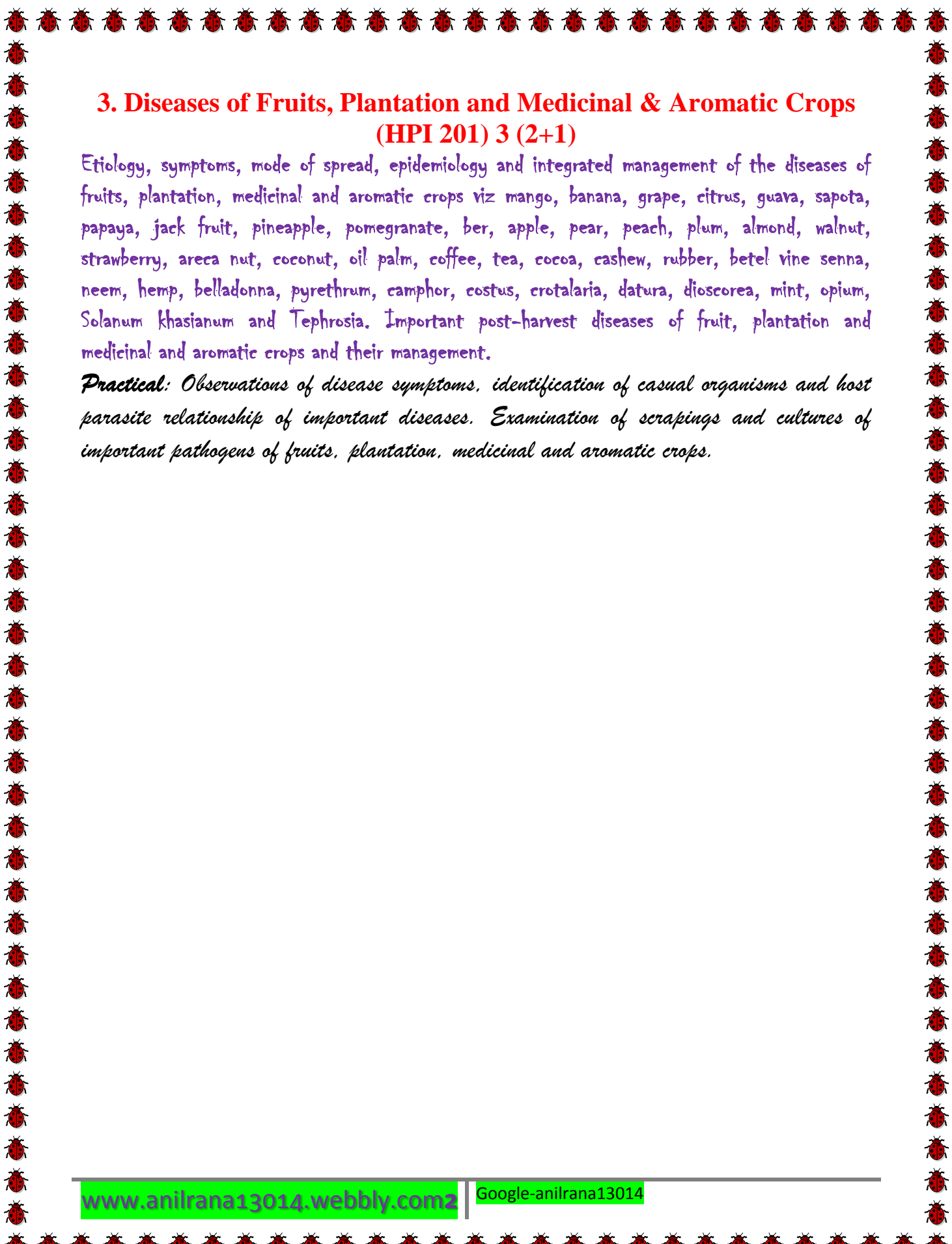


Diseases of Fruit, Plantation, Medicinal and Aromatic Crops
Diseases of Fruit, Plantation, Medicinal and Aromatic Crops





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.
- Chlamydo spores 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°c during December-January.
- The disease is mild in the areas where temperature is between 15-20°c, sporadic between 20-25° c and nil beyond 25° 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 acaricide (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 Maharashtra 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 oidia.
- 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>

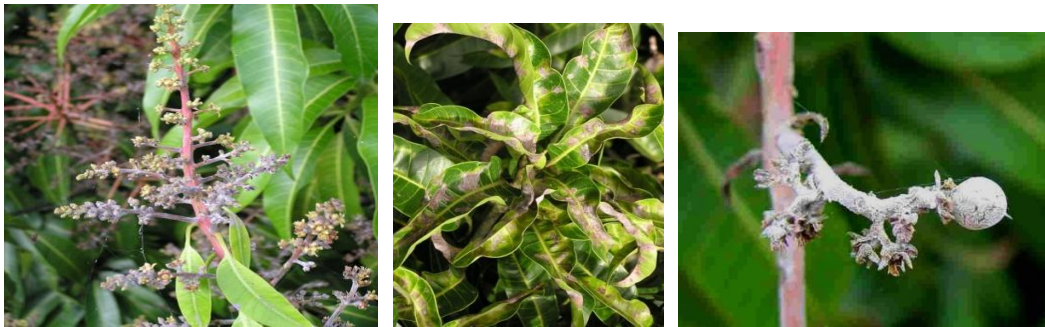
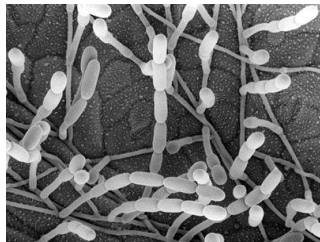


Fig: 2. Powdery mildew on leaves and flowers

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 produced 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 Maharashtra 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 3-4 days with maximum temperature above 30⁰c, minimum temperature around 15⁰c 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%) after 15-20 days 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 varieties 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 or 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-methyl 0.1% or chlorothalonil 0.2% for 15days interval until harvest effectively controls anthracnose.
- Before storage, fruits should be treated with hot water at 50-55⁰ c for 15min. or thiabendazole 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: *Botryodiplodia 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 31.5⁰ c and 25.9⁰ 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 43⁰c 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 sulphur, 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.



Etiology: *Pestalotiopsis mangliferae* (P.Henn.) Stey.

- The fungus produces septate mycelia and acervulus as an asexual fruiting body.
- Conidia are 5-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 olivaceous 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 20-25⁰ 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 mango 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: *Diplodia natalensis* (Pole Evans.)

The fungus produces brown to black, globose to sub globose, pyriform, erumpent pycnidia that are ostiolate. Two types of conidia are produced within a pycnidium. Hyaline 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 31.5⁰ C &25.9⁰ 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 elsewhere. 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 coalesce 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 ripened, the contents are converted into 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, maharashtra, 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 chlorotic 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 8 months 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 streptomycin 200-300ppm at 20 days interval reduce fruit infection. Dipping the fruits in 200ppm solution of agrimycin-100 is effective.
- Mango varieties like Bombay green, fazali, Jehangir and suvarnarekha are resistant.

Giant mistletoe: *Dendrophthoe* spp.

Symptoms:

- Infect mango trees. The flowering plant parasitizes slender branches of host tree at intervals by means of bulged haustoria which serve as 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 Parasites: *Dendrophthoe* (=Loranthus) ampullaceus, *D. calcycalatus*, *D. involucratum*, *D. longiflorum*, *D. parasiticum* and *D. philippensis*, *D. scurrula* are partial stem parasites.

Mode of spread and survival:

- The flowering parasite survives in the host plant.
- The parasites flower profusely in the host plant and produce fruits.
- Birds eat the fruits and excrete seeds on branches of other trees.
- Seeds of the parasites germinate during wet conditions 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 corticolum Masee – [Syn. *Pexiotruchum corticolum* (Masee) Subram.].
The occurrence of disease in mango was recorded at Pune. Now it occurs in A.P., Goa, Gujrat, Karnataka, maharashtra, T.N, and W.B.



Black, velvety or feathery growth on the surface of stems 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 presents 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 destroyed. 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 salmonicolor*) 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 Hingorani and 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. xanthomonas b. pseudomonas c. Erwinia d. None

3. Mango malformation caused by
 - a. xanthomonas 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 monocarpic; 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 dessert 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 – *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

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

Panama wilt is one of the most devastating 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

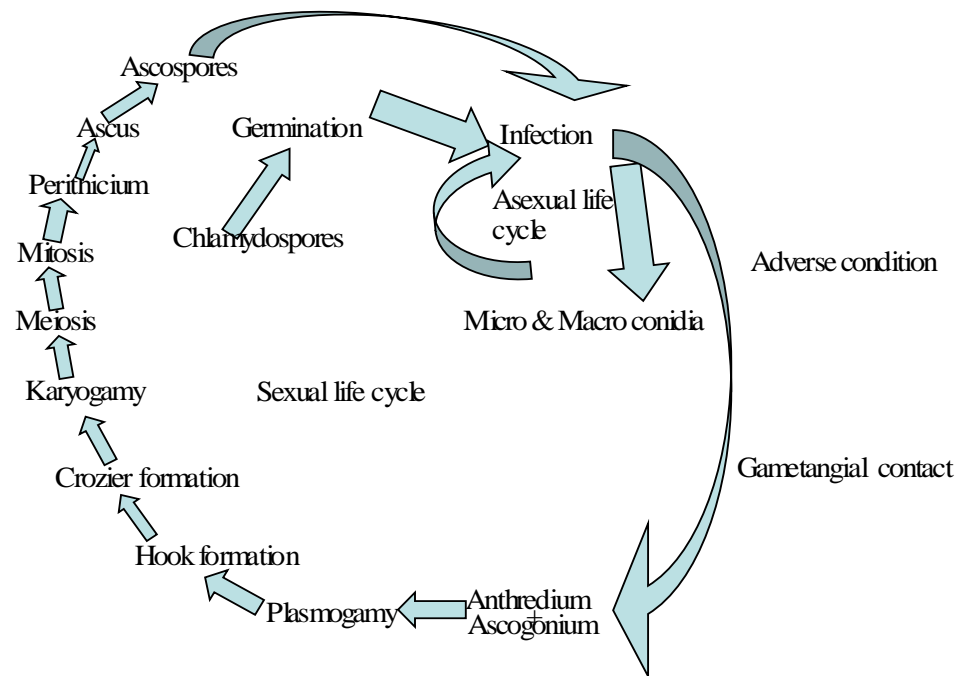
- Mycelium-septate, sporodochium is asexual fruiting body.
- Asexual spores are micro and macro conidia borne on sporodochium.
- Sexual fruiting body is perithecium and it produces ascospores in the ascus.
- Vegetative, resting structures are chlamydospores

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 -32⁰c, 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 varieties 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.

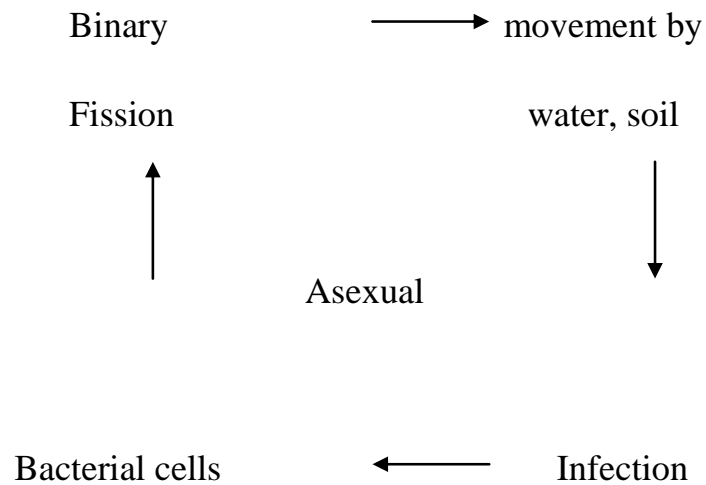
Mode of Survival and spread:

- 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 28-32⁰c, 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



Management:

- Use disease free planting material
- Use resistant varieties 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 Streptomycin @ 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 - 25⁰c, 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 23⁰ -25⁰ c. little infection occurs at temperatures 21⁰c- 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 ° 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 7-10⁰ 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. Ascospores 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

Chlorotic 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 25⁰ - 30⁰ C, high relative humidity and wounds are the predisposing factors.

Management: avoid creation of wound, Use resistant varieties, storage of fruit at 10⁰ 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 Andhra Pradesh and Madhya 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, (18-22⁰c) 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 – *Botryodiplodia 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) <i>Rhizophus stolonifer</i> |
| 2) Anthracnose | b) <i>Fusarium monaliformae</i> |
| 3) Crown rot | c) <i>Verticillium sps.</i> |
| 4) Black heart | d) <i>Botrydiplodia sps.</i> |
| 5) Rhizophus rot | e) <i>Colletotrichum musae</i> |

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 *nigronervosa* 2. Panama 3. Yellow to dark brown 4. *Pentagonia*
5. Chlamydo spores

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: *Oidium indicum* Kamat, *Oidium caricae* Noack, *Leveillula taurica* (Lev.) Arnaud
- (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) Rhizophus Rot or Soft Rot: *Rhizophus stolonifer* (Ehr.)
- (3) Phomopsis Rot: *Phomopsis caricae* (Pterrak and Cif)
- (4) Anthracnose: *Colletotrichum gloeosporioides*

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

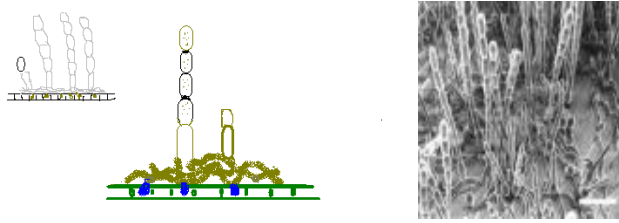
Symptoms

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



Causal Organism:

- *Oidium indicum* belongs to the Phylum: Ascomycota, and Order: Erisiphales.
- The pathogen is an obligate parasite. The mycelium is septate, hyaline.
- *Oidium 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.

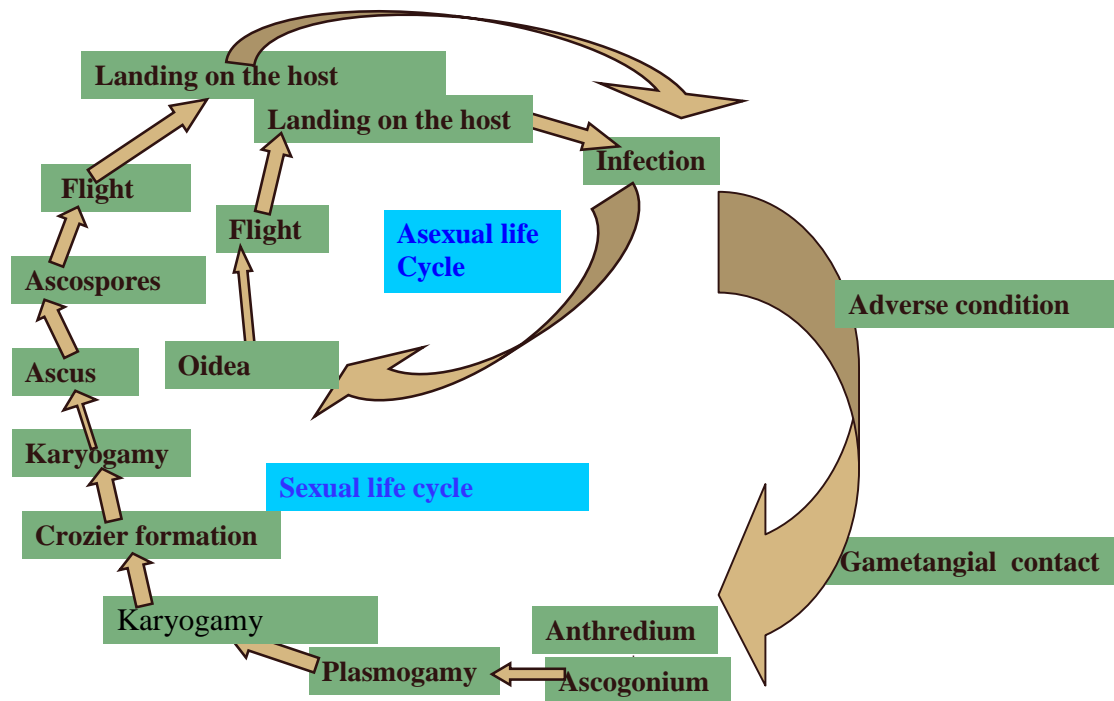


Epidemiology:

- 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 prone 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 from 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*

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

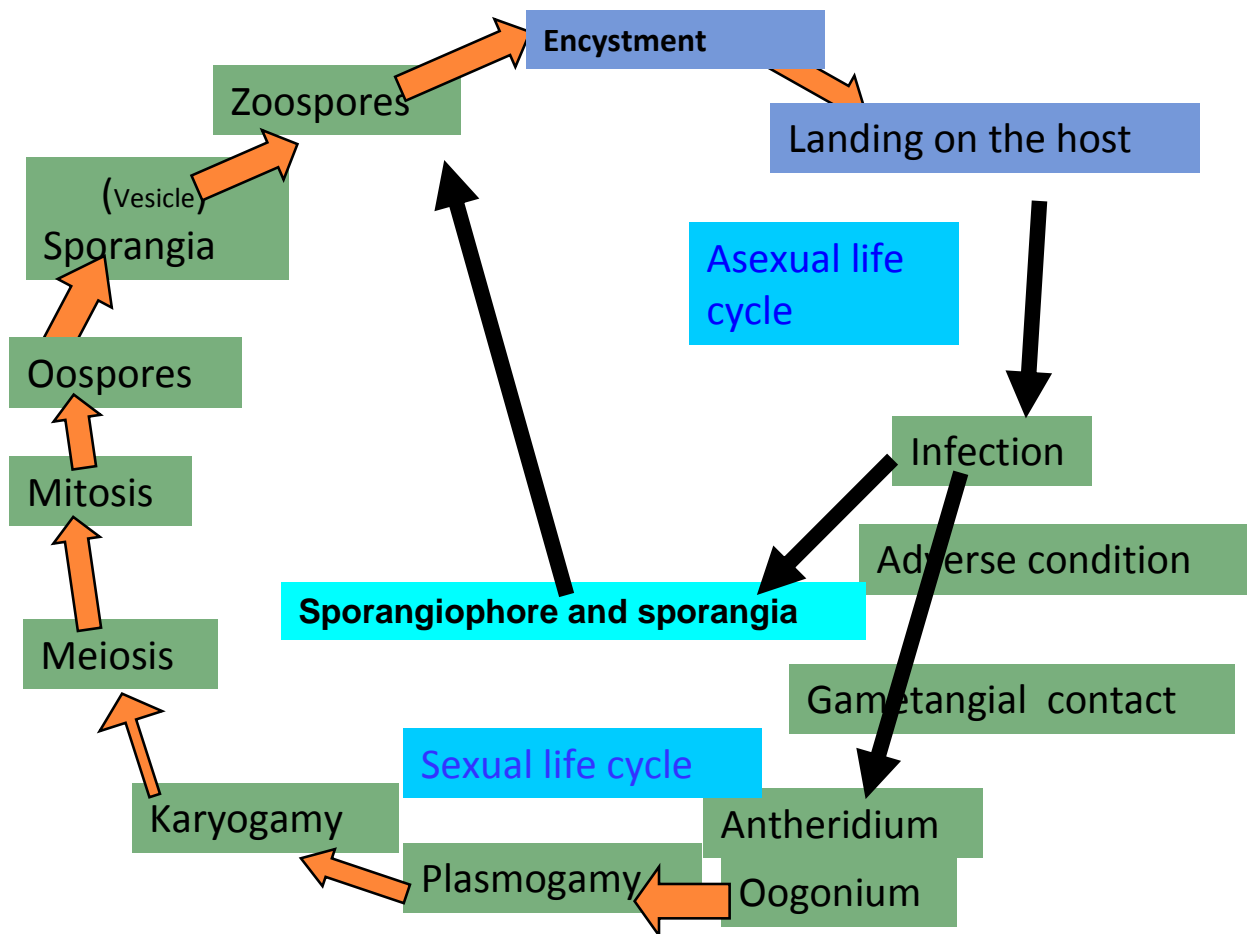
- Mycelium is well developed, wooly and coenocytic, hyphae 2.8-7.5 micron in diameter.
- Sporangia loculate, toruloid, and vesicle formed at the time of germination, zoospores 30-40 in number present within the vesicle and are born on spherical oogonia.
- They germinate by producing a germ tube.
- The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

Epidemiology:

- A number of factors like inoculum 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^o 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 belongs 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 °C and at relative humidity of 85-90%.
- The conidia of pathogen are disseminated by raindrops splashes and insects. The susceptible varieties are prone to infection.

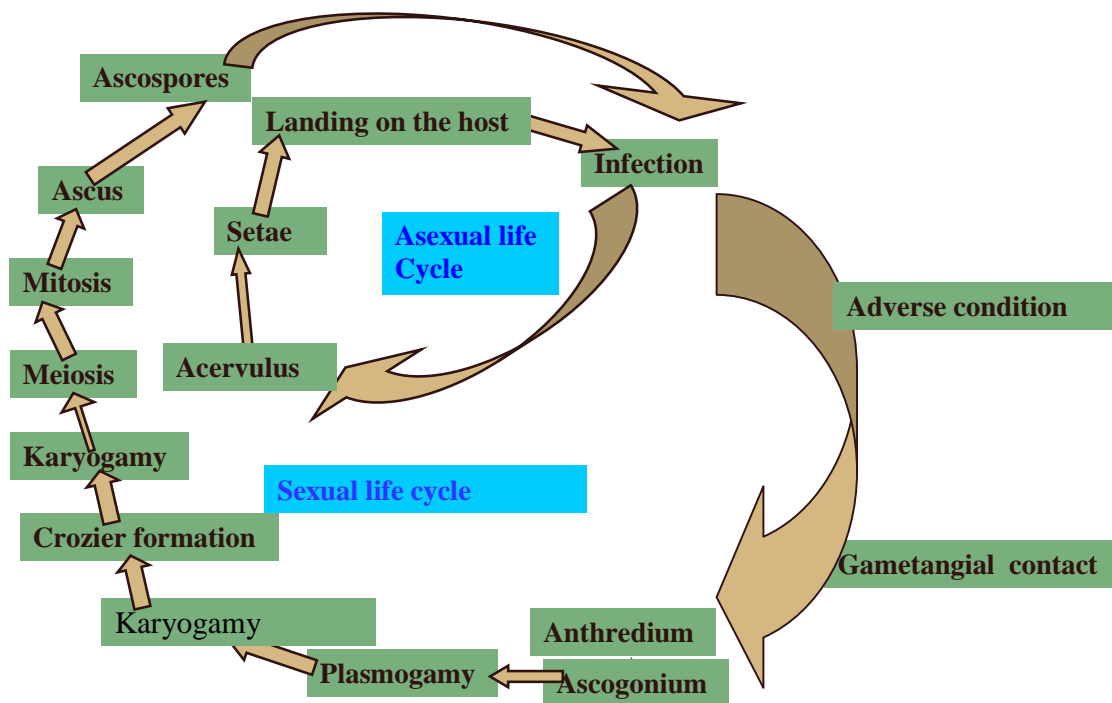
Disease cycle:

- 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 through 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-persistent 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 rationale 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 of 10 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 the 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 a 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.

epidemiology: It prefers warm weather and usually invades immature, unthrifty, damaged or senescent tissues. Maximum decay occurs at 30°C and 100% RH.

(2) Rhizopus rot or soft rot: Caused by *Rhizopus stolonifer*

SYMPTOMS: *Rhizopus* fruit rot or watery fruit rot develops on injured fruits, which develop 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 emits a foul smell. Infection spreads quickly to the adjoining fruits.

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

Epidemiology: 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 18⁰ 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:

- Important nursery disease in papaya.....
- casual organism for papaya anthracnose is
- Papaya ring spot isdisease.
- Powdery mildew resistant variety of papaya is.....
- In heavy rainfall areadisease is severe to papaya.

2. Match the following:

- | | |
|----------------------------------------|----------------------|
| a) <i>colletotrichum gleosporoides</i> | a) oideopsis |
| b) Virus | b) sclerotial bodies |
| c) <i>Rhizoctonia solani</i> | c) Oospores |
| d) <i>Leveillula taurica</i> | d) Vector |
| e) <i>Phythium aphanidermatum</i> | e) Acervulus |

3. Choose the correct answer:

- The disease we never seen in papaya
a. Anthracnose b. Rust c. Downey mildew d. Both b & c
- Congential temperature for *Phythium aphanidermatum* infection in papaya.....
a. 28-32⁰c b. 45-50⁰c c. 18-22⁰c d. None.
- It is the important post harvest disease in papaya.....
a. Anthracnose b. Powdery mildew c. Damping off d. None.
- Causal organism for papaya black leaf spot
a. *Cercospora* spp, b. *Alternaria* spp, c. *Asperisporium* spp, d. None.
- papaya ring spot disease is spread through.....
a. Vectors b. Air c. Water d. All of these.

4. Tick true or false:

- Papaya ring spot is severe in summer .
- Acervulus is a asexual fruiting body of *colletotrichum gleosporoides* .
- At green stage itself fruit shown symptoms of papaya anthracnose.
- Seed treatment is effective remedy for collar rot disease of papaya.
- Papaya ring spot is controlled by bavistin.

REFERANCE: 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:** *Phytophthora cinnamomi* and *Phytophthora 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: *Phytophthora cinnamomi* and

Phytophthora 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.
- Temperature: 25⁰c, 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 remain 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 situation.

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, *Dysmicoccus 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°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 discoloration 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) <i>brown spot</i> |
| 2) wilt virus | b) fungus |
| 3) bacterial fruit rot | c) <i>bacterial disease</i> |
| 4) basal rot | d) <i>mealy bug</i> |
| 5) fruit let core rot | e) <i>phytophthora cinnamomi</i> |

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: *Phyalospora 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.

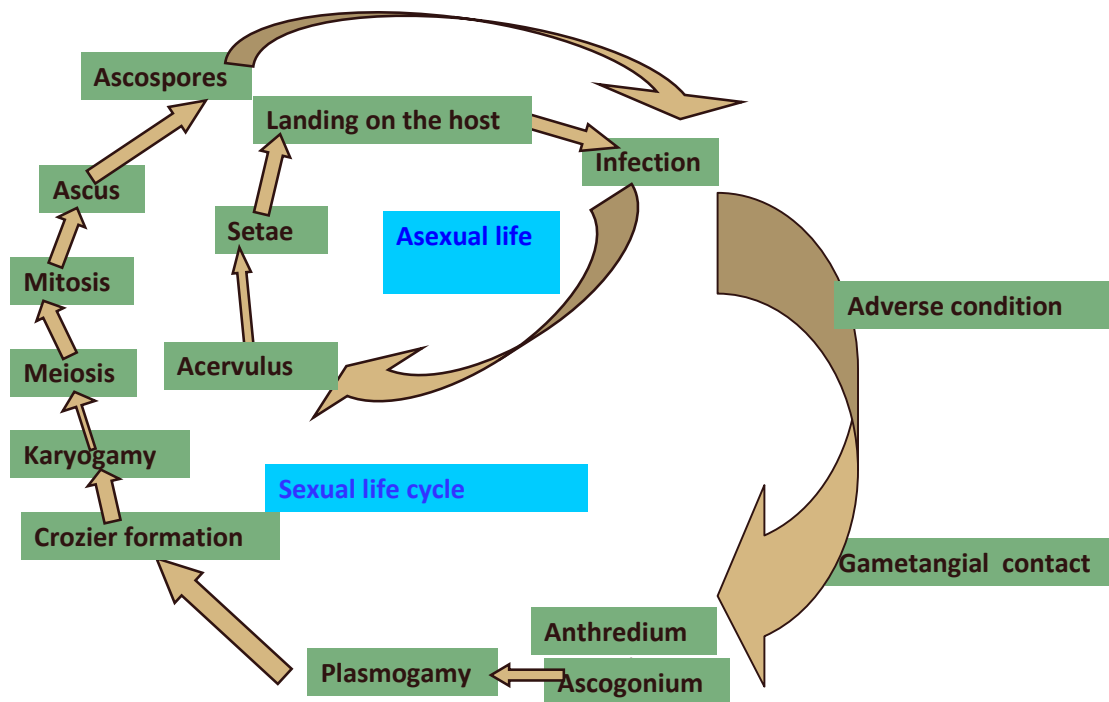
Secondary source of inoculum: inoculums produced on the infected host

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 severity 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 mixture 1.0 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 to 35°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 inoculum: 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*

Symptoms:

- 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 -32⁰C 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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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 adaptability 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 CANCKER: *Xanthomonas 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 18-22⁰C: 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 sporangia.
- 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. Antheridium 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, ectophytic, 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 scabrous 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 insect excreta or honey secretions by insects and plant. By growing such blacky mold on the surface, abstracting 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°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-1 gm/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 corky 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°-35°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 and 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 through 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 50°C 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 thickness 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 45⁰ C for 10-25 min.

- Removal of cuscuta and spraying of systemic insecticide, Dimethoate 2ml/lit 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 Exocortis

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 GREENING

Symptoms

- Stunting of leaves, sparse foliage 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°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 insecticide, Metasystax 2 ml/ltr aerial spray
- Antibiotic- Streptomycin 0.5gm/ltr, 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 stages 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 arbuscular 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 24⁰C.
- Growth is much slower if the temperature is above 30⁰C.
- 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°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 syringae* 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, drying, 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°C.
6. Ethylene sensitive commodities should not 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	- <i>Uncinula necator</i>
Downy mildew	- <i>Plasmopara viticola</i>
Anthracnose	- <i>Elsinoe ampelina</i> (= <i>Gloeosporium amphelphagum</i>)
Black rot	- <i>Guignardia bidwellii</i>
Bacterial canker	- <i>Xanthomonas campestris</i> pv. <i>viticola</i>

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)

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

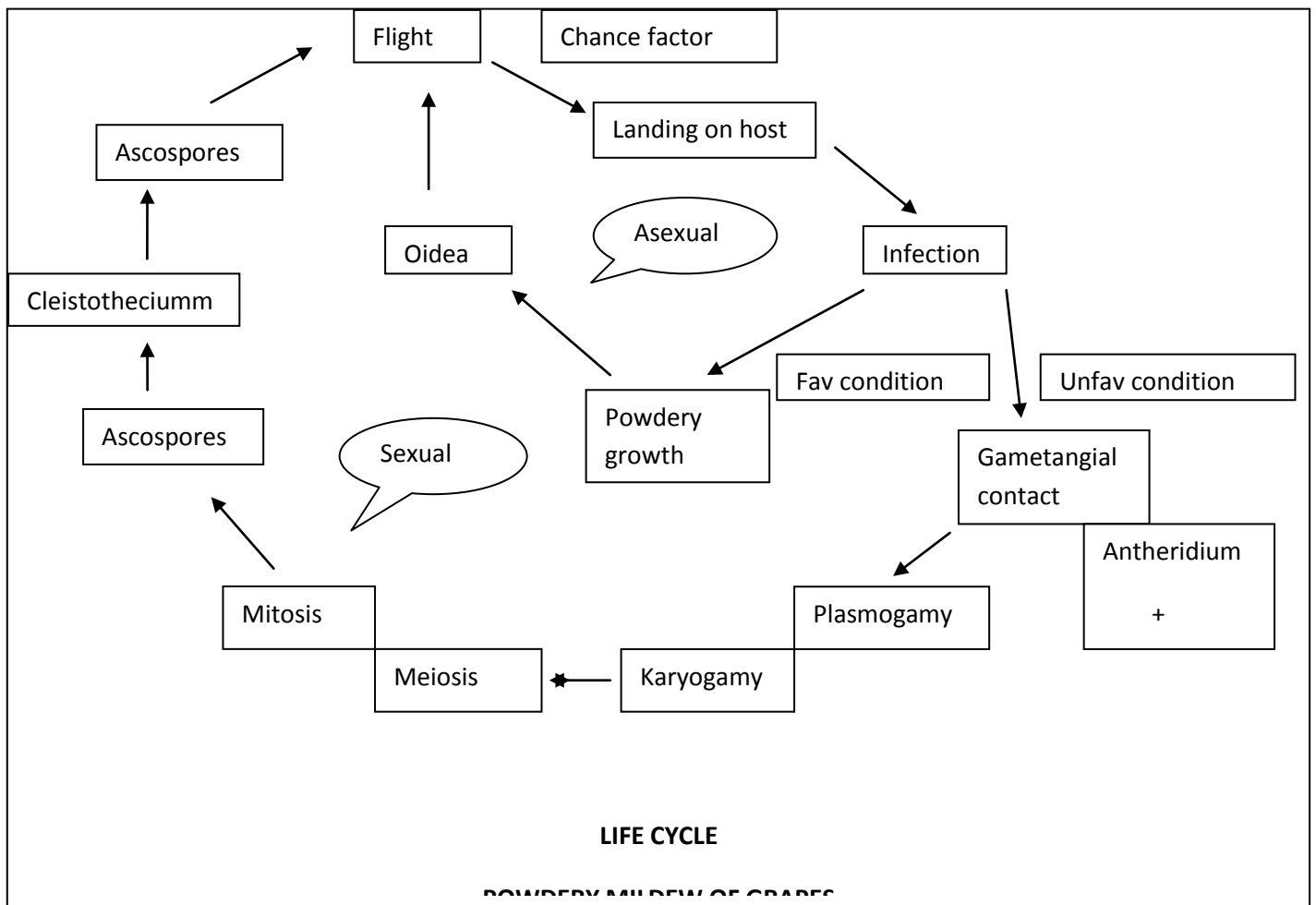
- Mycelia septate, external thin mycelia, haustoria sub epidermal, obligate parasite.
- Asexual spores are: barrel shaped, conidia borne on oidiophore in chains. Asexual stage of the pathogen is oidium.
- Sexual spores: Ascospores inside the Ascus in the ascocarp which is called as Cleistothecium.

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 33.5⁰C has been found to be the cause for epidemic in Hyderabad.
- Disease development is adversely affected by rain.



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.
- Sporangiohores 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.
- Sporangiohore 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 gametes, Oogonium and Antheridium) and are also called as dormant spores.

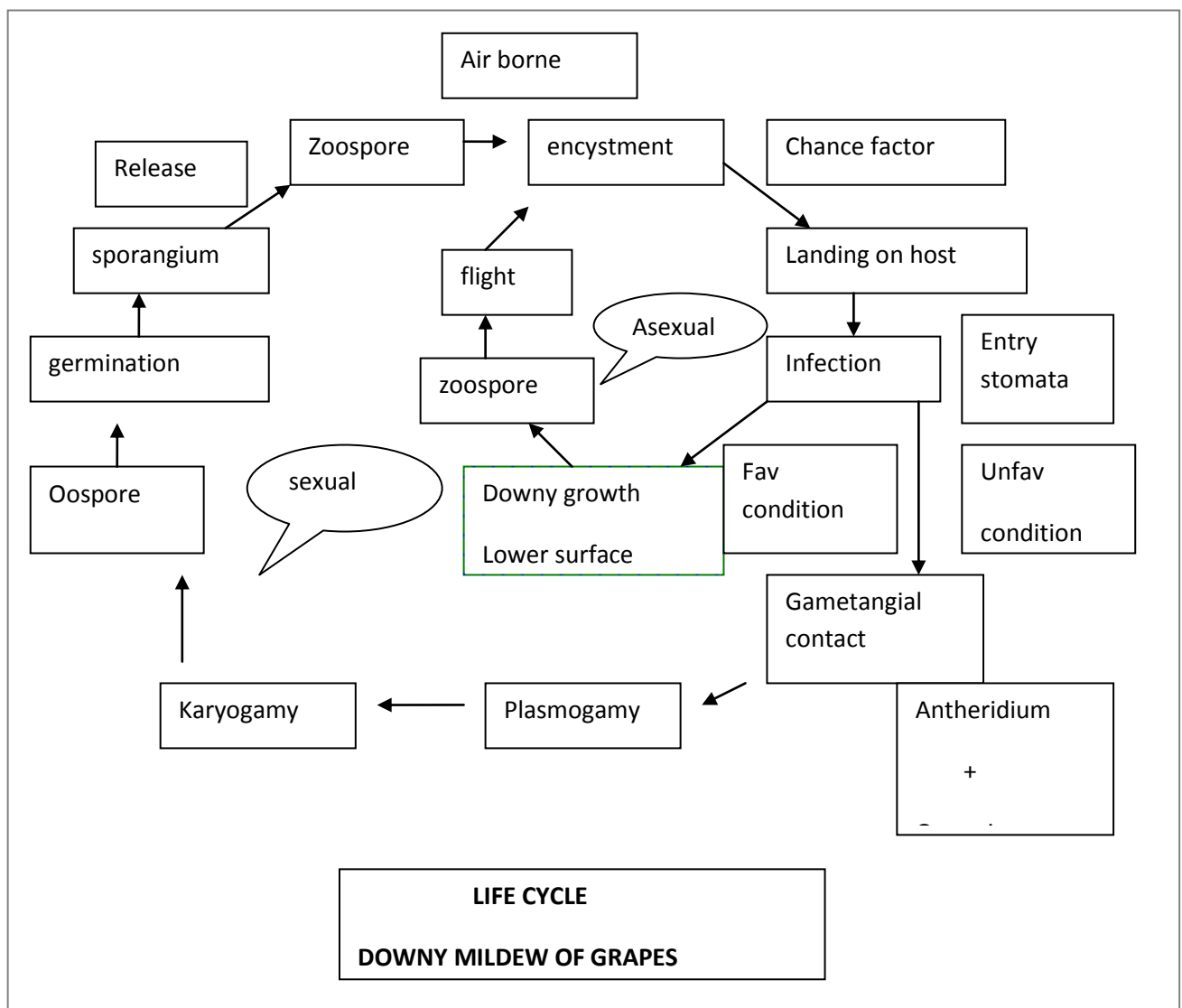
Mode of spread and survival

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°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°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 ampelina* (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. They are hyaline, single celled, oblong or ovoid . Perithecia (Pseudothecia) are small and inconspicuous. 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, Champagne 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 - Moniliaceae

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 25⁰C 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

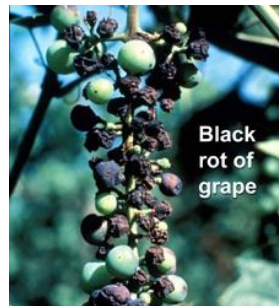
- Maintaining the sanitation in the vineyard is the most important cultural practice to keep the disease under check.
- Diseased vines, leaves and fruits must be picked up and destroyed.
- Removal of grape mummies acting as primary sources of infection from vines at the time of pruning and burning them.
- 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 destructive 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 sulphur 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 get 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. *viticola* (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 25-30⁰C 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 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. 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 60-65⁰ C.
- Longevity in vitro is 15-30days at 20⁰C
- Dilution end point is between 10³ and 10⁴.

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 (45-50⁰C) 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 ampelina*, b. *Sphaceloma ampelina*, c. *Spiloseae ampelina*, 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. *Rickettsia*, 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. nematocide, 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.
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	<i>Physopella</i> & <i>Plasmopara</i> .
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	<i>Xiphinema index</i>	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 fungicide

10	Peritrichus bacteria	j	Emulsified liquid
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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. Sporangiphore 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. Rickettsia 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 | - | <i>Cercospora punicae</i> |
| 2. Bacterial blight | - | <i>Xanthomas axonopodis</i> pv. <i>punicae</i> |
| 3. Leaf spots | - | <i>Colletotrichum gloeosporioides</i> |
| | - | <i>Sphaceloma punicae</i> |
| | - | <i>Fusarium fusaroidies</i> |
| | - | <i>Phomopsis aucubicola</i> |
| | - | <i>Drechslera rostara</i> |

Minor diseases

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

d. Soft rots	-	<i>Rhizopus arrhizus & R. stolonifera</i>
e. Dry rot	-	<i>Syncephalastrum racemosum</i>
f. Fusarium rot	-	<i>Fusarium equiseti</i>
g. Phomopsis rot	-	<i>Phomopsis sp.</i>
6. Root knot nematode	-	<i>Meloidogyne incognata</i>

Cercospora leaf spot - (*Cercospora punicae*)

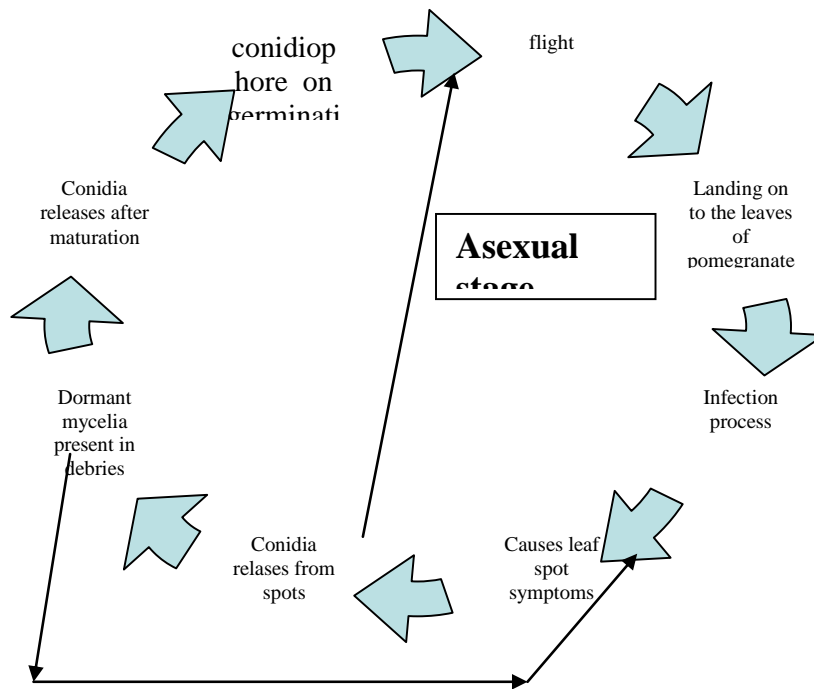
Symptoms:-

- 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 caused by fungus *Cercospora punicae* (***P.Henn***). Conidiophores are olivaceous brown, short fasciculate, sparingly septate. Conidia are hyaline to pale olivaceous cylindrical, sub fusoid 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 27°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: (*Xanthomonas 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 the 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 34°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% streptomycin 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 27°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 27⁰ 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.

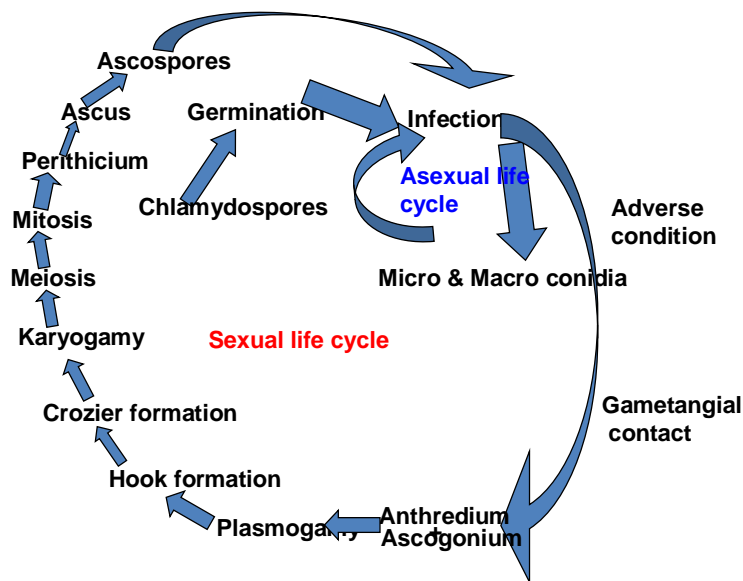
Mode of survival and Spread:

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 27°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 with 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. It enters 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. They then become splash borne or air borne and go on moving, when they come in contact with the host plant surface they enter into the host through stomata or through wounds, multiply inside the plant, cause infection, show symptoms like cankerous growth on the surface and continue 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 necrotic 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 bearing 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 beak, papillate

Life cycle:-

- Oospores are thick walled, sexual diploids spores, present in the affected debris
- When conditions are congenial they germinate as a sporangium and releases zoospores
- Zoospores flight then encystment (Short period resting phase) takes place where and lose 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 undergoes sexual reproduction in that gametangial 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 27°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 27°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 equiseti* (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 discard.
- 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. Chladosporium 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) bordeaux 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. <i>Phomopsis</i> spp. | <i>Fusarium fusaroides</i> (1) |
| 4. leaf spot | rain splash (2) |
| 5. <i>Sphaceloma punicae</i> | 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 sends 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 50 new 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 causes 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 20°C.
- Optimum conidial germination occurs at 97 to 99 per cent relative humidity and at temperature ranging between 17 to 24°C.
- Spore production is maximum at 24 to 28°C.

Disease cycle

- Affected leaves, buds and twigs having cleistothecia, 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 leads to powdery mildew. White powdery growth comprising of oidia.
- Oidia 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 Ascogonium.
- Gametangial contact type of reproduction once Ascogonium and Antheridium come in contact together, plasmogamy, karyogamy, meiosis followed by mitosis and ascospore formation take place.

Management:

- The diseased and fallen leaves should be collected and burnt.
- Four sprayings at 1 days 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 + Carbendazim 0.1% also controls the disease. Spraying with benomyl 0.1 per cent or triademefon (bayleton) 0.1 per cent at 3 days 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.
- On 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 unnecessary wounds
- Application of fertilizer should be delayed at least 1 day
- 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.

Causal 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 control *Trichoderma viride*
- Chemical Carbendazim 0.1% spray.

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 captan 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 overwintered.
- *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*
- Phytophthora 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. *Phytophthora 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 outwards 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 acervuli of *Colletotrichum gloeosporioides* are also observed.

CAUSAL ORGANISM: *Botryodiplodia theobromae*

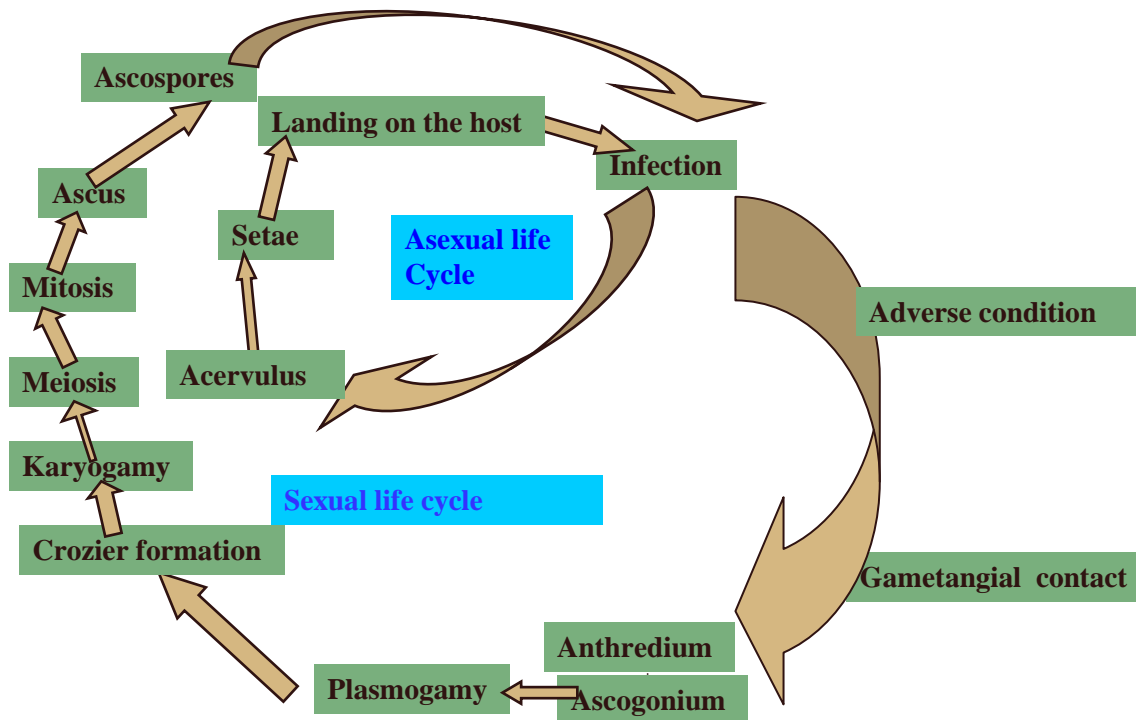
ETIOLOGY:

- 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.

EPIDEMIOLOGY

Temperature at 25⁰ -30⁰. 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 artocarp*

SYMPTOMS:

- The young fruits & inflorescence 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 decaying organic 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 captan 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: Phytophthora palmivora

Symptoms:

- Infection takes place through whole or wounded skin in rough skinned varieties & through wounds in smooth skinned varieties.
- Water soaked 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: *Phytophthora 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/lit 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 salmonicola* & *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: Caucasus 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 leucotricha*

Cedar rust : *Gymnosporangium juniperi virginiane*

Fire blight: *Erwinia amylovora*

Crown gall: *Agrobacterium tumefaciens*

Black Rot :*Botryosphaeria obtuse*

Sooty blotch: *Leptodontium elatius*

Flyspeck :*Zygothiala jamaicensis*

Phytophthora Crown Rot, Collar Rot, and Root: *Phytophthora 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 2 leaves 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: Bacterial 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 discoloured 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 appear on primary leaves, 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 russetting.

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

Disease Cycle

The fungus overwinters 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 overwintering buds is generally less than 5%. The overwintering 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 disease.

Dissemination

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

PSI; dormant mycelia

SSI; barrel shaped conidia

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 Options Depending on the susceptibility of the cultivar and the impact of cold weather temperatures on over wintering inoculum survival, chemical control may be needed.
- Cultural Controls Plant cultivars which are less susceptible to the disease. Reduce humidity in the tree canopy by pruning to increase air, light, and spray penetration.
- Chemical Bavistin 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 inoculum telial galls on cedar plant

Secondary source of inoculum airborne 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 management Spores 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 Options The grower should be most concerned about 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 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 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: *Botryosphaeria 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 frog-eye leaf spot due to these symptoms).

Black Rot 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 management A 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 Options A major decrease in incidence of this disease can be attained through cultural means. Control is usually attained through a combination of cultural and chemical methods.
- Cultural Controls Piles 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>
FELS and mummified 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 2 to 25 days) after the initial establishment of infection.

Management

- Key times for management The key time for management begins 1-2 weeks after petal fall and continues until 2-3 weeks before harvest. Temperatures between 6 and 70°C
- Cultural practices Remove reservoir hosts from the orchard and from the perimeter of the orchard. Sooty blotch the 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; 1 percent Bordeaux

FLYSPECK

Disease causing organism: *Zygothiala jamaicensis* E. Mason

Dissemination: Spores which produce primary infection are disseminated by wind during rainy periods from overwintering 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 overwinters 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 management A key time for apple infection accumulated from 1 days past petal fall. Periods of frequent occurs after 27 hours of leaf wetness have rainfall during above normal summer temperatures are particularly favorable to an outbreak of this disease. Management Options A major decrease in incidence of this disease can be attained through cultural practices.
- Cultural Management Options Pruning 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

Phytophthora 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 *Phytophthora*

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 Phytophthora 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 Phytophthora, management is best achieved through cultural methods.
- Cultural Controls Primary control of Phytophthora 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 Mancozeb 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 salmonicolor*
 - 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 salmonicolor*

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 virginianae* are _____ & _____ respectively.
6. *Amphelomyces quisqualis* is effective against the _____.
7. _____ stage is absent in the 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 heterocyclic 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 toringoides* are have resistance against the root rot.
6. Bitter rot, Sour rot, Brown rot are not post harvest diseases.

IV. Match the following

Powdery mildew	<i>Botryosphaeria obtusa</i>
Black rot	<i>Gloeodes pomigena</i>
Sooty blotch	<i>Glomerella cingulata</i>
White rot	<i>Botrytis cinerea</i>
Soft rot	<i>Botryosphaeria dothidea</i>
Grey mould rot	<i>Penicilium expansum</i>
Bitter rot	<i>Podospharea leucotricha</i>

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)

Genus, *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 *Podosphaera leucotricha*

Black rot *Botryosphaeria obtusa*

Sooty blotch *Gloeodes pomigena*

White rot *Botryosphaeria dothidea*

Soft rot *Penicillium expansum*

Grey mould rot *Botrytis cinerea*

Bitter rot *Glomerella cingulata*

REFERENCE; Diseases of fruit crops

Author; V KGuptha & 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 – *Cercospora 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

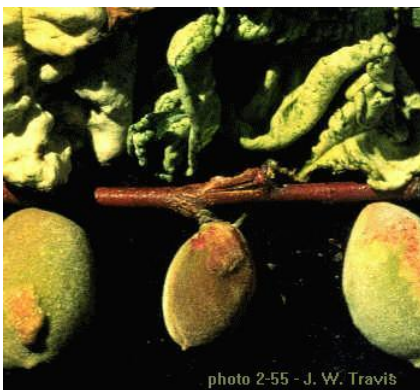
Major Diseases

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 25 to 40 into 8 to 11 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 borne)

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 captan 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 –olivaceous lesions appear on fruits.
- In sever infection the individual spots merge & form a uniform, dark olivaceous, velvety blotch.
- A thick 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: spore type of conidia (air borne)

Infection takes place in between the cuticle & epidermis.

Epidemiology:

- 9 hour of leaf wetness period, 17-18°C 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-carbendazim @ 1g/ liter.
 - C) Fruit stage-(pea nut stage) – captan 3g/ liter
 - d) 40 days before harvest –hexaconazole 1.5g /liter.
- Biological agent's like- *Althelia* species, *Chaetonium globosum*.

MINOR DISEASES:

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: *Cercospora 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:

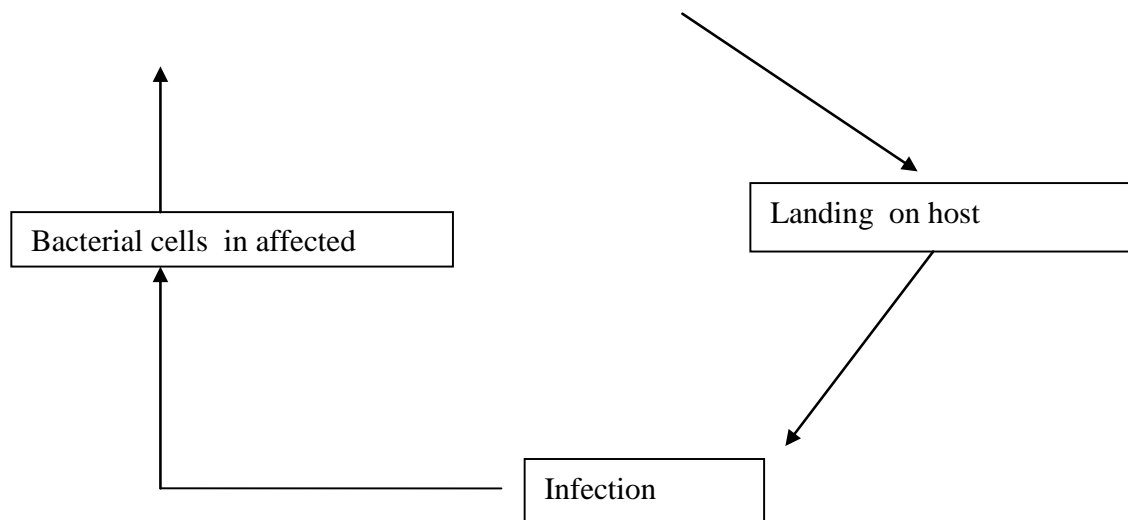
- Small circular green spots occur on the leaves.
- Later spots become angular, deep purple to black.
- The spotted area falls and shot holes are formed.
- Sever infection leads to defoliation which devitalizes the tree.
- Circular spots are noticed on fruits. They are water-soaked initially and become 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.



Dark, gummy resin on infected peach trunk.
Courtesy George Peck, TAMU, 1988.

Primary source of inoculum: affected plant

Secondary source of inoculum: air borne bacterial cell.

MANAGEMENT:

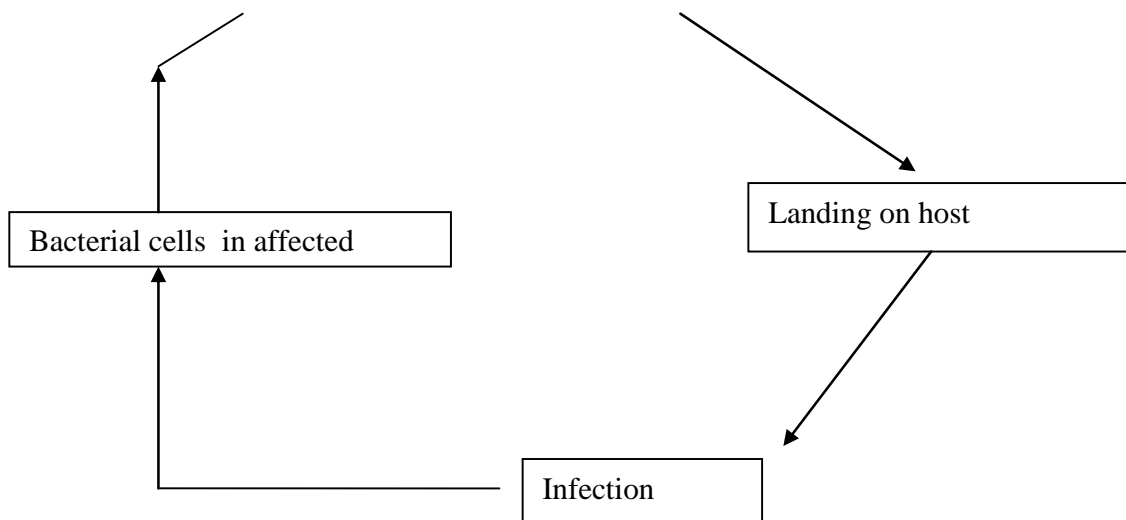
Cut & burn the affected plant part.

Aerial spray of streptomycin 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°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°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

- Shot hole
- Pustular spot
- Both a & b
- None of these

2. Causal organism of peach rust is

- Puccinia pruni*
- Tranzschelia pruni*
- Both a & b
- None of these

3. Peach scab is caused by

- Venturia carpophila*
- Venturia pirina*
- Both a & b
- None of these

4. Peach yellows is caused by

- Virus
- Fungi
- Mycoplasma
- None of these

5. Necrotic leaf spot is caused by

- Virus
- Fungi
- Mycoplasma
- 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. <i>Phyllosticta persicae</i> |
| 4. Peach X | d. <i>Pseudomonas mors-prunorum</i> |
| 5. Target leaf spot | e. <i>Pseudomonas syringae</i> pv. <i>persicae</i> |

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 *Cercospora 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 *Erysiphe* 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. *stigmiascarphila*
- 2. *Taphrina defromans*
- 3. All
- 4. *Sphaerotheca punnosa* var. *persicae*
- 5. *Phyllosticta persicae*

REFERANSE BOOK:

Introductory fruit crop:



PLUM

DISEASES, SYMPTOMS, ETIOLOGY, EPIDEMIOLOGY, 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, Ginseng, 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	- <i>Taphrina maculans</i>
2. Wilt	- <i>Verticillium albo-atrum</i> (Reinke & Berth)
3. Leaf curl	- <i>Taphrina deformans</i> (Berk & Tul)
4. Bacterial canker	- <i>Pseudomonas syringae</i> pv. <i>syringae</i> (van Hall).
5. Bacterial leaf spot	- <i>Xanthomonas syringae</i>
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

EPIDEMIOLOGY;

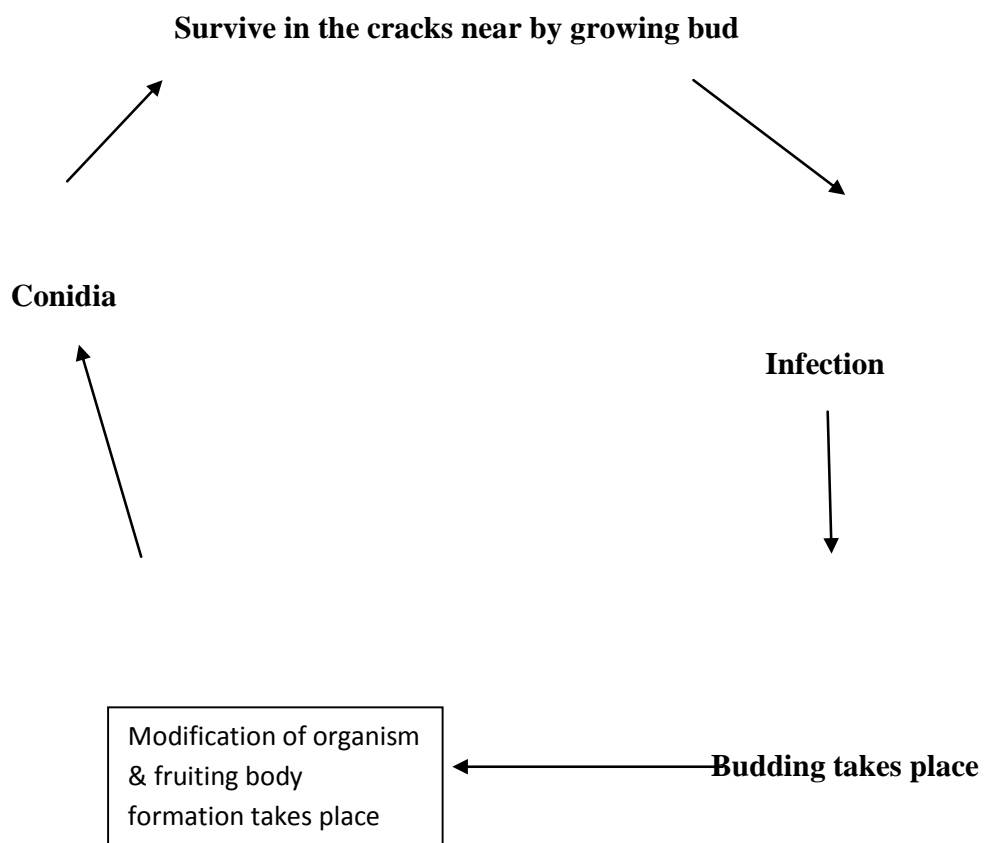
- The disease is prevalent in areas where cool mist spring weather prevails and the dry hot weather hastens defoliation.

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 severity.
- V – Shaped yellowing of leaf margin.

ETIOLOGY:

Septate mycelia, V – shaped conidiophores, on which single celled conidia is formed.

PSI: dormant mycelia

SSI: conidia (unicellular)

EPIDEMIOLOGY:

Warm weather loving alkaline **PH** & more severe in black clay soil, temperature-28-29⁰, and RH-80-85%. Low soil moisture, affected soil, nematode infected soil.

MANAGEMENT:

- Cut & burn the affected plant part.
- Treat the seeds with carbendazim.
- Carbendazim 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 25 to 40 into 8 to 11 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 & 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.

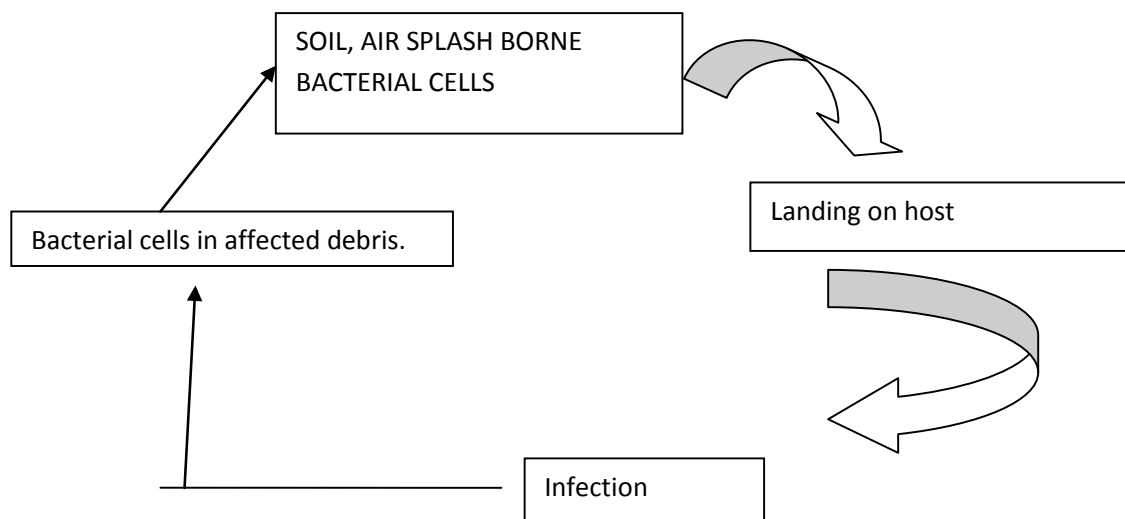
PSI: affected plant

SSI: air borne bacterial cell.

MANAGEMENT:

- Cut & burn the affected plant part.
- Aerial spray of streptomycin 0.5g/ liter.
- Resistant varieties -barbank, black champa, elephant heart & mariposa.

LIFE CYCLE:



5. BACTERIAL LEAF SPOT: *Xanthomonas syringae* pv. *pruni vauverin*.

SYMPTOMS:

- It is most commonly observed in nursery stages.
- The disease appears on leaf surface are angular dark brown spots of 0.5 to 3.0 mm diameter.
- The lesions are bordered by light yellowish green halo.
- In severe condition leaves turn yellow & drop.

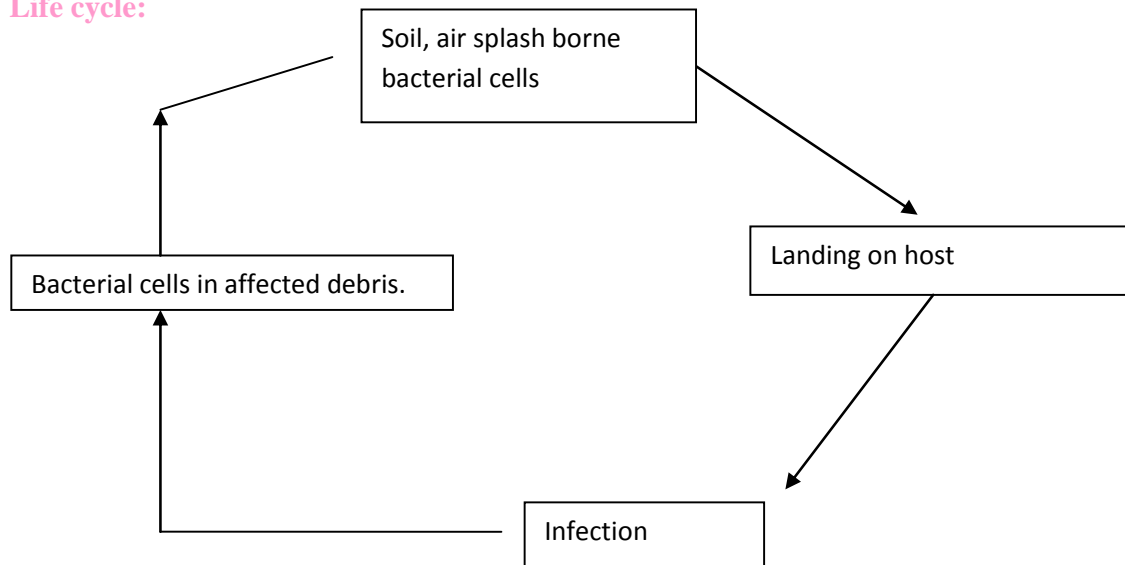
PSI: affected plant part

SSI: air borne bacterial cells.

MANAGEMENT:

- Cut & burn the affected plant part.
- Aerial spray of streptomycin (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



SHARON PLUMMER-GIBSON, UNIVERSITY OF CALIFORNIA, DAVIS
Courtesy: Four in a Row, THE S. Whitehead Co., 1999.

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
 - ii. Virus + vector
 - iii. **Fungus.**
 - iv. Both (i)&(iii)
2. Creamy white spot is caused by
 - i. **Virus**
 - ii. Bacteria
 - iii. Fungus
 - iv. Nematode
3. Thermal inactivation point for the organism responsible for Line pattern Disease of Plum is
 - i. 90⁰c
 - ii. 93⁰c
 - iii. **66⁰c**
 - iv. 91.5⁰c

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

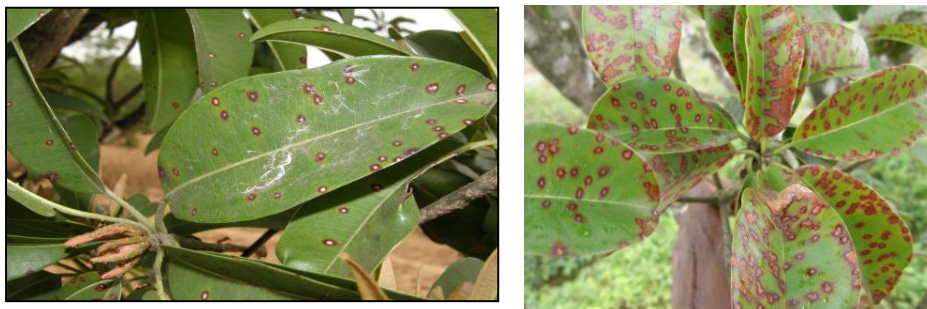
Dr. T. Raghuchander

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: *Botyodiplodia 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 -32⁰ 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 Oxchloride 0.3% or lime sulphur 0.2%.

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) *Phytophthora 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 *Phytophthora parasitica*.(T)
4. Anthracnose is due to *Capnodium* spp. (F) (*Colletotrichum* spp.)
5. Base rot is managed by COC 3gm/lit. (T)

