spots may coalesce to form a blighted appearance.
- Yellowing not observed but healthy plant suddenly wilt due to faster spread of the disease.
- Vascular browning, white or milky white colored oozing are common.
- Plants dry up completely.

4. LEAF BLIGHT

Causal organism: *Alternaria* spp.

- The infection starts with the appearance of minute spots on the leaf with irregular chlorotic areas on the tip portion of the leaves , then circular to oblong concentric black velvety rings appear in the chloroted area.
- The lesions then develop towards the base of the leaf. These spots coalesce and spread quickly to the entire leaf area causing blight.
- Sometime a yellow hollow develops around each lesion.
- As the disease advances, spot size increases and complete blightening takes place. The leaves gradually die from the tip downward.

Exercise-25

DISEASES OF DIOSCOREA

l. Damping off :*Pythium* spp.
2. Leaf spot :*Cercospora dioscoreae.*
3. Leaf fall & die back :*Colletotrichum* sp.
4.Leaf Blight :*Glomerella cingulata*
5. Tuber Rot :*Fusarium* sp., *Rhizoctonia* sp

l. Damping off

Causal organism : *Pythium* spp,

- Pre emergence damping off.
- Tubers or crowns fail to germinate.
- Rotting of tubers or crowns takes place inside the soil.
- Post emergence damping off. Water soaked lesions on collar region, leading to rottening and damping off.
- Stem size reduction. Toppling over of seedlings & death.

2) Leaf spot

Causal organism: *Cercospora dioscoreae.*

- Numerous irregular, angular dark brown to black spots.
- Later the spots move to stem, the spots start to coalesce & blightening takes place.
- Later the leaves fall off.

3) Leaf fall & die back

Causal organisms: *Colletotrichum sp.*

- Younger leaves dry up & branches also get dried from tip downwards.
- In sever cases, entire plant may die.

4) Leaf Blight

Causal organism : *Glomerella cingulata*

- Light brown, small circular spots on upper surface of leaves.
- Spot size increases &coalesce forming reddish brown to black patches.
- The death of tissue occurs and Plant dries up.

5) Tuber Rot

Causal organism: *Fusarium sp., Rhizoctonia sp.*

- Complete loss due to the disease. Lower leaves show yellowing followed by wilting of plants and vascular discoloration

Rhizoctonia sp.

- Organism colonizes the collar region.
- Rough cankerous growth on collar region and girdling of stem.
- Aerial part dries & droops.

Exercise-26

DISEASES OF NEEM

Fungal diseases

1) POWDERY MILDEW :*Oidium azadiractae (Erysiphae)*
2) Root rot :*Ganoderma lucidum*
3) Leaf web blight :*Rhizoctonia solani*
4) Leaf spot :*Pseudocercospora subsessilis*

Bacterial diseases

1) Bacterial wilt :*Pseudomonas azadiractae*
2) Angular leaf spot :*Xanthomonas azadiractae*

1) POWDERY MILDEW

C.O: *Oidium azadiractae (Erysiphae*)

- Greyish powdery growth on the upper surface of the leaves and can also be seen on young leaves.
- Infected leaves wrinkle and defoliate.
- On older mature leaves necrotic patches.
- Powdery growth on twigs, flowers and fruits is common in severe conditions.
- Necrotic patches are seen on older mature leaves.
- Fruit dropping is the common symptom.
- Powdery growth reduces photosynthetic area which in turn reduces the growth and yield drastically

2) Root rot

C.O: *Ganoderma lucidum*

- Yellowing of lower leaves which gradually progresses upwards followed by drooping of branches .
- Infected leaves bend or fall down**.**
- Longitudinal cracking can be seen through these cracks, gummy oozing appear which results in mushroom like basidiocarp formation.
- Root rotting is common after the death of the infected tree.

3) Leaf web blight

C.O: *Rhizoctonia solani*

- Water soaked lesions appear on the leaf, stem and twigs. Affected leaves are blighted.
- Mycelial growth and dark brown sclerotia are seen on affected parts

4) Leaf spot

C.O: *Pseudocercospora subsessilis*

- The leaf spots are first noted on older, fully expanded leaves as brown,subcircular to irregular lesions with a dark brown border.
- Upon enlargement, leaf spots coalesce to form large, dark-brown necrotic areas which is ultimately followed by abscission of the leaves.

1.Bacterial wilt

C.O*:Pseudomonas azadiractae*

- The bacterial pathogen multiply rapidly inside the water conducting tissues of the plant which results in rapid wilting of plant, where as the leaves stay green.
- When an infected stem is cut crosswise, it will show browning and tiny drops of yellowish ooze may be visible.
- In severe cases, falling of leaves takes place.

2.Angular leaf spot

C.*O:Xanthomonas azadiractae*

- Initially water soaked, angular spots appear on the leaf, which later turn into pale yellow in colour with oily appearance.
- Blightening, dry of leaf, defoliation followed by cell necrosis.

Exercise-27

DISEASES OF SENNA

1. Damping off: *Rhizoctonia bataticola*
2. Leaf spot : *Alternaria alternata*
3. Leaf spot *: Cercospora* spp.
4. Leaf blight : *Phyllosticta* spp.

1) DAMPING OFF OF SEEDLINGS

C.O: *Rhizoctonia bataticola*

Initially water soaked lesions appear on the collar region of the plant. After brown discoloration follows the epidermal layer collapse.Seedlings topple down.

2) LEAF SPOT

C.O: *Alternaria alternata*

- Concentric round spots are formed on the leaves .Spot size increases and covers the entire leaf resulting in blightening of leaves

3) LEAF SPOT

C.O: *Cercospora* spp

- Brown colored spots appear on lower surface of the leaf.
- Disease is severe in neglected crops in which blightening and leaf falling occurs.

4) LEAF BLIGHT

C.O*: Phyllosticta* spp.

- Oval shaped water soaked spots appear on lower surface of the leaf that moves to upper surface.
- Spot size increases and its centre portion turns whitish grey in color.
- Spots coalesce and blightning takes place.

Exercise-28

DISEASES OF CROTALARIA

- Fusarium wilt :*Fusarium udam*
- Stem rot :*Sclerotium rolfsii*

1. Furasium wilt

C.O*: Fusarium udam*

- It is a fungal disease.
- Yellowing of lower leaves and drooping of apical/arial parts
- On mature plants, brown colored streaks appears on the side of the main shoot with few white branches while remaining survive.
- **V**ascular bundle discoloration, later turns brown to black colour.

Mycelial strands can be seen in vascular bundles.

2. Stem rot

C.O: *Sclerotium rolfsii*.

- Sclerotial bodies are sorghum like structures which germinate and multiply by producing mycelia.
- It colonises and girdles the seedlings after infection.
- Once the epidermis is destroyed, the stem become yellow and the root length is also reduced.

Finally the infected plant dies.

Exercise-29

DISEASES OF HEMP

1. Leaf spot caused :*Cercospora cannabina.*
2. Wilt disease caused :*Fusarium* spp.
3. Phillody disease caused :Phytoplasma.

1. Leaf spot

C.O: *Cercospora cannabina*

- Characteristic dark brown spots appear on the leaves.
- These spots are round to oval, irregular in shape and enlarge with concentric rings.
- The spots become necrotic leading to withering & drooping.

2. Wilt disease of Hemp

Causal organism: *Fusarium*spp.

- External: Yellowing, upward drooping of older leaves and leaf epinasty.
- Internal: Brownish black coloration and blocking of vascular bundles.

3. Phillody:

Causal organism: Phytoplasma.

- Proliferation of floral parts, adherence of vegetative shoots formed by converted stamen & carpel.

Exercise-30

DISEASES OF OPIUM

Major disease

1.Downy mildew – *Peronospora arborescens*

Minor diseases

Fungal diseases

1.Damping off – *Pythium dissotocum*
2.Root rot – *Macrophomina phaseolina or Fusarium semitectum*
3.Powdery mildew – *Erysiphe polygoni*
4.Capsule rot – *Embellisia phragamospora*
5.Leaf blight –*Helminthosporium papaveris*

Virus diseases

1.Poppy mosaic virus
2.Cabbage-ring spot
3.Beet-yellow
4.Bean yellow mosaic

Bacterial diseases

Soft rot – *Erwinia papaveris*

1. Downy mildew

C.O*: Peronospora arborescens*(Berk.) de Bary.

- In India it is generally noticed during mid February, when the crop is fully mature.
- It is also noticed during November-February.
- It appears on seedlings and the affected seedlings get killed outrightly.
- The leaves near the tips and margins are covered with pale brown spots.
- Grey-violet fungal growth is seen on the under surface.
- Under favourable conditions the disease spreads and the infected leaves dry up, become papery and brittle.
- In severe cases of attack entire leaf is killed. Infection may spread to inflorescence and stem also resulting in yield loss from 7-65%.

Damping Off

- This disease was reported in India from Lucknow and the incidence ranges from 40-60%.
- Pre-emergence& post-emergence damping off occurs in opium. Severely infected seedlings show decay of root and collar region.
- Diseased seedlings die in 3-5days after attack.
- Mycelium of the fungus is white and coenocytic, sporangia are filamentous, slightly inflated with discharged tubes.
- Oogonia may be terminal or intercalary, spherical and 19-24 micrometer in diameter. Antheridia 1-3 micrometer
- Oospores are single, plerotic, 17-20µm in size with 1.3micrometer thick walls.

Root Rot disease of poppy

C.O*: Macrophomina phaseolina* (Tassi) Goid.

- The disease is prevalent in parts of Bihar and U.P.
- Affected plant begins to wither and dry up from the base. The stem at the collar region shows blackening and shredding of root barks. The infected plants dry up; the disease is noticed in patches. Large number of minute and black sclerotia can be seen on infected root barks.

Powdery Mildew

C.O: ***Erysiphe polygoni*** DC.

- The fungus attacks all the green plant parts at all the plant growth stages
- The fungus produces white to greyish powdery patches on the affected plant parts including fruits but young leaves are most susceptible and develop small whitish patches both on the upper as well as lower surfaces.
- These patches grow in size and coalesce to cover large areas on the leaf lamina. Malformation and discoloration of the affected leaves are also common symptoms, resulting in distortion.
- Similarly, powdery patches are produced on the stem, tendril, flowers and young fruit branches.
- Diseased vines appear wilted where as the stem portion turns brown.
- The infected blossom and berries turn dark in colour, irregular in shape and brittle.
- In advance stage of infection, berries may develop cracks which do not develop and ripe.

Capsule Rot disease

C.O: *Embellisia phragmospora*.(Van embess)

- Symptoms can be seen on mature and tender leaves.
- Large circular, irregular, water soaked lesions, dirty black in color appear on the margins of mature leaves.
- Lesions can be seen in the centre of the leaf on either side of the midrib.
- In some cases, large lesions extending the entire length of the leaf can also be seen. The exposed portions of the tender, unopened leaves may also rot.
- The leaves become shredded and remain attached to the pseudostem.
- Greyish patches of irregular outline and size with brownish margins are found at the base of the leaf sheath.
- The basal portion rots causing pseudostem to break away at the collar region even at the slightest disturbance.
- The infection spreads to the underground parts which become decomposing mass.
- Small light brown lesion appear on green, tender fruits which fall down in 3-6 days after infection leaving the small fruits stalk on the base of inflorescence and finally rotting occurs.

Soft Rot disease

C.O: *Erwinia papaveris (Ayyar)* Magrou.

- The disease is characterized by external blackening and internal disintegration, accompanied by discoloration of the mid rib of leaves.

- The disease commences at the apex and extends downwards turning whole of the plant into a slimy mass.

Poppy Mosaic disease

C.O: ***Poppy Mosaic Virus***

- Yellow + green patches appear on leaves followed by stunting of plants flower dropping and yield is reduced.
- This virus is very sensitive

Exercise-31

Post harvest diseases of aromatic crops

CELERY

1. **Early blight**

Causal organism: *Curvularia andropogonis*

- The pathogen causes dampingoff.
- Appearance of symptoms on leaves can be seen as severe yellowing and browning of leaf tips, initially with circular to oval spot which become irregular under favourable condition.
- These spots turn dark brown at a later stage surrounded by dark reddish brown borders.
- Small unclean brown spots can also be seen scattered all over the leaf lamina .
- The minute spots increase in size forming bigger spherical or irregular patches. The disease is severe in neglected crops.

2. Late blight

C.O: ***Septoria petosalanii***

- Initially circular to irregular blackish brown spots appear on leaves, later these spots are surrounded by yellow hallow. In severe infestation, the leaves remain small and curled.
- The dead leaves remain hang on the stem for some time.
- Black spots visible on the pycnidia of fungus

CITRONELLA

1. Leaf blight

C.O : *Cuvularia andropogonis*

- The pathogen causes damping off.
- Appearance of symptoms on leaves is seen as severe yellowing and browning of leaf tips initially with circular to oval spots which become irregular in favorable conditions.
- These spots turn dark brown surrounded by dark reddish brown borders.

Fennel

1. Leaf blight:

C.O: *Cercospora foeinicoli*

- Light brown zonated spots appear on the leaves.
- Black and elliptic spots appear on the twigs.
- The infected areas in the twigs become flattened and depressed with raised edges. Such infected twigs dry up.
- In severe cases the whole plant may die.

French basil

1. Leaf blight

C.O: *Colletotrichum capsici*

- The fungus attacks tender shoots and foliage.
- Brown, dark circular or irregular spots are formed on the leaves which become crinkled.
- The infected portion become dry and fall down and leaf ragged margins.
- Twigs remain base due to falling of infected leaves.

Jasmine

1. Leaf blight

C.O: *Cecospora jasminicola*

- Light brown zonated spots appear on the leaves where as black and elliptic spots appear on the twigs.
- The infected areas in the twigs become flattened and depressed with raised edges. Such infected twigs dry up.
- In severe cases the whole plant dies.

LEMON GRASS

1. Leaf spot diseas

C.O: *Colletotrichum cimbapogoni*

- The fungus attacks tender shoots and foliage.
- Brown or dark circular or irregular spots are formed on the leaves and infected leaves become crinkled.
- The infected portion dry up and fall down.

Often infected leaves are shed thus leaving the twigs bare.

2. Grey Blight/ Grey rot / Pestalotiopsis Leaf Spot:

C.O*: Pestalotiopsis mangliferae* (P.Henn.)Stey.

- Brown spots develop at the margins and tips of the leaf lamina and distributed irregularly on entire leaf.
- Initially the spots are brown and minute which gradually increase in size and become dark brown.
- Black dots appear at the center of the spots representing acervuli.

Palmarosa

1. Leaf blight:

C.O: *Curvularia trifolii*

- Appearance of symptoms on leaves is seen as severe yellowing and browning of leaf tips, initially with circular to oval spot which become irregular under favorable conditions.
- These spots turn dark brown surrounded by dark reddish brown border at a later stage.

Leaf spot

C.*O: Colletotrichum caudatum*

- The fungus attacks tender shoots and foliage.
- Brown to dark circular or irregular spots are formed on the leaves which become crinkled.
- The infected portion dry up and fall down leaving leaf ragged margins.
- Often these leaves fall down leaving the twigs bare.

Practical observation: Record the main symptoms of the given specimen and take free hand thin sections of the fungal affected host tissue and note down the microscopic observations.

PYRETHRUM

Pyrethrum: *Chrysanthimum cinerarifolium*

Pyrethrum refers to several Old World plants of the genus *Chrysanthemum* which are cultivated as ornamentals for their showy flower heads. It is also the name of a natural insecticide made from the dried flower heads of *C. cinerariifolium* and *C. coccineum*. Pyrethrum was used for centuries as an insecticide

It is a member of the daisy (or aster) family,Asteraceae. They are perennial plants with a daisy-like appearance and white petals.

MAJOR DISEASES

PYRETHRUM FUSARIUM WILT : *Fusarium oxysporum* f.sp.*solani*

LEAF SPOT/BLOCH*: Septoria chrysanthemella*

ROOT ROT*; Sclerotinia minor*

MINOR DISEASE

RAY BLIGHT; *Phoma ligulicola* var. *inoxydablis,*

1. PYRETHRUM FUSARIUM WILT

Causal organism: Fusarium oxysporum* f.sp.*solani

SYMPTOMS:

EXTERNAL SYMPTOMS

- Initially the older leaves starts showing yellowing then as disease advance the yellowing progresses to upper leaves.
- If the organism produces more toxin then leaf margin necrosis takes place.

INTERNAL SYMTOMS

Infected roots show black to brown discolouration, blocking of the vascular bundle by the fungal mycelia and chlamydospores, micro and macro conidia leads to drooping of the plant.

IMPACT of the disease dropping, wilting, stunting and reduce tillering. In advance stage majority of the tillers wilt and result in death of entire plant. Movement of nutrients and water from below groundceases and plant starts showing wilting.

Aetiology:

- Mycelia is septate, inter and intracellular haustoria[absorbing organ].
- Asexual spores are Micro and macro conidia.
- Sexual spores are Ascospores born in ascus present in perithecium where as the Vegetative spores are Chlamydospores

Primary source of innoculum is Chlamydospores and the infected planting material.

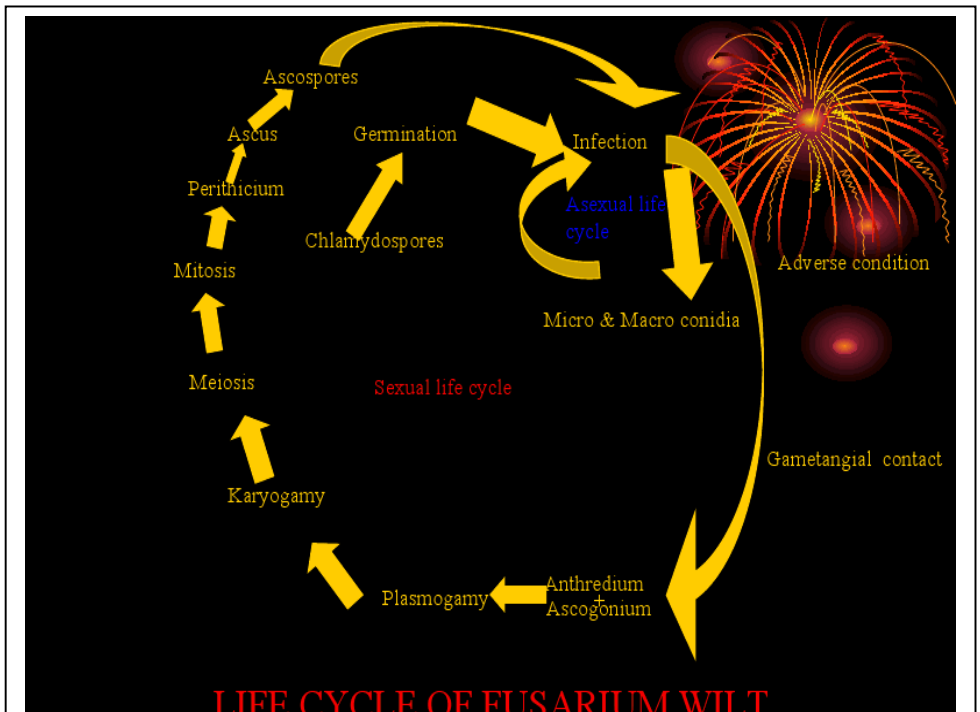
Secondary source of innoculum is Soil borne micro and macro conidia.

Spread: the fungal spores spreads through irrigation

EPIDIOMOLOGY:

- The organism causes disease when temperature is 28-32^{0}C
- Relative Humidity 80-90%
- Sandy loam soil
- Acidic pH(5.5-6.5) and
- Susceptible host, low soil moisture and the affected seed.

Life cycle:



MANAGEMENT:

Cultural method

- Summer ploughing is done
- Infected plant should be removed and destroyed
- Use healthy seed and treat the seed with **carbendazim 2g\kg of seed**
- Neutralize the soil pH by applying lime (200-300g\plant)
- Avoid excess nitrogen application
- Crop rotation with non host plant eg: Graminaceae
- Chemical: Drench the soil with **carbendazim 0.1% **
- Growing of resistant variety, KKL-1

2. Leaf spot\blotch: *Septoria chrysanthemella*

SYMPTOM:

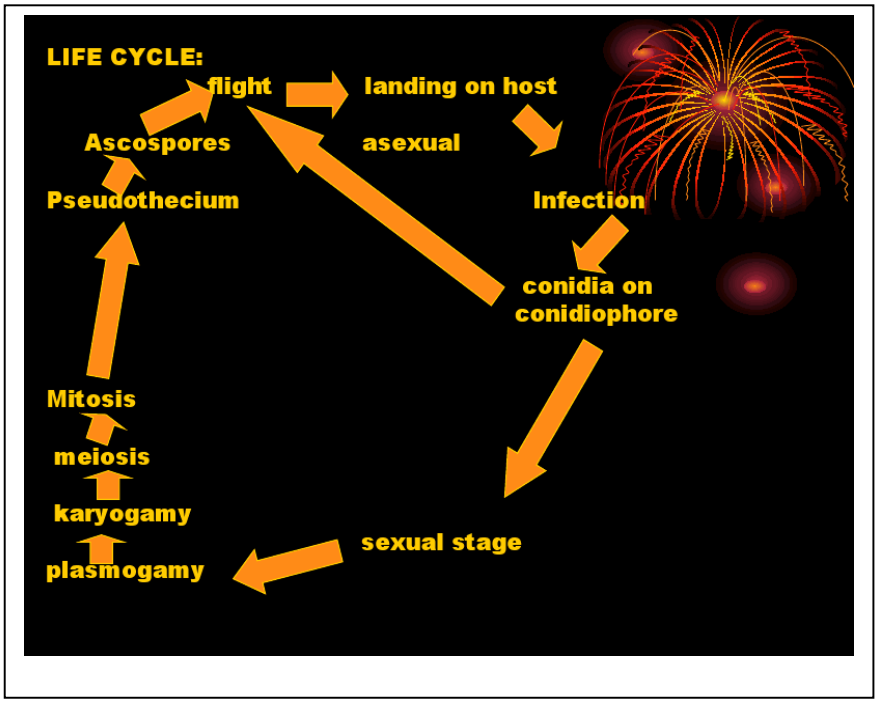
On young leaves

- Initially circular to irregular blackish brown spot on leaves
- later spot surrounded by yellow hallow.
- In severe infestation, the leaves remain small and curling takes place
- The dead leaves hang on the stem for some time

AETIOLOGY:

- Mycelium is septate inter and intrecellular haustoria,
- Sexual spores are Ascospores borne in pseudothecium.
- **Primary source of inoculumis** Ascospores (pseudothecium)
- **Secondary source of inoculums** is pycnidiospores

Mode of spread is infected debris in the soil and rain splash.



Lifecycle

EPIDEMIOLOGY:

- The organism requires cool weather with the temperature of 18 to 20^0 C
- Relative humidity 95 to 99%
- Cloudy weather
- Intermittent rain fall

MANAGEMENT:

- Collect the affected plants and burn.
- Regular Irrigation
- Spraying of systemic fungicide such as **carbendazim 0.1%**
- **Mancozeb 0.25%** as aerial spray for effective control.

3 .ROOT ROT: *Sclerotinia minor*

Symptoms:

- The organism colonize at epidermal layer at collar region of plant, discoloration of collar region, thinning at collar region leads to girdling
- Then the plant start drooping and drying then finally rotting takes place **.**

AETOLOGY:

- Mycelia is Septate, sclerotial bodies are vegetative structures strands
- Sexual spores are ascospores borne in apothecium

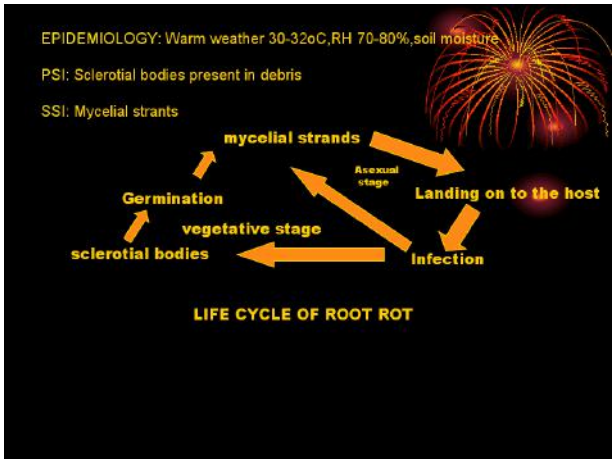
EPIDEMIOLOGY:

- The organism requires Warm weather condition with temperature of 30-32^{0}C
- Relative humidity of 70-80%.

Primary source of inoculums : Sclerotial bodies present in affected debris

Secondary source of inoculum is Mycelial strands.

life cycle



MANAGEMENT:

- Host destruction
- Crop rotation with graminacea family
- Low level of N application and increase K application
- Chemical: carbendazim 0.1% as soil drenching

Minor disease

Ray Blight ***Phoma ligulicola* var. *inoxydablis*,**

SYMPTOM:

- Necrosis of the ray florets of the flowers
- Distortion of developing stems of pyrethrum plants and necrosis in the growing tips are symptoms of a severe form of ray blight caused by ***Phoma ligulicola* var. *inoxydablis***
- Affect all above ground parts of the pyrethrum plant.
- The disease does not affect roots, but the pathogen is able to survive as epiphytic mycelium around root cuttings

Diseased bud affected by *Phoma ligulicola*

Etiology: mycelium is septate, asexual spores are pycnidiospores borne in pycnidia.

MANAGEMENT:

- Healthy seed used for sowing
- Crop rotation with graminacea family
- Affected plants cut and burn
- Chemical: carbendazim, 0.1% as soil drenching

RUBBER OF DISEASES

1. Bird's eye spot: *Helminthosporium heveae* Petch.
2. Powdery mildew: *Oidium heveae*
3. Leaf fall, Seedling blight and stem canker : *Phytophthora palmivora* Butler
4. Seedling blight: *Rhizoctonia solani* Kuhn
5. Pink disease: *Corticium salmonicolor*
6. Root rot disease- *Phellinus noxious*
7. Sooty mold: *Meliola* sp.
8. Leaf and seedling blight and wilt :*Fusarium oxysporum* f. sp. *vasinfectum*

Bird's eye spot:

C O: *Helminthosporium heveae* Petch.

Symptom:

- Affected rubber leaves have numerously-scattered small, circular spots with transparent centers with distinct brown borders, looks like birds eye.
- Young leaves are blackened and wrinkled, older leaves have necrotic lesions that result to shot holes caused by tissue drop-offs.

Etiology

- In culture, growth of this fungal pathogen is cottony white that later turns to light brown.
- Conidiophores single or clustered, tail, brown; stomata often present; conidia develop laterally through pores beneath septa while apex conidiophore is still growing, often appearing in whorls, single, subhyaline to brown obclavate, pseudoseptate, with prominent basal scar; conidia measures 65-170 x 9.5-10 mm with 3-6 septations under 100x.

✓ Management

- Bordeaux mixture 1%
- Mancozeb 0.25%
- Giving shade to nursery

Powdery mildew caused by *Oidium heveae*

Symptom:

- White, cottony, hairy or powder-like borders along the lesions.
- The shiny filamentous colonies of *Oidium* are clearly visible on both sides of the affected freshly-fallen leaves.
- High severity of powdery mildew are common during and after over wintering or during flushing of tree.

Etiology

- This fungus is an obligate pathogen and can not be grown in culture.
- It produces thin and membranous characterized by oval or barrel shaped conidia or oidia borne in chains on short conidiophores. The mycelium is ectophytic, septate have subepidemial haustoria.

Management

- Wettable Sulphur 0.2%
- Carbendazim 0.1%

Sooty mold caused by *Tripospermum* sp.

Symptom:

- Sooty molds on rubber foliage is seasonal and depend largely on excreta and honey secretions of scale insect and other insects. Honey dew like excreta are favorable to the growth of the fungus.

- It is not a pathogen. |It is purely ectophytic growing on the surface and never invade the host tissue. Sooty growth covers the green chlorophyll and hence greatly hinder the photosynthetic activity of the host plant.

Management

- Control the insects with any of the suitable systemic insecticides.
- Spray 1% starch solution on the fungal growth which dries up to form flakes and falls off leaving healthy green plant surfaces.

Leaf and seedling blight and wilt

Caused by *Fusarium oxysporum* f.sp. *vasinfectum*

Etiology and Symptoms:

- In culture, cottony whitish to yellowish, conidiophores simple and branching.
- Macro conidia several-celled slightly curved or bent at the pointed ends, multi septate (3-7), pointed ends, typically canoeshaped,hyaline, measuring 25-50 x 4-6 mm under 100x.
- Clusters of single-celled micro conidia in chains are also abundant.
- It infects both budded rubber and seedlings in nurseries and trees in plantations.
- Early symptom shows the presence of irregular, brown lesions, which later enlarge.
- As the diseases progresses, the infected leaf eventually withers and a pinkish, shiny, cottony growth is evident on the infected area beneath the leaf surface.
- In young budded seedlings the pathogen causes seedling/shoot tip blight.

Management

- Drench the nursery with Bordeaux mixture 1% and use the same spray mixture for seedlings also.

Seedling blight, black stripe, and stem canker *Phytophthora palmivora* Butler

Symptoms:

- Seedling blight caused by *Phytophthora palmivora* is noticeable especially during rainy season under nursery condition.
- Typical symptom of seedling blight show the leaf blades with few blotches that soon enlarge and coalesce.
- In severe cases, yellowing with defoliation will happen and eventually dieback takes place.
- *Phytophthora* leaf blight indicated by the chlorosis at leaf margin with eventually advances until a brown colored lesion develop and becomes water soaked. It is more commonly observed in field plantations.
- Black stripe, stem canker and bark splitting also frequently occur in rubber plantations.
- The typical symptoms of black stripe are sunken with slightly discolored areas on the tapping panel.
- Later, vertical fissures appear in the renewing bark; when these are removed, dark vertical lines are visible; presence of discolored or black lines in the tapping cut; clogging of the latex flow resulting to massive spilling of latex; cause uneven renewal resulting to burns and depressions on the tapping panel. For stem canker, the sunken canker is the best diagnostic symptom.
- As the cankers become older, they become brown with a shredded appearance.
- In bark splitting or cracking, there is a massive spilling of latex and when scraped, pinkish to reddish discoloration is observed.
- Reddish discoloration is observed that becomes black at a later stage.
- In the matured trees, the pathogen causes dropping of prematured leaves leading to defoliation and the disease also called as *'Phytophthora* leaf fall'.

Etiology

- This fungus belongs to the Phylum Oomycota, Family Pythiaceae grows abundantly on V-8 agar.
- The colonies are white, aerial, and cottony in culture.

- The sporangia are characterized by lemon-shaped and doubled papillate structures which measure from 34.5 – 57.5 x27.5 -49.0 mm under 100x and oospores with 22 - 28 mm.

Management

- Prophylactic spray with Bordeaux mixture 1%
- Zinc sulphate 0.2%

Seedling blight caused by *Rhizoctonia solani* Kuhn

Symptom:

- This disease infects mostly the seedlings.
- Symptoms start from the tip of the leaf with a chlorotic lesion. Mycelial growth of the fungus are easily seen at the lower or underside part of the leaves.
- Seedling blight of rubber caused by a complex of possibly *R. solani* (hyphal strands below right) associated with the presence of nematodes inside infected stem of budded rubber seedling. Discoloration and rotting of vascular tissue can also be noticed.

Management

- ✓ Seed treatment with carbendazm 2g\kg seed
- ✓ Give drenching spray with carbendazim 0.1%

Pink disease: *Corticium salmonicolor*

Symptom

- The symptom shows fungal salmon pink incrustations on the fork region of the tree or branches where moisture is easily trapped.
- The white silky threads (mycelia) of the fungus appear and, under favorable conditions, spread around the branch giving a thick cobweb effect.
- This is more visible during rainy season.

M**anagement**

- Affected plants are to be pruned and burnt, cut ends are pasted with Bordeaux mixture .
- Spray Triademorph 0.1%

Root rot disease- *Phellinus noxious*

Symptom

- Brown root rot caused by *Phellinus noxius*, have rhizomorphs found in the infected roots that form a continuous fungal skin, tawny brown, becoming almost dark with age.
- The diseased roots develop a very rough and irregular surface through a thick layer of soil adhering to them.
- In early stage, the rot is pale brown; later, brown zigzag lines appear. At a fairly advanced stage, the brown network of lines can also be seen on the wood surface beneath the bark.
- The fruit body is a hard, dark brown bracket fungus which is dark gray on the underside.

Management

- Application of lime 2.5tones\ha
- Affected and healthy roots are washed with Emisan (mercurial compound)

SENNA (*Cassia angustifolia*, family: legumianaceae)

INTRODUCTION:

Is a small perennial under shrub. Senna is used in medicine cathartic. It is especially useful in habitual constipation. The plant also contains sennasoids C and D. It is an imporatant medicinal crop which can be grown for its leaves and pods for the extraction of different types of sennosides present in pods and leaf...

DISEASES OF SENNA (*Cassia angustifolia*, family: legumianaceae).

1. Damping off: *Rhizoctonia bataticola*
2. Leaf spot : *Alternaria alternata*
3. Leaf spot : *Cercospora* spp.
4. Leaf blight : *Phyllosticta* spp.

1)DAMPING OFF: *Rhizoctonia bataticola*

SYMPTOMS:

Initially water soaked lesions on the collar region of the plant. Brown discoloration then the epidermal layer collapse.Seedlings topple down.

ETIOLOGY:

- Septate mycelia, sub epidermal haustoria
- Asexual spores are absent and Mycelial strands act as a conidia
- Sexual spores: Basidium (Basidiospores)
- Vegetative structure: Sclerotial bodies

EPIDEMIOLOGY:

- Warm weather ,soil temp 28^0-32^0 C. Optimum moisture, neutral pH
- Primary Source of Inoculum :sclerotial bodies
- Secondery Source of inoculum: Soil borne mycelial strands

TAXONOMY:

K: Fungi:

D: Deuteromycota:

C: Deuteromycetes:

O: Mycelia sterilia

F: ? G: Rhizoctonia Sp: bataticola

LIFE CYCLE:

- It is a Deuteromycetes fungi produces sclerotial bodies, these are like sorghum seed like vegetative structures, resting structures and long surviving structures.
- When there is congenial conditions these sclerotial bodies germinate penetrate to the host and causes disease.
- The affected host having mycelial strands again they germinate and cause infection that how disease cycle continues.

MANAGEMENT:

- Affected debris destruction
- summer ploughing
- Crop rotation
- Soil sterilization
- Biological agent
- Carbendazim 0.1% or Mancozeb 0.2% soil drenching.

2) LEAF SPOT: *Alternaria alternata*

SYMPTOMS:

Concentric round spot on the leaves .Spot size increases and covers the entire leaves leading to blightening of leaves

ETIOLOGY:

Septate mycelia, either conidia or conidiophores are colored

EPIDEMIOLOGY:

- Nutritionally poor soil,
- temp 28-35 D C, RH 85-90per cent,
- Susceptible host.

Primary Source of Inoculum: Dormant mycelia

Secondery Source of inoculum: Air borne conidia

LIFE CYCLE:

- Perithecium present in the affected plant parts serves as a primary source of inoculum.
- Favorable climatic condition it will release ascospores and land on to the host, causes infection and these are responsible for primary infection
- Conidia are borne on conidiophore on the affected host and release to cause infection by asexually.
- During adverse climatic conditions the fungi switched on to sexual reproduction where gametangial contact followed by plasmogamy, karyogamy, mitosis and meiosis takes place to produce ascospores in pseudothecium.

TAXONOMY:

Kingdome: Fungi

Division : Deuteromycota

Class : Deuteromycetes

Order : Moniliales

Family : Dematiaceae

Genus : Alternaria

Species : alternata

MANAGEMENT:

- Collect and destroy affected plant parts
- Increased nutritional status

- Reduce plant population
- Mancozeb 2.0% as aerial spray

3). LEAF SPOT: *Cercospora* spp.

SYMPTOMS:

- Brown color spots on lower surface of the leaf.
- In severe cases, blightening takes place. Leaf falling. severe in neglected crop.

ETIOLOGY:

- Septate mycelia,
- Inter cellular mycelia and intracellular haustoria.
- Asexual spores- whip like conidia on conidiaphores,
- Sexual spores- Ascospores borne in ascus and which are situated in Pseudothecium
- Vegetative structure is dormant mycelia.

EPIDEMIOLOGY:

- Temp 30-32^{0}C, RH 85-90 per cent, cloudy weather, poor management.

Primary Source of Inoculum: Dormant mycelia.

Secondery Source of inoculum: Air borne conidia.

LIFE CYCLE:

- Pseudothecium is the primary source of inoculum presenting the affected debris.
- During favourable climate it produces ascospres. and causes primary infection.
- In the affected host whip like conidia are present on conidiophore and cause infection by asexually.
- During adverse climatic conditions the fungi switched on to sexual reproduction where male gametangium is antheridium and female is ascagonium.
- After gametangial contact plasmogamy, karyogamy, mitosis followed by meiosis and ascospore formation takes place.

MANAGEMENT:

- Collect older leaves and burn.
- Avoid more density of plants.
- Proper nutrient management.
- Mancozeb 2g/lit.

4) LEAF BLIGHT: *Phyllosticta* spp.

SYMPTOMS:

- Oval shape water soaked spots on lower surface of leaf. Then moves to upper surface.
- Spot size increases, center portion of spot turns whitish grey color.
- Spots coalesce and blightning takes place.

TAXONOMY:

Kingdome: Fungi
Division : Deuteromycota
Class : Deuteromycetes:
Order : Sphaeropsidales
Family : Sphaeropsidacea:
Genus : Phyllosticta

MANAGEMENT:

- Avoid more density of plants.
- Proper nutrient management.
- Bordeaux mixture 0.1% or captafol 0.2% as spray.

TEA (*Camellia sinesis*)

INTRODUCTION

Genus: camellia

Family: camellia

Tea is an ancient, cultivated plant. It is used as a beverage in south India and china. A native of south east Asia . Tea was first planted on a large scale in north India in 1834,while south India Dr.Christy experimented at Nilgiris in 1832 and commercial tea planting was started at various tea growing region like Nilgiris 1859, Kannan Devan hills 1878.

Tea research was started in north India during 1960 and in south India 1926.

In India, tea cultivation is localized in the eastern corner of Assam, Eastern Bengal and Southern extremities of western ghats. The plantation in the south are distributed in the states of Tamil Nadu, Kerala and Karnataka. India is the largest producer, consumer and exporter.

1. Root rot diseases
    a. Brown root disease _ *Fomes lamoensis*
    b. Black root disease _ *Rosellinia arcuata*
    c. Red root rot _ *Poria hypolateritia*
    d. Armillariella root rot _ *Armiilartella mellea*
    e. Inter root disease _ *Botryodiplodia theobromae*
2. Blister blight _ *Exobasidiun vexans*
3. Grey blight _ *Pestalotia theae*
4. Black rot _ *Corticium invasum, C.theae*
5. Red rust _ *Cephaleuros mycoidea*

Minor diseases

a. Pink disease _ *Pellicularia salmonicolor*

b. Sooty mould _ *Capnodium* sp.

c. Leaf spot - *Cercospora theae*

d. Branch canker _ *Macrophoma theicola*

e. Thread blight _ *Pellicularia koleroga*

f. Stump rot _ *Ustulina zonata*

1. Root rot diseases

a. Brown root disease: *Fomes lamaoensis* (Murrill) Sacc. & Trott.

- The disease arises from the decaying slumps of jungle and shade trees that have been cut and left in the soil It is widely distributed in the tropics occurring in Java, Malaysia, Sri Lanka, Sumatra, East and West Africa.
- It also attacks a number of other trees like bread fruit, cacao, coffee, rubber, etc.
- The roots of the tea bush are encrusted with a mass of earth and small stones cemented to the root by the mycelium. When aged, the mycelium acquire a black covering, sometimes with a brown powdery outer layer.
- Between the bark and the wood, there is usually a thin layer of white or brownish mycelium.
- The fructification is rarely on cultivated plants killed by this fungus.
- The disease spreads through root contacts.
- This is a faster killer than stump rot and is more common on sandy soils than clayey soils.

b. Black root disease: *Rosellinia arcuata* Fetch.

- It is a common disease of tea and occurs in India and Sri Lanka.
- This fungus is believed to originate usually in heaps of dead leaves and found in the top 5.0 to 7.5 cm of the soil especially where there is mere of dead leaves.

- It spreads rapidly in the form of strands attacking the roots of several other plants besides tea. The black strands closely adhere to the roots as loose cob-webby mass.
- These enter the bark and spread out into star- like sheets of white mycelium and easily seen after peeling the bark from the larger roots.
- The attack usually begins at the collar region. In older tea bushes it soon forms black strands closely applied to the root.
- The mycelium penetrates inside and ramifies between the bark and wood. At each point of entry it divides into number of strands which radiate over the surface of the wood and form s a white star upto 1.0 cm in dia.
- This has two kinds of fructifications, a conidial stage and a perithecal stage.
- Spread to other parts of the field are brought about by the distribution of conidia by the wind. The mycelium surrounds the stems at the surface of the soil and kills bark all round for a length of 7.5 to 10.0 cm.
- Consequently, a swollen ring of tissue is formed round the stem above the dead patch and similar ring below the latter.
- The conidia are borne on short bristle-like stalks.
- The perithecia are black, Spherical bodies about 0.5 to 1.0 mm in dia. They bear asci which in turn bear ascospores.
- The disease is spread by wind.

c. Red root rot: *Poria hypolateritia* Berk.

- It occurs in India, Malaysia and Sri Lanka.
- In India it is noticed in Assam and Tamil Nadu.
- The fungus is confined to the underground parts. When the bark is lifted characteristic, flat, black rhizomorphs ars exposed
- These strands form branched markings on the surface of the wood.
- The strands vary in colour when fresh pink to brown or black according to age.
- The root has generally a mottled appearance of red and white.

- Plants of one to two years old are killed more rapidly than older bushes^ The mycelium extends throughout the cortex and wood and may advance some distance up the stem within the wood.
- The bark is oftened and the wood may be discoloured as bluish black.
- On the bark at the colour region the conidial.
- stage appears in the form of reddish tufts.
- The conidia are of two types, thin and thick walled.
- At a later stage perithecia appear on the bark.
- They are small, dark red bodies, rounded below and drawn into a short conical neck above. Each contains numerous asci without paraphyses.
- The asci are cyclindrical with a short stalk. They contain eight ascospores.
- The fungus lives as a saprophyte or pieces of fallen woo i of several trees.
- It spreads mostly by the rhizomorphs present in soil.
- The spores are distributed by wind

d. Armillariella root rot: *Armillariella mellea*.

- It occurs in all temperate areas but is limited to Africa and Asia in the tropics where it is more predominant in mountain areas, but it is does occur in lowland areas in Central and West Africa.

- Usually the disease becomes apparent after it has severely damaged the root systems of bushes when the foliage begins to wilt, turns chlorotic and falls, 'Death of the whole plant then follows.'
- As the parasite spreads up the roots and reaches the collar region of the plant, the bark often beneath the bark often cracks.
- Sheets of creamy coloured mycelium occur beneath the bark accompanied by flattened brown rhizomorphs.
- Rhizomorphs are also found on the outside of roots where they often grow epiphytotically in advance of infection.
- The characteristic sporophores are usually produced on the collar region of the host in advanced stages of the diseases? They occur in clumps, are pale brown and mushroom -shaped.
- Old tree stumps large root pieces or other woody material that has been colonized by the fungus provide the main sources from which The pathogen invades tea bushes or other,, perennial crops Rhizomorphs can grow through the soil to reach potential hosts Basidiospores from the sporophore are able to initiate saprophytic growth which can colonise wood.

e. Inter root disease: *Botryodiplodia theobromae* Pat.

- The disease usually appear from six weeks to three months after pruning.
- The roots of a dead bush does not bear any external mycelium.
- In some cases the bark is rough and abnormally thickened.
- The mycelium runs within the cells of the plant. The fructifications of the fungus are minute, black, spherical bodies which are embedded in the bark.
- They are not visible from the exterior. If the bark is slightly shaved, the spheres are cut across, black circles with a white centre may be seen.
- The fungus enters through the fine rootlets and the fungus attacks the tap root also. Soil fumigation is the best method to control, though expense.

- It is the most suited method to arrest further spread of the disease in young and high yielding mature tea bushes.
- Replanting can be done after 12 weeks as against 24 months of rehabilitation following uprooting of the dead and suspected plants.
- Vapam and metham sodium may be applied into an apparently healthy ring of bushes, 20 to 25 cm away from the collar region of the living plant to avoid phytotoxicity. Dueofume C.P. (methyl bromide + ethylene dibromide 1:1) which is supplied in 450 g ca. s is enough to fumigate 526 sq.feet.
- Isolation drenches 120 cm deep and 45 cm wide may be dug around ;he infected bushes to isolate them and to prevent the spread of disease.
- Lime should be added in the affected patch and also in the trench.
- The shade trees should be pruned to permit more sunlight. Digging up of dead and infected stumps and bushes and burning them reduce the spread.
- Adequate manuring should be done to keep the bushes in vigorous conditions.
- The dieback branches after pruning may be sprayed with Bordeaux mixture 1.0 per cent to prevent infection.

2. Blister blight

This disease was first reported from Assam in 1868, spreading since then to most other tea growing areas of North and South India.

It also occurs in Burma, Indonesia, Japan, Malaya, Sri Lanka and Taiwan. Since 1946 it has become severe year after year ir? most tea gardens of South India, causing heavy damage to the industry.

The succulent growth of the plants developing after pruning is highly susceptible to infection. Temperatures above 24°C are fatal to the blisterance and disappearance of this disease.

Symptoms:

- The first symptom is the appearance of small pale or pinkish spots on the leaves.
- These spots are round from the very beginning and in due course enlarge in size upto about an inch in diameter.
- Youn g shoots are very much affected.
- On the upper surface of the leaf, the spot becomes light green in colour and depressed into a shallow cavity while the under side bulges correspondingly forming a blister like swelling. The lower bulged surface is covered by white growth of the fungus.
- In later stages the blister turns dark brown and shrinks to flattened patch.
- Old leaves of four weeks and above are immune and only young leaves are circular shape but becomes elongated along the midrib.
- When many blisters occur near the margin or apex and coalesce, much distortion and curling of the leaf may be caused.
- The infection passes on to petiole and young succulent stem which results in serious damage. On the stem, spots without blisters are formed.
- The fungus eventually penetrates and damages the stem.
- The leaves, and buds above the point of attack wilt end to wither.
- The leaf yield may be reduced and the vitality of the tea bush is affected finally.
- It, is probable that under severe attack, the bush may be permanently injured and the growth impaired.

Fungus: *Exobasidium vexans* Massee.

- The mycelium is confined to the blistered areas on the leaves.
- They are septate and collect in bundles below the lower epidermis.
- Later by rupturing the epidermis a continuous layer of vertical hyphae are projected on the surface of spot.
- The fungus produces two kinds of spores viz., the conidia and basidiospores.

- The conidia are most abundant, borne singly at the tips of long stalks.
- They are hyaline, elliptical, straight or slightly curved and measure 12 to 21 x 4.5 to 6 ^ra. Basidia are formed on the surface in larger number but never form a continuous hytneniurn. They are intermingled with 'conidial stalks and sterile fairs.
- Each basidium is long, club shaped with usually two short sterigmata at the end , each bearing a basidiospore.
- The basidia are ovate to oblong, hyaline and 30 to 90 x 2.3 to 4.5Mm.

Mode of spread and survival:

- The fungus completes its life cycle in 11 to 28 days and several generations of spores are produced in a season.
- It produces conidia and basidiospores in the same blister.
- Spores are air-borne.
- The perpetuation of the fungus appears to be from the pre-existing infected bushes.
- No dormant or resting stage is known.

Epidemiology:

- Relative humidity plays an important role in the epidemics of blister blight.
- If the relative humidity is below 80 per cent for 5 days, the rate of infection decreases.
- If it is above 83 per cent for 7 to
- 10 days, the infection is moderate to serious.
- The disease is favoured by cool day and nights , with wet or humid conditions.
- More severe outbreaks occur under shade or adjacent to jungle or v/ind breaks or in damp low lying areas where mist persists.
- The succulent growth of the plants developing after pruning is highly susceptible to infection. Temperatures above 24 °C are fatal to the blister blight disease, a fact which account for the periodical appearance and disappearance of this disease.

- Cool, moist, relatively still air favours infection.
- Moist and shade are therefore conducive to the development of severe attacks.

Management:

- Removal of affected leaves and shoots by pruning aim destruction of the same have been recommended.
- Spraying the bushes with Bordeaux mixture or copper oxychloride is found to be effective. Copper fungicides have been widely used often in combination with nickel salts which have a slight eradicant effect.
- A mixture of 210 g of copper oxychloride + 210 g of nickel chloride per ha sprayed at 5 days interval from June to September and 11 days intervals in Oct-Nov gives economic control.
- Spraying the bushes with 420 g of copper oxychloride and 27 g of Agrimycin 100 per hectare gives better control over the disease, compared to the treatment with copper oxychloride alone at the same dosage.
- Among the organic fungicides, chlorothalonil gives protectant and therapeutic effect. Triademorph, Mancozeb, Baycor, Bayleton and Pyracarbolid offer good disease control.
- Disease control achieved with triademorph at 340 and 560 ml /ha is satisfactory under mild and moderate rainfall conditions.
- Spraying schedule can be regulated according to weather conditions.
- Dry leaves are less prone to infection than damp ones and exposure to the sun for only one hour at a temperature of 29.5 °C is lethal.
- The formula recommended is that spraying can be suspended until the average daily hour of sunshine for the previous five days has dropped below 3 3/4 h.
- Spraying with the systemic fungicide, (Atemi 50 SL) at 400 ml/ha or bitertanol 300 EC (Baycor 300 EC) at 340 ml/ha at weekly intervals controls the blister blight effectively.

3. Grey blight

It occurs in North and South India. In South India it occurs in Karnataka, Kerala and TamilNadu. Apart from India it has been reported from Java and Sri Lanka.

Symptoms:

- The disease appears as minute brownish spots on older leaves which soon turn grey.
- The "spots are mostly irregular and several of them may coalesce to form irregular grey patches. The spots have fine concentric lines.
- Fructifications of the fungus appear as black dots in older spots on the upper surface.
- The fungus infects plucking points and causes die-back. Generally grey blight attacks older leaves of the tea plant.
- If young leaf is affected, the leaves are blackened and frequently the attack takes place even before the leaf is unfolded.
- It sometimes attacks the ends of plucked shoot and kills them back for a short distance and repetition of this process have been known to result in the production of a bush of dead shoots.

Fungus: *Pestalotia theae* Sawada

Mode of spread and survival: The conidia wind borne

Epidemiology:

The incidence is more frequent on wet bushes especially if potassium is deficient.

The infection is also predisposed by sun scorch, insect puncture and plucking wounds.

Management:

Copper oxychloride 0.3% or Bordeaux mixture 1.0 per cent may be sprayed twice, once in cold weather and again in April or May to check the disease,

4. Black rot

Symptoms :

Small dark brown irregular spots appear on leaf| They coalesce to produce a dark brown patch which eventually covers the whole leaf and drop off| Before the leaf turns black the lower surface assumes a white powdery appearance.

Fungi : *Corticium invasum* Fetch and *C. theae* Bernard

Mode of spread and survival: Basidiospores carried by workers.

The disease develops rapidly when temperature is high and air is humid.

At the beginning of rainfall they germinate and produce which start fresh infection.

Epidemiology: Occur in nursery shaded with Crotalaria,'Bosidiospores germinate only in wet weather or when leaves are covered with dew.

Management:

Prune in December end, remove the prunings immediately, burn after drying.

Collect all dead and dried leaves. Spray a copper fungicide in third week of April.

5. Red rust

- The trivival name of this disease is a misnomer.
- The cell contents of the genus, *Cephaleuros* are orange red, hence the misapplication of the name rust.
- The disease is widespread and important in India, Sri Lanka, Africa and America.
- It attacks all kinds of tea both young and old when vitality is impaired.
- It is occurring on tea in many parts of India.

Symptoms:

- On the leaves the alga may sometimes exist as parasitic or sometimes epiphytic while in the stem it is normally parasitic producing cankers and killing the tissues.
- The leaf infection can be seen throughout the year in an acute condition while the stem infection escapes except at certain periods.
- The leaf infection of red rust does little damage but it is important in that it serves as a source of stem infection.
- The alga occurs as orange yellow, roughly ciruclar patches on the upper surface of the leaf. The patches may "be few or numerous, crowded or scattered and may occupy any part of the leaf. They are rare on the petiole.
- Under favourable conditions the alga penetrates the leaf tissues
- The penetrating filaments may extend laterally between epidermis and adjacent layers and also downwards between palisade cells.
- The filaments never penetrate leaf cells but get nourishment by osmosis.
- The host cells in contact get killed and their contents turn brown and dry up Ultimately the alga itself ceases to grow, cells die and a crater-like depression is left surrounded by an elevated ring.
- On the stem the pathogen occurs as red hairy patches
- The new shoots arising from infected wood show lack of vigour or even cease to grow prematurely.
- As a result of infection the host bark is removed in successive layers and where this fails, the parasite penetrates deeper, into the cortex and may ultimately cause the death of the shoot.

Causal agent: *Ceplaleuros mycoidea* Karst, Red rust also attacks *Tephrosia* sp. and *Desmodium gyroides* grown as green manure and shade. ".

Epidemiology: Rainy season is best suited for propagation of alga. :

Management:

- The algal parasite may be tackled in two ways.
- The first one is achieved by the removal of all infected portions by spraying Bordeaux mixture.
- The other approach is by increasing the vigour of the bushes since it is considered that there is a direct connection between lack of vitality of the bush and the virulence of the disease.
- Improving the nutrient status of the soil by application of nitrogen, phosphorus and potassium fertilizers is important.
- Destruction of affected plant parts should be done.

6. Minor diseases

Pink disease: *Pellicularia salmonicolor* (Berk. & Br.) Dastur

- A number of fine silky threads united into a thin film appear first on stem. It is found on leaves. Fungus forms pink fructifications over affected stems.
- Young branches on the outside of the bush lose their leaves and die-back.
- The pink concentrations crack into small fractions at right angles.
- They are generally confined to lower side of branches. Bark killed in patches.
- When the branch increase in thickness it grows only in areas where bark is to dead. So branch become irregularly swollen.Pink tissue become white when old.
- Basidiospores are wind-borne.
- The disease first appears on borders adjacent to jungles. Addition of potash promotes recovery. Very difficult to eradicate by removal of affected plants.

Sooty mould: *Capnodium sp*.

- A black film of mould sometimes appear on stem or upper surface of leaves.
- The film is superficial and its presence is usually related to the presence of scale insects.

Leaf spot/Bird's eye spot: *Cercospora theae* Van Breda.

- This is a minor leaf disease causing the so called bird's eye spot on young leaves.
- The spots are 3.5 mm in dia, brown in the centre and reddish or dark brown at the edge.
- The disease has been reported to cause severe attack after heavy rains.

Branch canker: *Macrophoma theicola* Fetch is the causal agent.

- This is a disease affecting stem and produces characteristic cankered appearance.
- The disease appears during the early part of the monsoon as small, slightly sunken, oval patches on the bark of young bi inches.
- These patches grow in the cambium, spreading rapidly between the bark and the wood.
- The barsc above the affected cambium quickly dies, turning black and fall off.
- The black patches of dead bark crumbles off and the unaffected white wood underneath is exposed.
- In slight attacks, the affected patches are completely callused within a few months and after one or two only a sight scar remains.
- During the attack, the pycnidia or small fruiting bodies are produced under the bark and these may be covered over by callus.
- Where the callus formation is incomplete, spores from these pycnidia may give rise to subsequent attacks.

- Repeated attacks of stems result in encircling the stem and finally killing them out. Prolonged drought renders the bark susceptible to Macrophoma.

Thread blight: *Pellicularia koleroga* Cke.

- Sterile white threads or strands pass along the branches and spread into a fine web like film on the under surface of the leaves.
- This may cause browning and death of the leaf cells.

Stump rot / Charcoal rot: *Ustulinia zonata* (Lev.) Sac:.

- It is prevalent in most of the tea growing areas.
- It attacks cocoa, coffee, rubber and other woody plants.
- The disease causes tea bushes to die in patches.
- The diseased bushes dry as if suffering from drought.
- The leaves wither, turn brown and drop off. Generally the bushes die gradually by becoming thin by the fal' of leaves and sometimes then dry up suddenly with leaves intact.
- New shoots rarely arise from be-low once wilting sets in.
- The disease spreads to the surrounding bushes in wide circles.
- The roots do not show any external mycelium. Brownish or whitish mycelium with fan shaped fructifications can be seen when the bark is removed.

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