

COURSE MATERIAL FOR PATH 372
DISEASES OF HORTICULTURAL CROPS AND THEIR MANAGEMENT

Prepared By

**DR. P. KISHORE VARMA,
ASSISTANT PROFESSOR,
DEPARTMENT OF PLANT PATHOLOGY
AGRICULTURAL COLLEGE,
ASWARAOPET 507 301**

DISEASES OF HORTICULTURAL CROPS

LECTURE 1

CITRUS

Citrus	Phytophthora Gummosis	<i>Phytophthora nicotianae</i> var. <i>parasitica</i> , <i>P. palmivora</i> , <i>citrophthora</i> , <i>P. hibernalis</i> , <i>P.syringae</i> , <i>P. cactorum</i>
Citrus	Diplodia Gummosis	<i>Diplodia natalensis</i>
Citrus	Dry root rot	<i>Fungal complex (Fusarium sp., Diplodia., etc)</i>
Citrus	Scab	<i>Elsinoe fawcetti</i>
Citrus	Canker	<i>Xanthomonas axonopodis</i> pv. <i>citri</i>
Citrus	Tristeza	<i>Citrus tristeza virus</i>
Citrus	Greening	<i>Candidatus Liberibacter asiaticus</i>
Citrus	Felt	<i>Septobasidium pseudopedicellatum</i>

1) **Gummosis:** *Phytophthora nicotianae* var. *parasitica*, *P. palmivora*, *P. citrophthora*, *P. hibernalis*, *P.syringae*, *P. cactorum*

Economic importance: Gummosis is widespread in Punjab and Assam. Lemons are highly susceptible compared to grapefruit, rough lemons and sweet orange. In South India, it is common in the sweet orange.

Symptoms

- Disease starts as water soaked large patches on the basal portions of the stem near the ground level
- First symptoms are dark staining of bark which progresses into the wood.
- Bark in such parts dries, shrinks and cracks and shreds in lengthwise vertical strips.
- Bark at the base is destroyed resulting in girdling and finally death of the tree.
- Later profuse exudation of gum from the bark of the trunk occurs. There may be a considerable amount of gum formation in sweet oranges, but relatively little in grapefruit.
- Infection extends to crown roots.
- Prior to death, the plant usually blossoms heavily and dies before the fruits mature.

Favourable conditions

Prolonged contact of trunk with water as in flood irrigation; water logged areas and heavy soils predispose the disease. Incidence is more in black soils than in light soils; high water table leads to high incidence. The disease is severe in high rainfall areas.

Mode of spread and survival

The fungus survives as oospores or as dormant mycelium. Sporangia and zoospores spread by splashing rain water and irrigation water.

Management

Preventive measures:

- Selection of proper site with adequate drainage and **high budding** (30 to 46 cm or above).
- Provision of an **inner ring** about 45 cm around the tree trunk to prevent moist soil. (**Double ring method of irrigation**)
- Avoid irrigation water from coming in direct contact with the trunk.
- Avoid injuries to crown roots or base of stem during cultural operations.
- Use resistant **sour orange rootstocks** for propagating economic varieties
- Painting Bordeaux paste or with ZnSO₄, CuSO₄, lime (5:1:4) to a height of about 60 cm above the ground level at least once a year.

Curative measures:

- Scrape the diseased portion with a sharp knife.
- Protect the cut surface with Bordeaux paste followed by spraying of 0.3% fosetyl-AL reduces the spread.
- Soil drenching with 0.2% metalaxyl and 0.5% *Trichoderma viride* commercial formulation is also effective.

2) **Diplodia gummosis: *Diplodia natalensis* (Perfect stage: *Physalospora rhodina*)**

Economic Importance: Occurs commonly in Andhra Pradesh, Tamil Nadu and Uttar Pradesh. It is common on **Sathgudi** and **Batavian** oranges, **mandarins** and **lemons** in A.P. and Tamil Nadu.

Symptoms:

- Profuse gumming on the upper portions of the trunk, branches and twigs.
- Infection starts at growth cracks or ridges at **crotches**.
- Gum oozes out from the cracks developed on the diseased portion.
- From bark, the infection spreads to wood which dries and becomes discoloured.
- Large limbs are killed and if left unchecked the whole tree may be killed in course of time.
- Sometimes branches break at the infected portion.

Favourable conditions

Reduced tree vigour, insect damage, malnutrition and old age predispose the disease.

Mode of spread and survival

- Black **pycnidial** bodies appear on the diseased bark which gets removed in flakes.
- The disease spreads through dissemination of pycnidiospores or conidia by air, rain and insects

Management

- The tress should be kept in a vigorous growing condition.
- Wound in the bark especially on limbs and forks should be scraped and protected with Bordeaux paste.

- Gummy portions of affected bark should be removed and the cut surface protected.
- Spraying with 0.1% carbendazim on the affected limbs and forks is useful to restrict the disease spread.

3) **Dry root rot: Fungal complex** (*Fusarium sp.*, *Diplodia natalensis* and *Macrophomina phaseolina*)

Economic Importance: Dry root rot is a major problem in all citrus growing areas of Andhra Pradesh in both **sweet orange** and **acid lime**. It is also common in North Arcot district in Tamil Nadu and in Mandarins in Wynad

Symptoms:

- The disease is characterized by moist decay of root bark in the early stages. Later, the bark becomes dry and shredded with hard dead wood underneath.
- The affected trees show yellowing of foliage and bare necks.
- The flowering is increased and the affected trees bear a heavy crop of small sized fruits. The affected roots emit a foul odour and the tree finally dies.
- Peeling of bark of the affected roots and formation of black sclerotia on the root surface is also common

Favourable conditions

Excessive moisture, direct contact of water with trunk, poor aeration, heavy soils, and frequent injuries to roots, excessive manuring at long intervals and close planting favour dry root incidence. Lack of sufficient moisture or inadequate supply of nitrogen may also lead to this disease. Defective soil, hard pan formation below the second foot and unfavourable soil-air-moisture relationship in the subsoil leads to inadequate oxygen at root zone which is primarily responsible for the incidence of dry root rot.

Management:

- Cut and destroy the diseased roots, if only one or two roots are affected and the tap root and crown are still in good condition. The cut surface should be protected with Bordeaux paste.
- Avoid deep ploughing or digging which are likely to injure roots
- Leaf mulch in the tree basins during the dry season helps in conserving the soil moisture and thereby reduces disease incidence
- Spray with Urea (4.5 kg in 450 litres of water) to reduce disease intensity
- Drench the soil with 0.25 carbendazim + 0.25% Mancozeb at the rate of 1 litre per m² of the tree basin in early stage of infection
- Apply 10 kg of neem cake followed by soil drenching with 0.5% *Trichoderma viride* formulation + 0.2% copper oxy chloride in the early stages of infection

4) **Scab / Verucosis:** *Elsinoe fawcetti* (I.S: *Sphaceloma fawcetti*)

Economic Importance: In India this disease is reported from Bengal, Punjab, Assam, Karnataka, Uttar Pradesh and Andhra Pradesh. It is one of the common diseases of sour oranges, rough lemon, tangelos and Pummelo. In Andhra Pradesh it is severe on **Rangapur lime**. The **sweet oranges** are mostly resistant to the disease.

Symptoms:

- The disease attacks leaves, twigs and fruits.
- The lesions on leaves in early stages consist of **small, semi-translucent dots** which become sharply defined pustular elevations usually on the underside, flat or somewhat depressed at the center. The opposite surface corresponding to the warty growth shows a circular depression with a **pink to red centre**. In later stages, leaves often become distorted, wrinkled, stunted and mis-shapened.
- The twigs also develop similar lesions and the affected twigs are ultimately killed.
- On the fruit, lesions consist of **corky projections** which often break into scab affecting larger areas on the fruits. The surface becomes rough and distorted.
- The market value of the fruits is considerably reduced, though the fungus rarely affects the fruit flesh below the skin.

Favourable conditions

- Young leaves are highly susceptible.
- The fungus infects tissues only when the surface is wet and prefers temperature of 16 to 23⁰C. The disease is a problem under low temperature and high humidity conditions

Mode of survival and spread

- The fungus survives the off-season as **ascospores**
- The secondary spread is through air borne conidia

Management:

- The diseased leaves, twigs and fruits should be collected and destroyed
- Spray with 0.3% COC or 1.0% Bordeaux mixture or 0.2% Difolaton or 0.2% chlorothalonil at 15 days interval.

5) Citrus canker: *Xanthomonas axonopodis* pv. *citri*

Economic Importance: In India, citrus canker is endemic and occurs in all the citrus growing areas. It is reported from Punjab, Tamil Nadu, Andhra Pradesh, Karnataka, Rajasthan, Madhya Pradesh, Assam, and Uttar Pradesh. **Acid lime** is highly susceptible to canker.

Symptoms:

- Canker appears on leaves, twigs, petioles, branches, fruit stalks, fruits and thorns. When it is severe, trunk and roots are also affected.
- But the symptoms are most conspicuous on leaves, twigs and fruits.
- The lesions appear as minute water soaked round, yellow spots which enlarge slightly and turn brown, eruptive and corky.
- On acid lime and sweet orange they are about 2 to 3 mm in diameter. These pustules are surrounded by a characteristic yellow halo.
- Canker lesions on the fruit do not possess the yellow halo as on leaves. Several lesions on fruit may coalesce to form a patch. The crater-like appearance is more marked on fruits than on leaves.
- The market value of the fruits is considerably reduced by the canker spots, though such infections are mostly confined to the fruit skin.

- Due to severe infections of the leaves there may be defoliation, and severe infections of the twig and stem may cause die-back symptoms.
- The plants also remain stunted and fruit yields are reduced considerably.



Favourable conditions: Free moisture for 20 minutes at 20-30°C initiates the disease.

Mode of survival and spread

- Survives in infected leaves for 6 months.
- Bacteria overwinters in leaf, twig and fruit canker lesions
- Citrus leaf miners (*Phyllocnistis citrella*) helps in the dissemination of the pathogen
- Spread by rain splashes.

Management

- Prune out and burn all canker infected twigs before monsoon
- Periodical spraying of bactericides along with an insecticide
- Use canker tolerant varieties like “Tenali selection” and “Balaji”
- Select seedlings free from canker for planting in main field
- Spray Streptocycline (1g) + Copper oxy chloride (30g) in 10 litres of water at fortnightly intervals for effective management of canker in citrus nurseries
- Three sprayings of Streptocycline (1g) + Copper oxy chloride (30g) in 10 litres of water at an interval of 20 days during rainy season is effective for leaf canker
- Fruit infection can be prevented by two sprays of Streptocycline (1g) + Copper oxy chloride (30g) in 10 litres of water at marble stage followed by another spray 30 days later
- Control leaf miner when young flush is produced.

6) Tristeza or quick decline: Citrus Tristeza Virus (CTV)

Economic Importance: This disease was first reported in *Citrus aurantifolia* and *C. sinensis* from Italy and Florida in the U.S.A. In India, tristeza is present in Andhra Pradesh, Tamil Nadu, Karnataka, Madhya Pradesh, Maharashtra, Punjab, Bihar, West Bengal and Sikkim.

It affects all kinds of citrus plants but primarily orange, grapefruit and lime. Tristeza symptoms consisting of a quick or chronic tree decline are particularly common and severe on trees propagated on sour orange root stocks. The name “Tristeza” was suggested to describe the **sad appearance** of the diseased citrus trees. **Kagzi lime** and **Nasnaran** are **indicator** plants for CTV detection.

Symptoms:



- Tristeza affected trees look chlorotic and sickly in the early stages. Gradually the leaves drop and the defoliated twigs show die-back. The declining trees die gradually but sometimes apparently healthy trees die suddenly.
- Vein clearing or vein flecks (elongated translucent area) in young leaves of acid lime is seen intermittently when viewed against light (characteristic symptom).
- In sweet orange, the specific symptom of tristeza is **honeycombing**, a fine pitting of inner face of bark in the portion of trunk below the bud union. In acid lime which is highly susceptible to the disease, vermiform or linear pits appear in the woody cylinder.
- Tristeza infected citrus trees on sour orange rootstocks cause **phloem necrosis** at the graft union
- Diseased trees usually **blossom heavily**. Trees with stem pitting are stunted and set less fruits. The fruits are of smaller size and of poor quality (insipid fruits). As the fruits develop, the tree wilts partly or completely.
- Grapefruit and acid lime are susceptible irrespective of root stock.

Pathogen: Tristeza is a highly flexuous filamentous virus 2000nm long and 10-12nm in width. The virus is restricted to only phloem tissue and is a member of Closterovirus group. CTV has ss +ve sense RNA of 20 K nucleotides as its genome.

Mode of survival and spread

The disease primarily spreads through grafting and budding. Under field conditions, it is transmitted by the black citrus aphid, *Toxoptera citricida*. The virus is not seed borne.

Management:

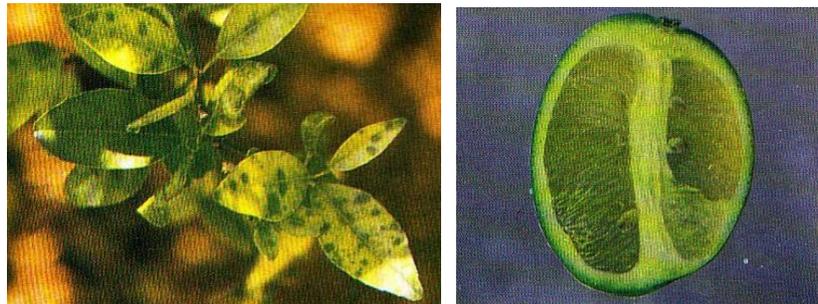
- Strict quarantine measures to be enforced
- Use certified budwood free of CTV
- Remove all diseased trees as and when the disease is noticed. Fresh plantings to be taken with virus free materials on tolerant rootstocks. For sweet orange and mandarin avoid susceptible root stocks.
- For Andhra Pradesh, Maharashtra and Karnataka, **Rangapur lime** is recommended as a root stock resistant to Tristeza. For the Punjab region, Jattikhatti, Cleopatra mandarin and sweet orange are recommended as resistant root stocks.
- For acid lime, use seedling preimmunised with mild strain of tristeza virus (Cross protection).
- Periodic sprays of insecticides like Monochrotophos 0.05 % reduce s the secondary spread of the disease in the orchard.

7) Greening or Huanglongbin: *Candidatus Liberibacter asiaticus* (*Fastidious Phloem limited Bacterium*), Obligate gram negative bacterium

Economic importance: Greening disease is known to occur in Andhra Pradesh, Karnataka, Punjab, Uttar Pradesh, Himachal Pradesh, Rajasthan, Maharashtra, Jammu, Bihar, Bengal and Sikkim. The disease is more **severe on sweet oranges** than on acid lime, mandarin and grapefruits. This disease affects almost all citrus varieties irrespective of root stock. In India **Mosambi sweet orange** and **Darjeeling orange** (*Citrus reticulata*) are good **indicator plants** for greening.

Symptoms:

- Affected trees are stunted with pronounced leaf and fruit drop. Varied chlorotic patterns on leaves are noticed which are persistent and cannot be corrected by zinc sprays.
- Reduction in leaf size is common. Many affected leaves show small **circular green islands** within the chlorotic areas. Heavy leaf fall occurs with the onset of summer. Often new flush may come out and leaves formed are short, upright and chlorotic with green veins or with green blotches on the leaves.
- Twig die-back occurs. Some branches in a tree exhibit severe symptoms whereas others in the same tree are apparently normal.
- Fruits show reduction in size, lopsided growth and oblique columella.
- The rind surface exposed to sun appears yellow whereas the remaining portion remains dull green. Diseased fruits are valueless owing to small size, distortion, low in juice and soluble solids, high in acid and insipid taste.
- **Seeds are poorly developed, dark coloured and aborted.**



Mode of spread:

The disease is transmitted through infected bud wood and citrus psylla, *Diaphorina citri*. The disease also transmits from citrus to Periwinkle (*Catharanthus roseus*) through dodder.

Management

- Select certified disease-free seedlings.
- Control psyllids with insecticides like dimethoate.
- Use pathogen free bud wood for propagation.
- Raise virus free plants through shoot tip grafting
- 500 ppm tetracycline spray though effective, requires fortnightly application which is not economic.

8) Felt disease: *Septobasidium pseudopenicillatum*

Symptoms:

- The disease starts with onset of monsoon in case of acid lime.
- A soft felt like fungal growth encircles the twigs and branches.
- The fungus grows over the bark and does not penetrate the surface. The growth is light brown to grey in colour and colonies of **scale insects** can be seen underneath it.
- This results in drying of stems.

Management:

- Spray twice with monochrotophos 0.05% and [zineb@0.25%](#) with the onset of monsoon at monthly interval.

LECTURE 2

Mango

1. Powdery mildew: *Oidium mangiferae* (*Erysiphe polygona*)

Economic importance: The disease is worldwide in distribution. Reported from India, Pakistan, Ceylon and South Africa. In India the disease is particularly destructive in U.P. Maharashtra and Karnataka severe particularly during the months of December-March, i.e. cooler months.

Symptoms:

- The disease can easily recognized by whitish or grayish powdery growth on the inflorescence and tender leaves.
- Generally the infection starts from the inflorescence and spreads downwards covering the floral axis, tender leaves and stem. Leaves become twisted, curled and defoliate.
- Infected floral parts are severely damaged and drop off. If the fruits are set, they do not grow in size and may drop before attaining pea size. Fruits are sometimes malformed, discolored due to severe mildew attack.
- Because of poor fruits set and heavy flower and fruits drop, the loss due to the disease may go as high as 70-80%.



Favourable conditions

Disease spread is favored by warm humid weather with cool nights.

Pathogen and Disease cycle: P.S: *Erysiphe polygona* -(Rare) in India.

Mycelium branched, hyaline, superficial, septate, haustoria lobate. Conidia hyaline, unicellular, elliptical, borne singly or rarely in chains of two, conidiophores simple, erect with two or more basal cells.

Mode of spread:

Dissemination is by wind and the progress of the disease in the orchard is along the direction of wind.

P.I: Through infected plant debris by conidia

S.I: Wind borne conidia of *Oidium mangiferae*.

Management

- Can be controlled with two preventive sprays with wettable sulphur 0.3% once before the flowers open and 2nd after the fruit set.
- Dusting twice or thrice with fine sulphur will check the disease.

- Spraying with Karathane 0.1% or cosan 0.1% before flowering and after fruit set (peanut stage).
- Resistant varieties: Neelum, Zardalu, Banglora, Torapari-khurd and Janardhan pasand

2. Anthracnose: *Colletotrichum gloeosporioides*

Economic importance: SATTAR and MALIK in 1939 observed the disease in several districts of Punjab. Since then it has been found in all mango – growing tracts of the country.

Symptoms:

- The fungus produces leaf spots, blossom blight, wither tip, twigs blight and fruit rot.
- On leaves initially circular, light yellow brown spots are produced which soon enlarge with dark brown to black margins. If infection is severe individual spots coalesce leading to twisting of foliage and premature defoliation.
- The disease spreads rapidly during rainy season and covers the tender twigs and floral axis causing them to wither.
- Spots appear on fruits near the stem end as small brown areas that enlarge rapidly and become black. In some cases the areas involved are in the form of streaks running down from the stem end. Fruit pulp beneath the spots become hard followed by cracking and decay at ripening.
- The decay is confined to the skin of the fruit except in late stages where it penetrates the flesh in shallow areas. Infected fruits may also drop off prematurely.
- The latent infection is carried from the field and develops further which causes rotting in the storage. Neelum and Banglora are more susceptible.



Disease_cycle :

P.I: Mainly through previous season infected leaves, defoliated branches, mummified flowers and flower brackets.

S. I: Mainly due to rain splash or wind driven rain water.

Favourable conditions: Temperature of 25°C and R.H 95-97%

Management

- Avoid over-crowding of orchards
- Tree sanitation is important. Diseased twigs are to be pruned and burnt (along with fallen leaves.)
- Spray carbendazim or Topsin M (0.1%) or Chlorothalonil (0.2 at 14 days intervals until harvest.

- Before storage, treat the fruits with hot water (50-55°C), for 15 minutes or dip in Benomyl solution (500ppm) or Thiobendazole (1000ppm) for 5 minutes or expose them to ammonia and sulphur dioxide gases.

3) Mango Malformation: *Fusarium moliliforme* var. *subglutinans*

Economic importance:

- This is one of the severe diseases of mango and is important in North India. It appears in and around Hyderabad & Medak Districts.
- In A.P. this was first noticed in Aragonda village in 1971.
- In India it is known to occur in U.P., Maharashtra, Haryana, Bihar, Punjab and A.P. particularly severe in U.P. causing much damage.
- In North West India nearly 50% incidence on orchards were recorded.
- Where as in north East and south the incidence may go up to 10%. Coastal areas are free from the disease.

Symptoms:

There are two types of symptoms namely **floral** malformation and **vegetative** malformation.

- **Vegetative malformation:** There is a proliferation of infected tissue. The affected plants develop excessive vegetative branches which are of limited growth, swollen and have short internodes.
- These dwarf branches are of various sizes which are often produced on the top of young seedlings giving a **bunchy top** appearance. The axillary buds of dwarf branches are unusually enlarged.
- Vegetative malformation is more pronounced in young seedlings and seedling trees than in grafted plants.
- **Floral malformation:** The flowering panicles instead of coming out as a normal one turns into just compact bunch of hard flowers. **Individual flower is greatly enlarged** and has a large disc.
- The inflorescence gets **hypertrophied**. The percentage of bisexual flowers in malformed panicles is very low.
- The malformed heads dry up in black masses and persist on the trees for a long time.



Disease cycle:

P. I: Through malformed inflorescence

S. I: Either by air borne conidia or by conidia carried by eriophid mite *Aceria mangiferae*

Management:

1. Use of disease free planting material and prophylactic spray of insecticides and fungicides.
2. Pruning of diseased parts along with basal 15-20 cm apparently healthy portions.
3. Spray Captan (0.2%) or Benomyl (0.1%).
4. Spray naphthelene acetic acid (NAA) 200 ppm during first week of October.

4) Bacterial leaf spot: *Pseudomonas mangiferae- indicae*

Economic importance: The first description of bacterial leaf spot was given by Patel *et al* in 1948 from Maharashtra. In India the disease occurs in Delhi, Tamil Nadu and other states

Symptoms:

- Symptoms are seen on leaves and fruits.
- On the leaves initially slightly water soaked yellowish, translucent irregular spots are formed towards leaf tip which enlarge soon and become dark brown with a yellow halo.
- These dark spots are limited by veins and become angular resulting in cankerous raised lesions.
- Spots appear all over the lamina.
- Under high humid conditions these spots fuse, leaves turn yellow and drop down prematurely.
- Longitudinal cracks develop on petioles.
- On green twigs, dark lesions of infection spread to inflorescence stalks.
- When fruits are attacked, water soaked lesion develop and turn dark brown to black.
- The affected fruits become yellow with deep cracks severely affected fruits are shed prematurely.

Disease cycle: Primary infection is through infected leaves, branches, and fruits. Secondary infection occurs by wind driven rain and rain splash.

Management:

- Forthrightly spray of 1% B.M. or Agrimycin - 100 or Paushanycin or Plantomycin (200ppm) or Streptomycin
- Resistant variety: Bombay green

5) Sooty mould: *Capnodium ramosum*

Symptoms:

- Black encrustation seen on upper surface of the leaves affecting the photosynthetic activity.
- Superficial growth of the fungus on the flowers, both tender and old leaves, stem and fruits.
- Black encrustation forms on the fruits; appearance is lost yielding low price.
- Pathogen grows and thrives on the sugary or honey dew secretions of **plant hoppers**.



Mode of spread: Diseased leaves serve as primary inoculum. Scale insects and aphids, *Lecanium hemisphaericum*, *L. viride*, *L. nigrum*, *Hemilecanium imbricans* and *Pulvinaria Psidii*.

Management:

- Controlling of plant hoppers by spraying Carbaryl (2g/l) or Phosphomidon 0.03%
- Spray dilute solution of starch or maida 5% (Boil 1 kg of maida or starch in 5 litres of water, cool and dilute to 20 litres), which dries up and comes off in flakes, removing along with it the sooty mold growth.

6) Red rust: *Cephaleuros virescens* (algae)

Economic importance: In India it has been observed in Bihar, Karnataka and U.P. The disease appeared in an epidemic form in orchards of 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 red rusty spots on the leaves and young twigs
- The spots are initially circular, slightly elevated and later coalesce to form irregular spots.
- The upper surface of the spot consists of numerous unbranched filaments of the pathogen which project through the cuticle. Some of the filaments represent the sterile hairs while others the fertile ones
- Initially the spots are greenish-grey in colour and variety in texture, but later on the surface bears reddish-brown appearance.

Disease cycle: Common in close plantations. High moist conditions favour the development of fruiting bodies.

P.I.- Zoospores.

Management:

- Avoid close plantations
- Spray Bordeaux mixture 1-2% or Fytolan / Blitox 0.5% or lime sulphur 0.1%

7) Loranthus

Symptoms:

- Loranthus is a **partial stem parasite**. Loranthus seeds are disseminated by birds on to the stems of the host.
- Loranthus seeds do not require a host germination stimulus and will germinate spontaneously.

- The seedling radicle is negatively phototropic and thus grows towards a dark surface (often the host branch).
- The first attachment structure formed is called a **holdfast**. The haustorium from the holdfast eventually connects to the host xylem.
- Parasite removes water and mineral nutrients from the host.
- When in contact with the host cambium, the loranth haustorium induces the formation of additional wood that enlarges into fluted columns.

Management:

- Pruning of affected branches
- Periodic removal of mistletoes from infected branches and stems
- Ethephon effectively controls mistletoes in some situations
- Inject copper sulphate and 2,4-D into affected branches
- Spray of diesel oil emulsion in soap water

LECTURE 3

DISEASES OF BER

1. Powdery mildew – *Oidium erysiphoides f.sp. zizyphi*

- The disease is noticed generally at the end of October and prevails from **November to April**

Symptoms

- Powdery mass appears on young leaves and fruits
- Severely affected leaves shrink and defoliate
- Small white powdery growth appear on young fruits which later enlarge and coalesce and finally turn brown to dark brown in colour
- Infected fruits become corky, crack, misshapen, underdeveloped and finally drop prematurely

Survival and spread

- P.I: Budwood of host plant
- S.I: Air-borne conidia

Favourable conditions

- Warm humid conditions with R.H more than 90%

Management

- Spray [Dinocap@0.1%](#) or [Wettable S@0.2%](#) during first and third weeks of Nov
- Two sprays of [carbendazim@0.2%](#) at 15 days interval, starting from the time when the fruits are of pea size followed by [Dinocap@0.1%](#) spray at 10-15 days interval
- Add Teepol or Sandovit to the fungicide solution

DISEASES OF GUAVA

1. Wilt – *Fusarium oxysporum f.sp. psidii*, *F. solani*, *Macrophomina phaseolina*, *Cephalosporium sp.*, *Gliocladium roseum* and *Verticillium alboarum*.

Economic importance: It was first reported in 1935 from Allahabad. Jhoty et al., in 1984 reported that seven thousand acres of land in A.P under guava cultivation was reduced to half the land value by the presence of the disease.

Symptoms

- The affected plants show yellow colouration with slight leaf curling at the terminal branches, becoming reddish at the later stage and subsequently premature shedding of leaves takes place.
- Twigs become bare and fail to bring forth new leaves or flowers and eventually dry up. Fruits of all the affected branches remain underdeveloped, become hard, black and stony.
- The entire plant becomes defoliated and dies. A few plants also show partial wilting, which is very common symptom of wilt in guava.

- The finer roots show black streaks which become prominent on removing the bark. The roots also show rotting at the basal region and the bark is easily detachable from the cortex.
- The cortical regions of the stem and root show distinct discolouration and damage. Light brown discoloration is noticed in vascular bundles. Bark splitting can be seen in wilted plants in later stages.
- The disease can be categorized into slow wilt and sudden wilt. In slow wilt, plant takes several months or even a year, to wilt after the appearance of initial symptoms and in sudden wilt, infected plant wilts in 15 days to one month.

Favourable conditions:

- **pH 6.0** is optimum for disease development. Both pH 4.0 and 8.0 reduces the disease.
- Disease is more in clay loam and sandy loam compared to heavy soil.
- Higher disease incidence in monsoon period.
- Disease appears from August and increases sharply during September-October.
- The presence of nematode, *Helicotylenchus dihystra*

Management

Cultural:

- Proper sanitation of orchard.
- Wilted plants should be uprooted, burnt and a trench of 1.0-1.5m should be dug around the tree trunk. Treat the pits with formalin and cover the pit for three days and then transplant the seedlings after two weeks.
- While transplanting seedlings avoid damage to the roots.
- Maintain proper tree vigour by timely and adequate manuring, inter-culture and irrigation.
- Intercropping with turmeric or marigold.
- Soil solarization with transparent polythene sheet during summer months.
- Application of oil cakes like neem cake, mahua cake, kusum cake supplemented with urea. Apply 6kg neem cake + 2kg gypsum per plant.
- Judicious amendments of N and Zn.

Host Plant Resistance:

- Resistant variety: **Apple guava**
- Guava species, *Psidium cattleianum* var. *lucidum* and *Syzigium cumini* (Jamun) are resistant to wilt.
- *Psidium cattleianum* (*P. molle*), *P. quianense*, Chinese guava (*P. friedshthalianum*) and Phillipine guava are recommended as resistant root stocks

Biological:

- ***Aspergillus niger* strain AN 17**, *Trichoderma viride*, *Trichoderma harzianum* and *Penicillium citrinum* can be used as biocontrol agents

Chemical:

- Stem injection with 0.1% water soluble 8-Quinolinol sulphate
- Drench with 0.2% Benomyl or Carbendazim, four times in a year and spray twice with Measystox and Zinc sulphate.
- Disinfestation of soil with Metam-sodium at 252 ml/10m² area to control nematodes.

DISEASES OF SAPOTA

1. Phavophleospora leaf spot – *Phavophleospora indica*

Symptoms

- Numerous, small, circular, **pinkish to reddish brown, conspicuous spots with whitish center** on mature leaves
- Spots coalesce and leaves drop prematurely

Favourable conditions

- Severe during Oct-Dec
- Fungus grows best at 25⁰ C and 90% RH
- Susceptible varieties: Cricket ball, Kirthabarthi, *Mimusops hexandra* (root stock)

Management

- Avoid susceptible varieties
- Spray [zineb@0.2%](#) or [ziram@0.2%](#) or [COC@0.25%](#)

2. Pestalotiopsis leaf spot – *Pestalotiopsis versicolor* (Syn: *Pestalotia versicolor*, *P. sapotae* and *P. podocarpi*)

Symptoms

- Small, reddish brown specks on leaf lamina
- Spots enlarge, become circular measuring 1 to 3 mm in diameter
- Fully developed spots show grayish centre and dark brown to reddish margin
- Minute black fruiting bodies (pycnidia) are seen in the center of spots

Management

- Spray [zineb@0.2%](#)

3. Flat limb – *Botryodiplodia theobromae*

First reported from Maharashtra and Gujarat by Khurana and Singh in 1972

Symptoms

- Branches of affected trees become **flat and twisted**
- Leaves become thin, small and yellow
- Cluster of leaves and flowers on affected twigs
- Flowers remain infertile
- If fruits are set, they are undersized, hard and fail to ripen
- Foliage and fruits fall prematurely



Management

- Pruning of affected branches followed by Captan or Zineb (0.3%) spray

DISEASES OF PAPAYA

- Powdery mildew – *Oidium caricae*
- Foot rot – *Pythium aphanidermatum*
Rhizoctonia solani
- Mosaic – *Papaya mosaic virus* or *Papaya ringspot virus*
- Leaf curl – *Tobacco leaf curl virus* or *Nicotiana virus 10*
- Anthracnose – *Colletotrichum papayae*

1. Powdery mildew: *Oidium caricae*

Symptoms

- Diffuse mats of external, white mycelium develops on both the leaf surfaces
- Lesioned areas become chlorotic and sometimes surrounded by a dark margin
- Flower stalks and fruits are also affected
- Stems of young seedlings are affected when grown under reduced light conditions
- Severe attack leads to death of top portion of the seedlings

Survival and spread

- P.I: Mycelium or cleistothecia in infected plant debris
- S.I: Wind borne conidia

Favourable conditions

- Maximum disease incidence during Sept – Nov with a peak in October

Management

- Spray wettable Sulphur@0.3% at 10 days interval
- Spray systemic fungicides like [Bayleton@0.1%](#) or [carbendazim@0.1%](#) at monthly intervals

2. Foot rot / stem rot: *Pythium aphanidermatum*, *Rhizoctonia solani*

Symptoms

- Water soaked patches on the stem at the ground level
- Patches enlarge and girdle the base of the stem
- Diseased tissues turn brown or black and rot
- Terminal leaves turn yellow, droop and wilt
- Fruits shrivel and drop off
- Entire plant topples over and dies
- Internal tissues of bark appear dry and give **honey comb appearance**
- Roots deteriorate and may be destroyed

Survival and spread

- P.I: **Oospores** (*Pythium*) or **Sclerotia** (*Rhizoctonia*) in soil
- S.I: Seedlings raised in infected soil carry the disease to field

Favourable conditions

- Appears from June to August
- Younger seedlings are more susceptible than older ones
- Severity increases with intensity of rainfall

- *R. solani* is severe in **dry and hot weather** (36⁰ C)

Management

- Seedlings should be raised in well drained nursery area
- Uproot the diseased seedlings and burn
- ST with captan@4g/kg seed or chlorothalonil@2g/kg seed (*R. solani*)
- Drench the base of stem with [COC@0.25%](#) or [metalaxyl@0.1%](#) or Bordeaux [mixture@1.2%](#)

3. Mosaic: *Papaya mosaic virus* or *Papaya ringspot virus* or *Carica virus I*

Economic importance

- Occurs in a severe form in central India.
- In India 1st reported from Mumbai and Pune in 1947
- 90-100% damage occurs in severe cases

Symptoms

- **Mottling** and puckering of leaves, especially the young ones
- The lamina is reduced and malformed and are often modified into tendril like structures (**shoestrings**)
- Decline & marked reduction in growth of diseased plants (within 30-40 days)
- Older leaves fall down and a small tuft of younger leaves is left at the top with upright position
- The stem, petiole and fruits develop elongated **water soaked areas showing concentric or circular rings**
- Fruits develop innumerable circular, water soaked lesions with spots in the center
- Fruit size is severely reduced with deformed shape



Survival and spread

- P.I: Affected plant parts (Mechanical)
- S.I: Aphids (*Myzus persicae*)
- Other aphids: *Aphis malvae*, *A. gossypii*, *A. medicaginis*, *Rhopalosiphum maidis*, *Microsiphum solonifolii*
- Most of the cultivated species of *Carica papaya* are susceptible: *C. candamarcensis* and *C. microcarpa*
- Other hosts: *Cucumis sativus*, *Cucurbita pepo*, *C. maxima*, *Citrullus vilgaris*, *Luffa acutangula*, *Lagenaria siceraria*, Safflower and some ornamental plants.

Management

- Disease free seedlings
- Rouging and destruction of diseased plants
- Vector control
- *Carica cauliflora* is resistant
- Weekly sprays with 1% groundnut oil

4. Leaf curl: *Tobacco leaf curl virus* or *Nicotiana virus 10*

Symptoms

- Severe curling, crinkling and distortion of leaves accompanied by **vein clearing** and **reduction of leaf lamina**
- Leaf margins are rolled downward and inward in the form of **inverted cup**
- Curled leaves have thickened veins
- Leaves become leathery, brittle and petioles are twisted
- Diseased plants fail to flower or bear any fruits
- In advanced stage, defoliation takes place and growth is arrested

Survival and spread

- P.I: Infected plant parts
- S.I: Whitefly, *Bemesia tabaci* and grafting
- Virus also infects tobacco, tomato, sunhemp, chilli, *Petunia*, *Zinnia*, *Datura stramonium*, hollyhock, cape gooseberry etc.

Management

- Disease free seedlings
- Rouging and destruction of diseased plants
- Vector control with [monochrotophos@0.05%](#) or [Dimethoate@0.2%](#) or [metasystox@0.1%](#)

5. Anthracnose – *Colletotrichum papayae* (Syn: *Gloeosporium papayae* or *Colletotrichum gloeosporioides*)

Symptoms

- Spots on fruits appear as brown superficial discolouration of the skin
- Spots develop into circular, slightly **sunken** areas and 1 to 3 cm in diameter
- Lesions coalesce and sparse mycelial growth appears on the margins of the spots
- Early fruit infection results in mummification and deformation
- Necrotic spots on leaves and stems
- Older parts are generally highly susceptible

Favourable conditions:

- Excessive moisture
- Older leaves and mature fruits are more susceptible

Survival and spread

- P.I: Incipient infection carried by fruits from the field
- S.I: Conidia by wind and rain splash

Management

- Foliar spray, twice, with [carbendazin@0.1%](#) at 15 days interval or [chlorothalonil@0.2%](#) at 10 – 15 days interval. Last spray to be given 10 days before harvest
- Fumigation of fruits with **benzylisothiocyanate** and coating with groundnut oil controls post harvest spots and rots

LECTURE 4

DISEASES OF BANANA

1) **Yellow Sigatoka leaf spot - *Mycosphaerella musicola* (I.S: *Cercospora musae*)** **Black sigatoka – *Mycosphaerella fijiensis***

- First observed in Java in 1902
- Epidemic in 1913 in plains of Sigatoka in FIJI Island
- Wide spread in nature and occurs in many countries except in Egypt and Israel
- In India - states of Assam, Tamil Nadu, Karnataka & A.P
- Significant losses are caused by destruction of the foliage and reduction of the functional leaf surface of the plant

Symptoms

- Early symptoms appear on the third or fourth leaf from the top, *i.e.*, on young leaves
- Small **spindle shaped spots on foliage with greyish centre** and yellowish halo running parallel to veins.
- Spots are mostly seen along the edge of the leaf with defined margin and possess **dark brown to black margin**. Spots coalesce and whole leaf blade dries up
- On the upper surface of the spots, **fructifications** of the fungus appear as black specks



- If the fruit is nearing maturity at the time of heavy infection, the **flesh ripens unevenly** and individual bananas appear undersized and their flesh develops a buff pinkish colour, and store poorly.

Survival and spread

- Survives on dry infected leaves on the field soil and primary infection takes place through ascospores in the infected plant debris.
- Secondary spread through wind borne conidia and ascospores
- Infection takes place through stomata on the lower surface of young leaves.
- Surface moisture is necessary for release of both conidia and ascospores. Hence the disease is severe in moist weather.

Favourable conditions: High humidity, heavy dew and rainy weather with temp above 21 °C. Soils with poor drainage and low fertility favour the disease incidence. Thick planting, presence of weeds and increased number of suckers in a mat promote disease development.

Management

- Removal and destruction of affected leaves followed by spraying with BM (1%) + linseed oil (2%)
- Prevent water accumulation around the plant and go for periodical weeding.
- Spray zineb@0.25% or copper oxy chloride@0.3% suspended in mineral oil
- Spray chlorothalonil@0.2% or carbendazim or thiophanate methyl@0.1% or mancozeb@0.25% along with spreading agent. Wetting agent such as teepol or sandovit added at the rate of 1ml/lit of water.

2) Panama wilt- *Fusarium oxysporum f.sp. cubense*

- First reported from Australia in 1876
- The popular variety Gros Michel, mostly grown for export quality fruits, was most susceptible and had to be replaced with Cavendish bananas which were resistant
- Severe on **Rastali variety (Amrutapani), Gros Michel, Monthan Karpooravalli**



Symptoms

- Conspicuous symptoms usually appear on at least 5 months old banana plants, although 2-3 months old plants are also killed under highly favourable conditions
- Symptoms initially seen in **older plants** in a mat and on **older leaves**.
- The earliest symptoms are faint yellow streaks on the petiole of oldest, lower most leaves
- Affected leaves show progressive yellowing, break at the petiole and hang down along the pseudostem.
- Young leaves may not dry up but remain erect and they also get affected under severe cases. (**Heart leaf alone remains upright**)
- Varying degrees of **longitudinal splitting** along pseudostem are often observed
- Light yellow to dark brown vascular discoloration of pseudostem. Usually the **discolouration appears first in the outer or oldest leaf sheath and extends upto the pseudostem**
- The fungus grows and blocks the vascular system resulting in wilting of the plant.
- Affected plants give characteristic odour of rotten fish.
- Young suckers also develop the disease and rarely develop external symptoms
- Affected plants do not produce bunches. Even if produced, **fruits are malformed and ripen prematurely or irregularly**. However the pathogen does not infect the fruits.
- Roots of diseased rhizomes are frequently blackened and decayed

Favourable conditions

- Soil conditions like texture and structure, fertility level, temperature, drainage, cultural operation will greatly influence the disease incidence and spread in the field.
- Survival and growth of fungus are generally greater in acidic or light textured soils than in clay or alkaline soils with high calcium content. Sturated poorly drained soils have greater incidence.
- Insect injuries and wounds and infestation of burrowing nematode, *Radopholus similis*, predispose the disease

Survival and spread

- Survive as chlamydospores in soil or in infected rhizomes
- Spread as conidia through irrigation water or through root contact

Management

- Use of disease free suckers for planting.
- Avoid ill drained soils, and prefer slightly alkaline soils (7-7.5 pH) for cultivation
- Flood fallowing for 6 to 24 months or crop rotation with rice.
- Application of lime (1-2 kg/pit) to the infected pits after chopping of the plants parts.
- Dipping of suckers in carbendazim (0.1%) solution before planting
- Soil drench with 0.1% carbendazim or 0.01% Vapam
- Growing resistant Cavendish varieties, viz., **Basrai** (Vamanakeli), **Poovan** (Karpura chakkarakeli), **Moongil**
- Dwarf varieties are generally resistant

3) Moko disease / Bacterial wilt

- C.O: *Ralstonia solanacearum* (*Pseudomonas* or *Burkholderia*)
- First recorded in Guyana in 1840 in Moko plantain
- In India, first reported from West Bengal in 1968

Symptoms

- Symptoms start on rapidly growing **young plants**
- The youngest three to four leaves turn pale green or yellow and collapse near the junction of lamina and petiole.
- Characteristic discoloration of vascular strands, wilting and blackening of suckers.
- Vascular discolouration (pale yellow to dark brown or bluish black) is concentrated near the **centre** of the pseudostem, becoming less apparent on the periphery
- Greyish brown bacterial ooze is seen when the pseudostem of affected plant is cut transversely
- A firm **brown dry rot** is found within fruits of infected plants (characteristic symptom)
- Death of whole plant occurs under severe infection.

Pathogen:

Moko disease is caused by race 2 of *Ralstonia solanacearum* which infects *Musa* and *Heliconia*. Cells of bacterium are rod shaped and motile by 1-4 flagella. They are Gram negative.

Disease cycle

- P.I: Through diseased plant suckers used for planting.
- S.I: Through irrigation water, implements and by insects.

Management

- Grow resistant varieties like **poovan** and monthan.
- Adopt strict plant quarantine and phytosanitary measures
- Use of healthy planting material.
- Exposure of soil to sunlight during dry hot weather.
- Eradicate infected plants and suckers killing *in situ* by application of herbicides.
- Disinfestation of tools with formaldehyde diluted with water in 1:3 ratio.
- Crop rotation (3 years rotation with sugarcane or rice) & providing good drainage
- Allow fallow period or flooding during off-season
- Fumigation of infected site with Methyl Bromide or chloropicrin.
- Spray systemic insecticide to prevent transmission of disease to healthy plants.
- Biocontrol with *Pseudomonas fluorescens*

4) *Erwinia* rhizome rot: *Erwinia caratovora* sub.sp. *caratovora* or *Erwinia chrysanthemi*

Symptoms

- Affected plants show discolouration and soft rotting of rhizomes and suckers. The affected plants have scanty roots with dark brown lesions and necrotic tip.
- In many cases, the pseudostem tips over breaking across the rotted stems particularly at the ground level.
- Mature plants seldom show above ground symptoms until the disease is well advanced. Such plants may produce small sized fruits which may fail to emerge from the shoot tip.
- Infected plants can be pushed over easily and are very susceptible to wind damage. In severely infected soil newly planted rhizomes may rot and fail to sprout.
- When young plants are infected, a dark brown necrosis appears in the lamina of the older leaves. Later the plant becomes stunted and yellow.
- As the rhizome becomes infected, pockets of dark water soaked areas develop. Infection may result in the production of cavities which resemble root borer tunnels.

Disease cycle

- P.I: Through diseased plant suckers used for planting and infested soil.
- S.I: Through irrigation water, implements and by insects.

Favourable conditions:

- Prevalence of high temperature during initial stages of crop growth.
- Growing susceptible varieties like, vamanakeli, basrai and tella chekkarakeli

Management

- Avoid planting susceptible varieties during periods of high rainfall or in water logged soils in problematic areas
- Maintain proper soil aeration by intercultivation
- Ensure that only healthy suckers are planted
- Restrict ratoon to one or two based on disease incidence
- Crop rotation with rice or sugarcane

- Remove and destroy infected plants along with roots
- Dip the suckers in copper oxy chloride (5g/lt) + monochrotophos (2.5ml/lt) solution.
- Drench the infected suckers with bleaching powder (25g/lt) solution

5) Bunchy top / Curly top / cabbage top /strangles disease

- Bunchy top virus or Banana virus - 1 or Musa virus - 1
- First reported from Fiji in 1889 in Cavendish varieties
- Around 1940, introduced into **India from Srilanka** through cyclone
- Banana bunchy top virus is a **ss DNA** virus with single isometric particles

Symptoms

- Prominent dark green streaks on the petioles and midrib along the leaf veins
- Green streaks range from a series of dark green dots to a continuous dark green line (**Morse code**)
- Marginal chlorosis and curling of leaves
- Petioles fail to elongate
- Leaves are reduced in size, chlorotic, stand upright and become brittle and are crowded at the top (Bunchy top) and show dark green streaks with '**J hook**' shape near the midrib.
- Flowers display mottled and streaked discolouration
- Plants show marked stunting



Disease cycle

- P. I. Through infected plant suckers.
- S. I. By Banana aphid, *Pentalonia nigronervosa*
- Reservoir hosts: *Cucumis sativus*, *C. melo*, *Catharanthus roseus*, *Gynura aurantiaca*, *Colocasia esculenta*, *Amomum subulatum* and *Elettaria cardamom*

Management

- Adaptation of strict quarantine measures
- Eradication of all infected suckers by spraying with kerosene or by injecting herbicide, 2, 4-D
- Use of only certified banana suckers for planting
- The new crop should be regularly inspected and the diseased plants destroyed as soon as noticed.
- Vector control with systemic insecticides, *Viz.*, Phosphomidon @ 1ml/lt or Methyl demeton @ 2 ml/lt

6) Banana Mosaic / Infectious chlorosis / Heart rot: *Cucumber mosaic virus (ss RNA virus)*

Symptoms

- Typical mosaic-like or discontinuous linear streaking in bands extending from margin to midrib (**Mosaic**)
- Leaf size is reduced and leaves are malformed.
- Chlorosis of newly formed leaves (**Infectious chlorosis**)
- Rotting of heart leaf and leaf sheaths in severe cases (**Heart rot**) which progress into the pseudostem and plant dies.
- Diseased plants do not reach maturity

Disease cycle

- P.I: Infected suckers
- S.I: *Aphis gossypii*, *A. maydis*
- Reservoir host: *Cucumis sativus*

Management

- Use of disease free suckers for planting
- Dry heat treatment of suckers at 40⁰ C for 1 day
- Avoid growing cucurbits as intercrop
- Vector control with Methyl demeton or dimethoate@ 0.2% at 3 – 4 weeks interval

7) Banana bract mosaic: *Banana bract mosaic virus (BBMV)*

Symptoms

- Symptom expression is clearly seen in Monthan and plantain group of banana
- The disease is characterized by development of black streak on petiole, yellow or pinkish colouration on pseudostem and mosaic like **purple spindle shaped streaks on the bract**.
- In severe cases, pink streaks continue on the lower surface of the midrib.
- Suckers exhibit unusual reddish brown streaks at emergence and separation of leaf sheath from central axis.
- Leaves cluster at the crown region and leaf sheath separates from the central axis. Clustering of leaves at the crown with a ‘travellers palm’ appearance, elongated peduncle and half filled hands are other characteristic symptoms.

Disease cycle

- P.I: Infected suckers
- S.I: Aphids and planting material
- Among the Monthan group, Nendran and Robusta are severely damaged

Management

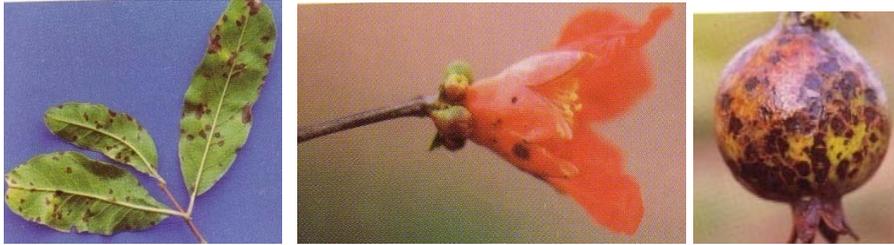
- Use of disease free suckers for planting
- Dry heat treatment of suckers at 40⁰ C for 1 day
- Avoid growing cucurbits as intercrop
- Vector control with Methyl demeton or dimethoate@ 0.2% at 3 – 4 weeks interval

DISEASES OF POMEGRANATE

1) *Cercospora leaf spot* – *Cercospora punicae*

Symptoms

- Light zonate brown 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 edge.
- Such infected twigs dry up.
- In severe cases the whole plant dies.



Survival and spread

- P.I: Diseased plant debris
- S.I: Wind borne conidia

Management

- Pruning and destruction of diseased twigs.
- Application of thiophanate- methyl 0.1% or chlorothalonil 0.2% or mancozeb 0.2%

2) *Anthracnose* – *Colletotrichum gloeosporioides*

Symptoms

- Small, regular to irregular dull violet or black spots on the leaves



- Spots surrounded by yellow margins
- Infected leaves turn yellow and drop off
- Small irregular lesions on the fruit
- Reduction in market value

Favourable conditions

- Severe during August-September
- High humidity and temp ranging from 20 to 27° C

Management

Spray [carbendazim@0.1%](#) or Thiophanate-methyl @0.1% or [mancozeb@0.2%](#) at fortnightly intervals

3) Bacterial leaf spot - *Xanthomonas axonopodis pv. punicae*

Symptoms

- Small irregular water soaked spots appear on the leaves.
- Small, deep red spots of 2-5 mm dia. with indefinite margins on leaf blade
- Leaves distorted and malformed
- Severely infected young leaves shed
- The bacterium attacks stem, branches and fruits also.
- On the stem, the disease starts as brown to black spots around the nodes.
- Girdling and cracking of nodes
- Branches break down
- Brown to black spots on the pericarp of fruit with **L or Y shaped cracks**
- Spots on fruits are raised with dark brown lesions of indefinite margins on the surface



Survival and spread

- P.I: Infected cuttings
- S.I: Wind splashed rains
- The bacteria infect through wounds and stomatal openings.

Management

- Clean cultivation and strict sanitation in orchard
- Spray B.M @1% along with antibiotic

LECTURE 5

DISEASES OF GRAPE

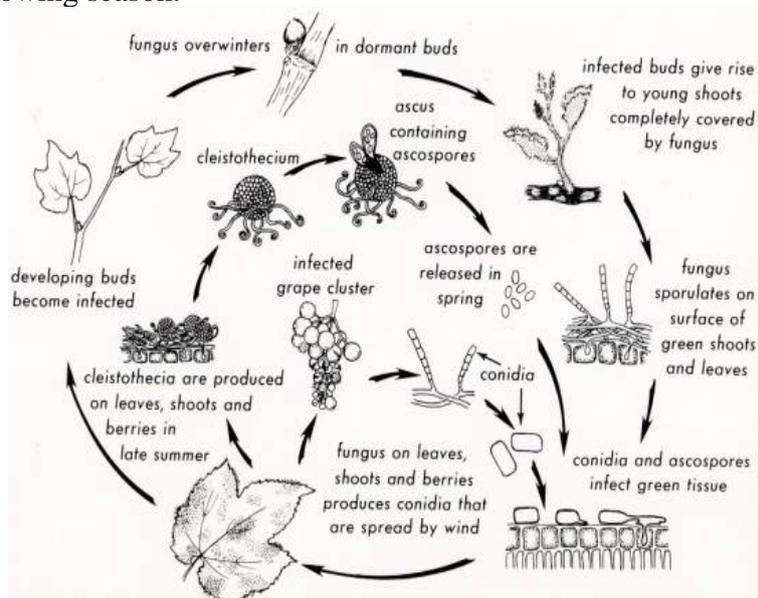
1. Powdery mildew: *Uncinula necator* (I.S: *Oidium tuckeri*)

Losses in yield of fruits may be upto 40-60%. In addition to loss of yield, infected berries tend to be higher in acid content than healthy fruits and are unsuitable for wine making.

Symptoms

- The disease attacks the vines at any stage of their growth. All the aerial parts of the plant are attacked. Cluster and berry infections usually appear first.
- Floral infection results in shedding of flowers and poor fruit set.
- Early berry infection results in shedding of affected berries.
- Powdery growth is visible on older berries and the infection results in the cracking of skin of the berries. Often infected berries develop a net-like pattern of scar tissues.
- Powdery growth mostly on the upper surface of the leaves.
- Malformation and discolouration of affected leaves. Leaf lesions appear late and doesn't cause much damage
- Discolouration of stem to dark brown.

Pathogen: The mycelium is ectophytic and produces bilobate or multilobate appressoria. The conidiophores are simple, multiseptate and erect bearing a chain of 3-4 conidia. Under Indian conditions, perfect stage of the fungus is not found. When the mating types are present cleistothecia can form on all infected tissues during later part of the growing season.



Mode of spread and survival

- Through dormant mycelium and conidia present in the infected shoots and buds.
- Through air-borne conidia

Favourable conditions

- Cool dry weather
- Maximum temperature in the range of 27-31⁰C with R.H. upto 91% favour disease incidence (November and December). Increase of R.H. by 1% increased disease incidence by 2.4% and increase of temperature by 1⁰C decrease the disease by 4.4%.

Management

- Clean cultivation of vines or removal and destruction of all diseased parts
- Dustings of vines with 300 mesh Sulphur (1st when new shoots are 2 weeks old, 2nd prior to blossoming, 3rd when the fruits are half ripe).
- Prophylactic spray with B.M. 1% or Lime sulphur at dormant stage delays development of disease by decreasing initial inoculum.
- Spray wettable sulphur @0.3% or karathane or calixin @0.1%
- Morestan @0.03% sprayed at 4 days interval starting from last week of December to 1st week of March
- Grow resistant varieties like Chholth Red, Chholth white, Skibba Red, Skibba White, etc.

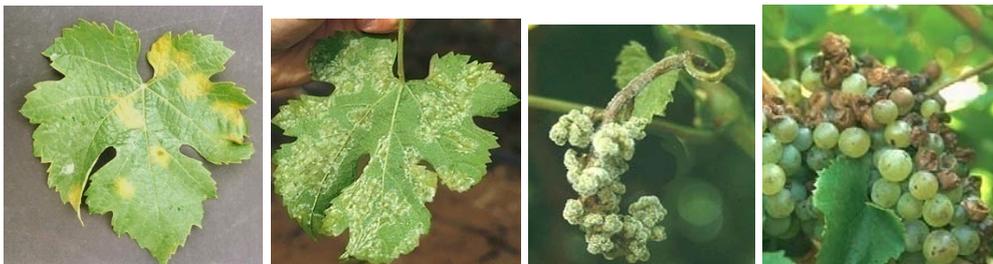
2. Downy mildew: *Plasmopara viticola*

Economic importance

- Since 1875, this disease caused heavy losses in France to wine industry.
- It led to discovery of B.M. by Prof. Millardet in 1885.

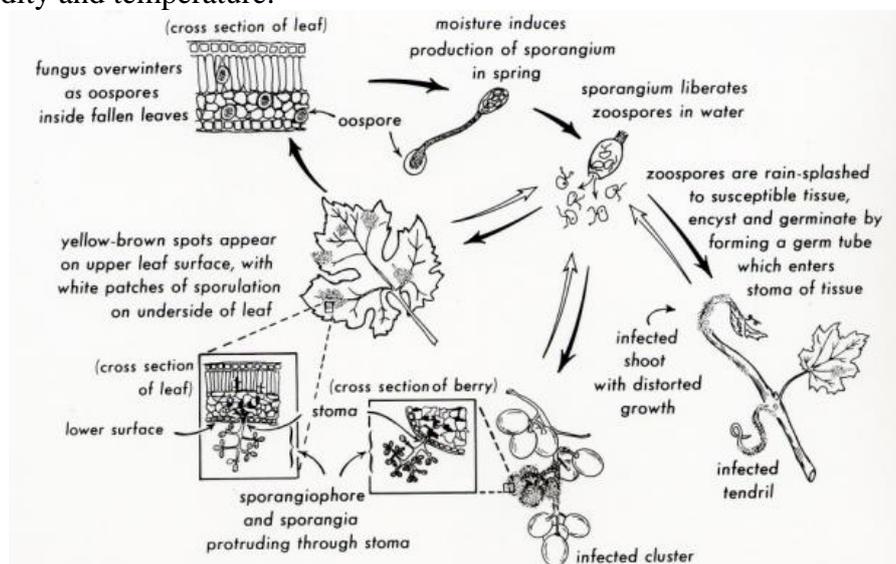
Symptoms

- Sym,ptoms appear on all aerial and tender parts of the vine. Symptoms are more pronounced on leaves, young shoots and immature berries.
- Irregular, yellowish, translucent spots on the upper surface of the leaves.
- Correspondingly on the lower surface, dirty white, powdery growth of fungus appears.
- Affected leaves become, yellow and brown and gets dried due to necrosis
- Premature defoliation.
- Dwarfing of tender shoots.
- Infected leaves, shoots and tendrils are covered by whitish growth of the fungus.
- White growth of fungus on berries which subsequently becomes leathery and shrivels. Infected berries turn hard, bluish green and then brown.
- Later infection of berries results in soft rot symptoms. Normally, the fully grown or maturing berries do not contact fresh infection as stomata turn non-functional.
- No cracking of the skin of the berries.



Pathogen: *P. viticola* is a biotroph. The intercellular mycelium of the fungus is coenocytic, thin-walled, hyaline, and produce spherical or pear shaped haustoria.

Sporangiophores arise from hyphae under high humid conditions. The branching of the sporangiophores is at right angles to the main axis and at regular intervals. From the apex of each branch 2-3 sterigmata arise and bear lemon shaped, papillate sporangia. Sporangial germination may be through zoospores or by germ tube based on humidity and temperature.



Spread and survival

- Sporangia or zoospores by wind, rain etc.
- Oospores present in the infected leaves, shoots and berries. Also as dormant mycelium in infected twigs.

Favourable conditions

- Optimum temperature : 20-22°C
- Relative humidity : 80-100 per cent

Management

- Collect and burn fallen leaves and twigs
- Sanitation of the orchard
- Vine should be kept high above ground to allow circulation of air by proper spacing
- Pruning (April- may & September and October) and burning of infected twigs
- Grow resistant varieties like Amber Queen, Cardinal, Champa, Champion, Dogridge and **Red Sultana**
- The disease can be effectively managed by giving 3-5 prophylactic sprays with 1% B.M or Fosetyl -Al (Aliette) 0.2% or metalaxyl + mancozeb 0.3 to 0.4% or Azoxystrobin or Dimethomorph
- Chemical -5 sprays with 1% B.M.
 - 1 – Immediately after pruning of vines
 - 2 - When new flush formed (3-4 weeks after pruning)
 - 3 – Before buds open
 - 4 - When bunches or berries have formed
 - 5 – During growth of shoots

3. Anthracnose / Birds eye disease: *Elsinoe ampelina* (I.S: *Gloeosporium ampelophagum* or *Sphaceloma ampelinum*)

It is especially serious on new sprouts during rainy season. Among various foliar diseases of grapevine in India, anthracnose has longest spell spread over the period from June to October

Symptoms

- Visible on leaves, stem, tendrils and berries.
- Young shoots and fruits are more susceptible than leaves.
- Circular, greyish black spots or red spots with yellow halo appear.
- Later the centre of the spot becomes grey, sunken and fall off resulting in a symptom called 'shot hole'.
- Black, sunken lesions appear on young shoots.
- Cankerous lesions on older shoots. Girdling and death of shoots occur.
- Infection on the stalk of bunches and berries result in the shedding of bunches and berries respectively.
- Sunken spots with ashy grey centre and dark margin on fruits (Birds eye symptom). In warm and wet weather pinkish spore mass develop in the centre of the spots
- Mummification and shedding of berries.



Etiology

- Anamorph – *Gloeosporium ampelophagum*, produce hyaline, single celled conidia.
- Teleomorph - *Elsinoe ampelina*, Produces hyaline 4 celled ascospores

Mode of spread and survival

- Survives as dormant mycelium in the infected stem-cankers
- Secondary spread is by means of conidia formed in the leaf and other plant parts which are easily disseminated by wind and splashed rain. Continuous drizzle of rain for 2-3 days encourages the disease. No infection can take place in the absence of rain. Wind associated with warm atmosphere (temp.) and heavy rains favour the disease spread.

Favourable conditions

- Warm wet weather
- Low lying and badly drained soils.
- Anab-e-shahi is susceptible.

Management

- Removal of infected twigs
- Selection of cuttings from disease free areas and dipping them in 3% **FeSO₄ solution** for ½ an hour before planting.
- Spraying Bordeaux mixture 1% or COC@ 0.2% or [carbendazim@0.1%](#).

- Grow resistant varieties like Bangalore blue, Golden muscat, Golden queen and Isabella.

4. **Alternaria leaf spot:** *Alternaria vitis*

Symptoms

- Appearance of patches mostly along the margin of leaves
- Individual spots appear rarely in the middle of the leaves
- In the initial stage, minute, yellow spots appear on the upper surface of leaves
- Later, spots enlarge and form brownish spots with concentric rings in them
- In severe cases of attack, leaves dry completely and defoliation occurs

Mode of spread and survival

- Survives as mycelium or conidia in infected plant debris
- Spreads through air borne conidia

Favourable conditions

- High humidity
- High rainfall and dew
- Heavy dosage of N₂ fertilizers

Management

- Destruction of crop debris
- Selection of disease free seed
- ST with mancozeb@2g/kg seed
- Foliar spray of [mancozeb@0.25%](#)

5. **Bacterial leaf spot:** *Pseudomonas viticola*

- First reported from S.V. Ag. College, Tirupati (1969 – 70).
- Anab-e shahi & Thomson seed less varieties are highly susceptible

Symptoms

- Symptoms appear on foliage and twigs
- Initially yellowish, circular, translucent spots develop along the midrib and veins of leaves
- **Necrotic areas along midrib & veins is the characteristic symptom**
- Leaves turn yellow, shriveled and shed pre-maturely

Disease cycle

- P.I: Mainly from infected twigs. Bacterium survives in the soil on plant debris.
- S.I Through wind splashed rain.



Management

- Prune out and destroy infected plant debris
- Spraying antibiotics like streptomycin 100 ppm along with copper fungicides

6. Rust: *Phakopsora vitis*

GLR is common throughout South-East Asia and other parts of the world. Cultivar **Black prince** is highly susceptible

Symptoms

- The presence of clustered, small, yellow to orange, powdery spores on the underside of mature grapevine leaves. Small, dark spots also appear on the upper surface.
- Under severe infection, the entire leaf surface is covered by sori and premature defoliation occurs
- The disease eventually lead to weakening of the vine due to poor shoot growth
- Reduction in quantity and quality of fruit.

Disease cycle

- P.I: Teliospores
- S.I: Uredospores
- GLR affects *Vitis* spp., including commercial and some ornamental grape varieties. It has also been found on native *Ampelocissus* species

Management

Spray [zineb@0.2%](#) or dust sulphur@25Kg/ha

LECTURE 6

DISEASES OF APPLE

1) Scab – *Venturia inaequalis*

- First reported from Sweden (1819)
- First reported on Ambri variety in Kashmir valley (1935)

Symptoms

- Scab infections usually noticed on leaves and fruits
- +Affected leaves become twisted or puckered and have [black, circular spots](#) on their upper surface.
- On the [under surface of leaves](#), the spots are velvety and may coalesce to cover the whole leaf surface
- Severely affected leaves may turn yellow and drop
- Scab can also infect [flower stems](#) and cause flowers to drop



- [Scabby spots](#) on fruit begin as sooty, gray-black lesions and may have a white or red halo
- The lesions later become sunken and tan and may have spores around their margins
- Infected fruit become distorted and may crack, allowing entry of secondary organisms
- Severely affected young fruit may drop

Mode of survival and spread

- P.I: Ascospores formed from pseudothecia
- S.I: Wind borne conidia

Management

- Clean cultivation
- **Resistant varieties:** Emira, red free, Ambstraking, Ambroyal, Ambrich and Ambred
- Spray [captan@0.2%](#) or [dodine@0.25%](#) at short intervals after petal fall
- Single application of [difolaton@0.3%](#) at green bud stage followed by [captan@0.2%](#) at petal fall
- **Spray schedule**
 - 1st spray - Silver tip stage - 0.2% captan (or) 0.3% mancozeb
 - IInd spray pink bud - 0.2% captan (or) 0.3% mancozeb
 - IIIrd spray at petal fall - 0.5% carbendazim
 - IVth spray - after 10 days - 0.2% captan
 - Vth spray - 15 days after - mancozeb 0.3%

- Fruit set - 0.15% captafol

2) Powdery mildew – *Podosphaera leucotricha*

Symptoms

- Appear soon after the buds develop into new leaves and shoots
- Small patches of white or grey powdery masses on under surface of leaves
- Leaves grow longer and narrower than normal leaves and the margin is curled
- Twigs covered with powdery mass
- Affected fruits remain small and deformed and tend to develop roughened surface
- In nursery plants, formation of wood is affected



Mode of survival and spread

- P.I: Mycelium in diseased vegetative buds and fruits
- S.I: Wind borne conidia

Management

- Sanitation of orchard
- Pre-bloom spray of lime sulphur (1:60)
- Spray [dinocap@0.05%](#) or Wettable S
- Resistant varieties: Maharaja chunth and Golden Chinese (apple cultivars), Yantarka Altaskya, Dolgoe (Crab apple cultivars)

3) Fire blight of apple

Symptoms

- All above ground tissues including blossoms, fruits, shoots, branches, and in the rootstock near the graft union on the lower trunk are affected
- **Blossom clusters and young shoots:** Blossom symptoms are first observed 1-2 weeks after petal fall. The floral receptacle, ovary, and peduncles become water soaked and dull, grayish green in appearance. Later these tissues shrivel and turn brown to black.
- **Shoot symptoms:** Tips of shoots may wilt rapidly to form a "shepherd's crook". Leaves on diseased shoots often show blackening along the midrib and veins, before becoming fully necrotic.



- Numerous diseased shoots give a tree burnt and blighted appearance

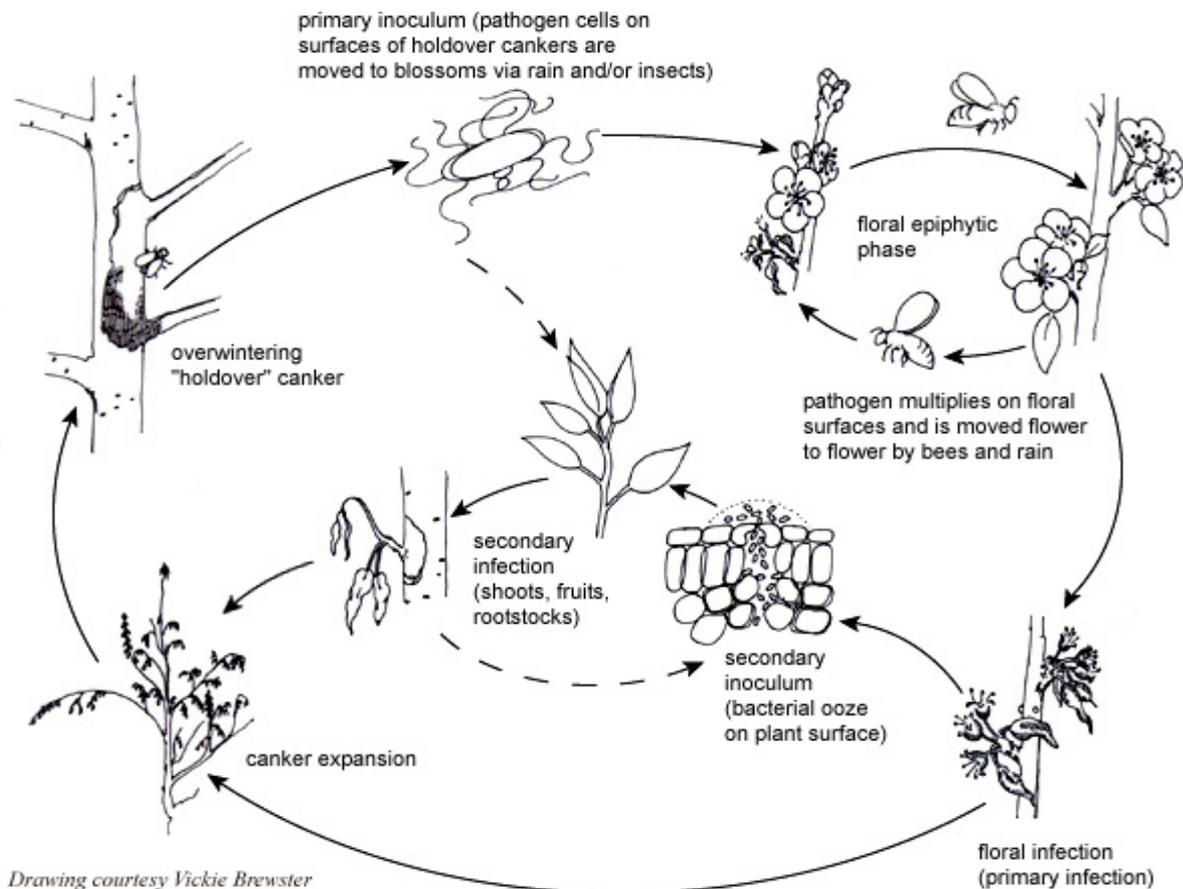
- Bark on younger branches becomes darkened and water-soaked. At advanced stages, cracks will develop in the bark, and the surface will be sunken slightly.
- Wood under the bark will show streaked discolorations. Similar symptoms can be observed in infected apple rootstocks
- Infected small immature fruit becomes water soaked, then turn brown, shrivel, turn black and cling to the tree for several months after infection
- Droplets of milky coloured, sticky ooze may appear on infected parts which usually turns brown on exposure to air

Survival and spread

- The bacteria overwinter at the margins of the cankers and possibly in buds and apparently healthy woody tissue
- Insects such as bees, flies and ants spread the bacteria to the flowers

Management

- During winter prune out and burn blighted twigs, branches and cankers, and even whole trees, at about 30cm below the point of visible infection
- Disinfect the tools after each cut with 10% sodium hypochlorite
- Insect control
- Resistant varieties
- Dormant sprays with copper sulphate or bordeaux mixture, however, bordeaux mixture or streptomycin are the only effective blossom sprays



4) Crown gall – *Agrobacterium tumefaciens*

Symptoms

- Small outgrowths on stem and roots near soil line
- Galls are spherical, white or flesh coloured (young stage)
- Galls become hard and corky on woody stems, knobby and knotty
- Affected plants stunted with chlorotic leaves



Management

- Regulatory measures
- Crop rotation with maize or other grain crops
- Avoid injuries to roots or lower stem parts
- Penicillin or vancomycin - partial control
- *Agrobacterium radiobacter* (Strain K1026) (No gall) applied to fresh wounds.

LECTURE 7

DISEASES OF CHILLI

1) **Damping off** – *Pythium aphanidermatum*, *P. debaryanum*, *P. ultimum*, *Fusarium* and *Rhizoctonia*

- Disease of nursery beds and young seedlings resulting in reduced seed germination and poor stand of seedlings.
- 25-75% loss

Symptoms

- ❖ Pre-emergence damping off: Seedlings disintegrate before they come out of soil surface. This is known as pre-emergence damping-off which results in poor field emergence / poor seed germination.
- ❖ Post-emergence damping off is characterised by development of disease after seedlings have emerged out of soil surface but before the stems are lignified.
 - Lesion formation at collar region
 - Infected areas appear brown and water soaked
 - Plants shrivel and collapse as a result of softening of tissues
 - Infected stems become hard, thin (Wire stem symptoms) and infected seedlings topple. Disease appear in patches both in nursery and field beds.

Disease cycle

- P.I: Oospores in soil or plant debris
- S.I: Zoospores through irrigation water

Favourable conditions

- Heavy rainfall
- Excessive and frequent irrigation
- Poorly drained soil and close spacing
- High soil moisture with temp around 25-30° C
- *P. aphanidermatum*, prefer temp above 20° C
- *P. debaryanum*, *P. ultimum*, prefer cool temp (<20° C)

Management

- Raise nursery in light soil with proper drainage
- Burning farm trash on the surface of the beds.
- Sowing seed on raised beds of 6-8” high (15cm)
- **Using low seed rate of 650 g/cent.**
- Seed dressing with Argosan or ceresan or Thiram or captan @ 2-3 g/Kg.
- Soil drenching with 1% Bordeaux mixture or COC@ 0.3% or [metalaxyl@0.2%](#)
- Biocontrol with *Trichoderma viride* and *Trichoderma harzianum*

2) **Die-back and fruit rot** – *Colletotrichum capsici* (Tel: *Glomerella cingulata*)

- Severe in Guntur and Krishna districts

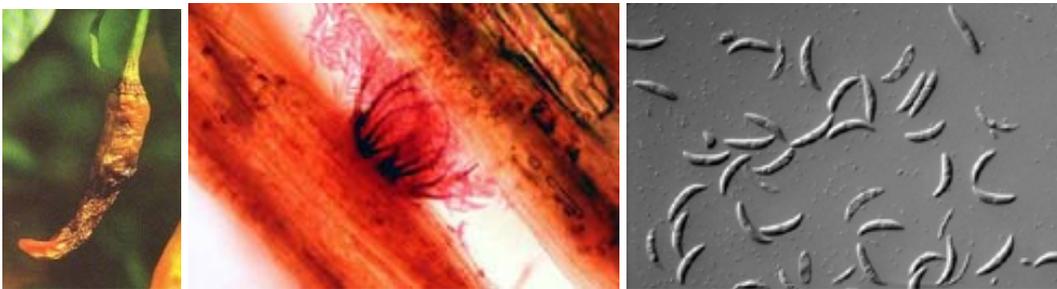
Symptoms

- December - October in transplanted crop
- Small, circular to irregular, brownish black scattered spots appear on leaves

- Severely infected leaves defoliate
- Infection of growing tips leads to necrosis of branches from tip backwards
- Necrotic tissues appear grayish white with black dot like acervuli in the center
- Shedding of flowers due to the infection at pedicel and tips of branches

Fruit symptoms

- Ripe fruits are more liable for attack than the green ones
- Small, circular, yellowish to **pinkish sunken spots** appear on fruits
- Spots increase along fruit length attaining elliptical shape
- Severe infection result in the shrivelling and drying of fruits.
- Such fruits become white or greyish in colour and lose their pungency.
- On the surface of the lesions minute black dot like fruiting bodies called '**acervuli**' develop in **concentric rings** and fruits appear straw coloured
- The affected fruits may fall off subsequently. The seeds produced in severely infected fruits are discoloured and covered with mycelial mat.



Pathogen: The mycelium is septate and grows both inter and intracellularly in the host tissue. The asexual fruiting bodies, acervuli contain many rigid, brown coloured, 1-5 septate setae. A large number of conidia are borne on conidiophores in each acervulus which are falcate, unicellular, hyaline having a normally truncated base.

Disease cycle

- P.I: Infected seeds and diseased crop debris
- S.I: Conidia dispersed by rain splash and wind

Favourable conditions

- Temp, 28⁰ C with RH more than 97%
- Humid weather with rainfall at frequent intervals

Management

- Collect and destroy all infected plant parts
- Collect seeds only from fruits without infection
- Removal and destruction of Solanaceous weed hosts and infected plant debris
- Seed treatment with captan or Thiram 3-4g/kg
- Spray thrice with [captan@1.5%](#) or [mancozeb@0.25%](#). just before flowering, at fruit formation stage and 15 days after second spray.
- Resistant varieties: **G3, G4, B61, Lorai, etc.**

3) Choanephora blight /Wet Rot (*Choanephora cucurbitarum*)

Symptoms:

- The pathogen attacks flowers, buds and tender young shoots.
- This disease produces a blossom blight as well as a fruit rot stage and occasionally a leaf blight.
- Blossoms exhibit a lack of turgidity as petals begin to wilt.
- Luxuriant growth of the pathogen is seen on infected portion which appears as black pin heads or Stiff whisker-like strands of the causal fungus, topped with black heads (sporangia) grow off the infected blossoms causing a blossom drop.
- Young fruit may become infected, soften and abort with the black fungal growth apparent on the fruit.

Management:

- A dopt recommended spacing to maintain adequate air circulation.
- Select the seeds from healthy fruits and treat the seed with captan or thiram@3g/kg seed
- Spray [Mancozeb@0.25%](#) or Copper oxy chloride@0.3%
- Grow resistant varieties like Seoul hot, Liachi-2, AT-Good, etc.

4) Mosaic complex

- Chilli mosaic virus, Potato Virus Y, Cucumber Mosaic Virus (CMV), Tobacco Mosaic Virus (TMV) and Tomato spotted wilt virus

Symptoms: Symptoms vary with the infected virus

TMV:

- Backward bending of petiole
- Raised blisters and mottled areas of light and dark green areas on the foliage
- Leaves point towards ground.
- Necrotic spots on stem.
- Fruit ripens unevenly and is reduced in size

CMV

- Downward curling along with midrib
- Most plants exhibit some degree of "shoestringing" (narrowing of the leaves) in addition to stunting, yellowing, and whitish spotting of the leaves.
- Fruit may be small and distorted.

PVY

- Vein banding
- Small, crinkled leaves.

Spread

- Sap transmissible (TMV)
- Aphids: *Myzus persicae*, *Aphis gossypii*, *A. craccivora*

Tomato Spotted Wilt Virus. The disease affects late-maturing pods, reducing yield. This virus occurs throughout temperate and subtropical regions and infects a diverse group of plant species from tomatoes and peppers to peanuts, lettuce, pineapple and many ornamentals. The virus is transmitted from diseased to healthy plants by **thrips**. The virus overwinters in perennial weeds.

Symptoms: The disease is most commonly recognized by the symptoms on the fruit. Both green and red fruit can be infected. Infected green pods display small, off-colored spots. Red fruit exhibit patches of yellow that never turns red. Other fruit symptoms include **chlorotic and necrotic spotting, concentric ring patterns**, and distortion. Foliage symptoms include general mosaic, chlorotic ring spots, and deformation. In some cultivars, the **shoot terminals die** and leaves defoliate. When new growth develops, it is severely distorted. Plants infected at an early age are stunted severely.

Managemet

- Select healthy seed for planting
- Crop rotation with non-hosts
- Control perennial weed hosts.
- Rogue out and destroy infected plants in early stages of infection
- Grow disease tolerant varieties like Bhagyalakshmi, Bhaskar and LCA 305
- Soak the seed in Trisodium orthophosphate (Na_3PO_4) solution (150g/lt) for 30 min prior to sowing
- Growing barrier crops like sorghum or maize (2-3 rows) around chillies to reduce the disease incidence.
- Cover the seed bed with nylon net or paddy straw
- Spray seedlings in nursery with [monochrotophos@1.5ml/lt](#) or dimethoate@2ml/lt before transplantation in the main field.
- Apply carbofuran granules@10-12kg/acre in the main field or spray with [monochrotophos@1.5ml/lt](#) or dimethoate@2ml/lt

5) Powdery mildew – *Leveillula taurica*

- Usually seen from December - February

Symptoms

- White powdery coating appears mostly on the lower surface
- Sometimes the powdery coating can also be seen on the upper surface.
- Correspondingly on the upper surface yellow patches are seen
- Severe infection results in the drying and shedding of affected leaves.
- Powdery growth can also be seen on young fruits, and branches.
- Diseased fruits do not grow further and may drop down.

Disease cycle

- P.I: Dormant mycelium in the infected crop debris.
- S.I: Air-borne conidia

Favourable conditions

- Cool dry weather favours conidial germination
- High RH favours disease development

Management

- Spraying wettable S@0.3% or Dinocap or Carbendazim or Tridemorph 0.1%.

6) Cercospora leaf spot – *Cercospora capsici*

- October - November and continues up to February

Symptoms

- Circular spots with brown margins appear on leaves
- The spots enlarge and coalesce with others
- The central portion of the spot becomes white and the leaves turn yellow and defoliate
- Sometimes central portion of spot drops off
- Spots also appear on stems and twigs as dark brown, irregular lesions with whitish centers
- In severe cases die-back of twigs occur

Disease cycle

- P.I: Dormant mycelium in infected plant debris, infected seeds and volunteer plants
- S.I: Wind borne conidia.

Management

- ST with carbendazim@2g/kg seed
- Spray [carbendazim@0.1%](#) or [Difolaton@0.3%](#) at 15 days interval

7) Bacterial leaf spot: *Xanthomoas campestris pv. vesicatoria*

Symptoms

- Leaves, fruits and stems are affected
- Lesions on leaf begin as circular, water soaked spots
- Spots become necrotic with brown center with chlorotic borders
- Enlarged spots may develop straw coloured centres
- Lesions are slightly raised on lower leaf surface
- Severely spotted leaves turn yellow and drop
- Raised brown lesions appear on fruits
- Narrow elongated lesions or streaks may develop on stems

Mode of survival and spread

- The bacterium is seed borne
- Spread by rain splash

Management

- Seeds should be collected from healthy fruits,
- Seed treatment with copper oxychloride 2g/kg seed.
- Spray twice with Agrimycin (100 ppm) or plantomycin (200ppm) along with 3g COC per litre of water at 15 days interval

LECTURE 8

DISEASES OF BRINJAL

1) Little leaf – Phytoplasma

Symptoms

- Small or little leaves.
- The petioles are so short that the leaves appear to be sticking to the stem.
- Affected plants have narrow, soft, smooth and yellow shorter leaves.
- Newly formed leaves are much shorter.
- Internodes of the stem are also shortened.
- Axillary buds get enlarged but their petioles and leaves also remain shortened giving the plant a bushy appearance.
- Mostly there is no flowering but if flowers are formed they remain green.
- Fruiting is rare, if any fruit is formed, it becomes hard, tough and fails to mature. Young fruit turns necrotic, get mummified and cling to the plant



Pathogen: the disease is caused by phytoplasma having ovoid to spherical body which is concentrated in the phloem sieve tubes.

Spread

- The pathogen perennates in weed hosts
- Jassid - *Hishimonas phycitis*. The disease is also transmitted by *Empoasca devastans*, however, it is a less efficient vector.
- The varieties pusa purple long and selection T are highly susceptible
- Collateral hosts: *Datura fastuosa*, *D. stramonium*, *Vinca rosea*, *Argemone mexicana*, **chilli, tomato and tobacco**

Management

- Tolerant variety: **Pusa Purple Round, Pusa purple cluster and Arka sheel**
- Destruction of affected plants
- Eradication of solanaceous weed hosts
- Spray methyl demeton, 2 ml/l or Malathion 3 ml/l or soil application of phorate granules.
- Seed dip in tetracyclines (10-50ppm)

2) Bacterial wilt – *Ralstonia solanacearum*

Symptoms

- Sudden wilting and death of infected plants is the characteristic symptom. The petiole of older leaves droop down and the leaves show epinasty symptoms accompanied by yellowing and stunting of whole plant.

- Typical browning of vascular tissues of roots and stems can be seen
- From cross sections of infected plants whitish bacterial exudate comes out.

Pathogen: the bacterium is Gram negative motile rod having rounded ends with 1-4 polar flagella. Race 1 of *R. solanacearum* affects solanaceous plants such as tomato, egg plant and many other non-solanaceous plants also.

Mode of survival and spread

- The bacterium is both soil and seed borne in nature and overwinters in infected plant parts, in wild host plants and weeds.
- Spread through irrigation water or infested soil and agricultural implements.

Favourable conditions

- Relatively high soil moisture and soil temperature favour the disease development.

Management

- Grow resistant varieties like **Pant Samrat**, Arka Nidhi, Arkas Kashav, Arka Neelakantha, Surya and BB 1, 44 & 49.
- Crop rotation with non solanaceous hosts
- Green manuring with *Brassica* species (Biofumigation)
- Soil solarization with a transparent polyethylene sheet (125 µm thick) for 8-10 weeks during March-June
- Biological control with *Pseudomonas fluorescens*, *P. glumae*, *P. cepacia*, *Bacillus sp.* & *Erwinia sp.*

3) Phomopsis fruit rot or blight – *Phomopsis vexans* (P.S: *Diaporthe vexans*)

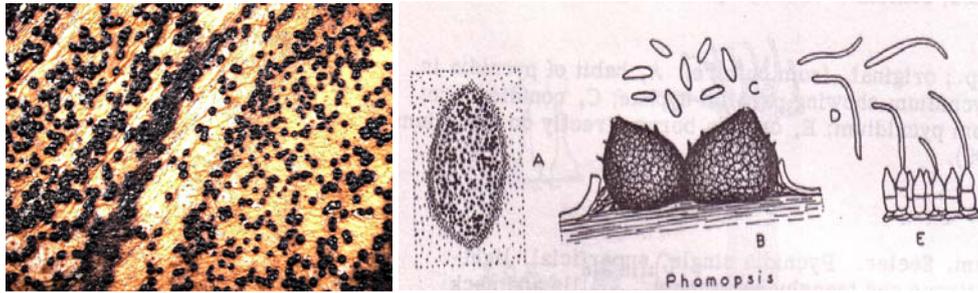
The disease is severe in tropical and sub-tropical areas of the world. In India, it was reported in 1935 in Gujarat. The pathogen attacks foliage and fruits, but the latter phase is more destructive.

Symptoms

- The plants are attacked at all stages of growth, producing damping-off symptoms in nurseries and collar rot on young plants
- On leaves, circular to irregular, clearly defined grayish brown spots having light centers appear. The diseased leaves become yellowish in colour and may drop off. **Several black pycnidia** can be seen on older spots.
- The lesions on stem are dark brown, round to oval and have grayish centers where pycnidia develop. At the base of the stem, the fungus causes characteristic constrictions leading to canker development and toppling of plants.
- On fruits, small pale sunken spots appear which on enlargement cover entire fruit surface. These spots become watery leading to soft rot phase of the disease. A large number of dot like pycnidia also develop on such spots.
- The infection of fruit through calyx leads to development of dry rot and fruits appear black and mummified.

Pathogen: The mycelium of the pathogen is septate and hyaline becoming dark with age. Pycnidia are submerged and later becoming erumpent with a prominent ostiole. Conidia are produced on simple to branched conidiophores and are of 2 types: Alpha conidia, which are sub cylindrical and beta conidia, which are filiform and curved. Role of beta-conidia in the epidemiology of the disease is not very clear. The perfect

stage produces perithecia in which asci with 8 hyaline, bicelled, ellipsoid-fusoid ascospores are produced which are usually constricted at septum.



Mode of survival and spread

- P.I: Pathogen is seed borne and also survives in plant debris as mycelium and pycnidia.
- S.I: Conidia dispersed through rain splashes, irrigation water, agricultural tools and insects.

Favourable conditions

- High relative humidity coupled with higher temperatures favour disease development. Maximum disease development takes place at about 26⁰C under wet weather conditions with 55% R.H.

Management

- Removal and destruction of diseased crop debris
- Practicing crop rotation and summer ploughings helps in reducing initial inoculum.
- Use of disease free seed
- Hot water treatment of seed at 50⁰C for 30 minutes
- Seed treatment with thiophanate methyl at 1g/kg seed
- Spray twice with thiophanate methyl or [carbendazim@0.1%](#) at 20 days interval.

DISEASES OF BHENDI

1) Yellow vein mosaic: *Bhendi Yellow vein mosaic virus or bhendi vein clearing virus*

Symptoms

- Yellowing of the entire network of veins in the leaf blade (vein clearing) is the characteristic symptom. In severe infections the younger leaves turn yellow, become reduced in size and the plant is highly stunted.



- In a field, most of the plants may be diseased and the infection may start at any stage of plant growth.

- Infection restricts flowering and fruits are not formed, if formed, turns smaller, harder and rough. Loss in fruit yield ranges from 50-100% based on disease incidence

Disease cycle

- P.I: Infected plant parts
- S.I: The virus is transmitted by the **whitefly**, *Bemisia tabaci*.

Management

- **Tolerant varieties:** **Parbhani Kranti**, Pusa savani, Janardhan, Haritha, Arka Anamika and Arka Abhay
- The disease spread can be restricted by spraying Monocrotophos, 1.5 ml/l.

2) Cercospora leaf spot: *Cercospora malayensis*, *C. abelmoschi*

- *C. malayensis* causes brown, irregular spots and *C. abelmoschi* causes **sooty black, angular spots** on lower surface of leaves
- Both the leaf spots cause severe defoliation and are common during humid season.

Disease cycle

- P.I: The fungi survive through conidia and stromata on crop refuse in soil.
- S.I: Air borne conidia

Management

- Spray mancozeb or [zineb@0.2%](#) or [carbendazim@0.1%](#) for disease control a month after sowing and repeat at fortnightly intervals based on disease incidence.

3) Powdery mildew: *Erysiphe cichoracearum*

Symptoms

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

Management

- Dust finely ground sulphur at 30 kg/ha or spray wettable [sulphur@0.3%](#) or [Dinocap@0.1%](#) , three to four times at 15 days intervals.

LECTURE 9

DISEASES OF POTATO

1) Late blight – *Phytophthora infestans*

- Usually infection starts in **6 weeks** old plants
- First reported from Andes mountains of South America
- In India, the disease was first reported in Darjeeling district in India (1880)

Symptoms

- Initially starts from leaf tips or margins and spread inward
- Small faded green patches on upper surface of leaf which turn into brown spots
- Downy growth of the pathogen on subsequent lower surface
- Progressive defoliation and collapse of plants under favourable conditions
- Water soaked stripes on stem which becomes necrotic
- Purplish brown spots appear on skin of tubers
- On cutting, the affected tubers show rusty brown necrosis spreading from surface to the centre
- Decay of plant parts under favourable weather which emits foul smell



Disease cycle

- P.I: Infected potato tubers or oospores
- Collateral host: Tomato (*Lycopersicon esculentum*), Pepper and egg plant.
- S.I: Conidia dispersed by wind or water

Favourable conditions

- Cool moist conditions
- RH: >90% and with suitable temperature (12-24⁰ C)

Dutch rules

- Night temperature below the dew point for 4 hours or more
- Night temperature not below 10°C
- Cloudiness on the next day.
- Rainfall at least 0.1mm on the following day

Management

- Regulatory measures
- Select healthy tubers for planting
- Delayed harvesting
- High ridging to about 10-15cm height reduces tuber infection
- Grow resistant varieties such as **Kufri Jyothi, Kufri Badshah, Kufri Jeevan, Kufri Sherpa**, etc.
- Resistant sources: *Solanum demissum* and *S. phureja*

Prophylactic measures

- Metalaxyl (0.1%) or Mancozeb (0.25%) or chlorothalonil (0.2%) or BM (1%) can be applied at 7 to 10 days intervals in the hills and 10 to 15 days intervals in plains.
- Dip sprouted tubers in 0.2% metalaxyl for 30 min

2) Common scab – *Streptomyces scabies*

- Important in Punjab and Himachal Pradesh



Symptoms

- Small brownish and slightly raised spots on tubers
- Spots enlarge, coalesce and become corky
- Lesions typically possess a raised margin and slightly depressed center
- Characteristic symptoms have descriptive names:
 - **Russet scab** appears on tubers as superficial tan to brown [corky lesions](#)
 - **Pitted scab** is characterized by lesions with [depressions](#) beneath the tuber surface
 - **Raised scab** appears as cushion like warty lesions

Survival and spread

- P.I: Soil and infected tubers
- S.I: Soil, water, wind blown soil and infected tubers
- Pathogen enters through unsubsized lenticels or wounds

Epidemiology

- **Soil pH (5.2-8.0)**
- Soil temperature of 20-22⁰ C
- Low soil moisture

Management

- Use of disease free tubers
- Crop rotation with wheat-oat or potato-onion-maize (4yrs)
- Hold the soil pH at about 5.3 by addition of sulphur
- Green manuring before planting potato
- Dipping of infected tubers in 3% boric acid for 30 min
- Soil application of PCNB

3) Wart – *Synchytrium endobioticum*

- Losses seen in temperate regions
- In India, the disease is restricted to Darjeeling

Symptoms

- Host cells at the point of infection are **hypertrophied**
- White granular swellings form on the eyes of tubers
- White tumour like outgrowths, called as warts, develop on stems and tubers
- As the crop matures, warts become black and rot

- Infected axillary bud or the leaf is transformed into cock's comb like greenish yellow outgrowth



Disease cycle

- P.I: Resting sporangia in soil
- S.I: Zoospores dispersed by water

Favourable conditions

- High soil moisture
- Optimum temperature of 21⁰ C (12 to 28°C)
- Slightly acidic to neutral pH

Management

- Strict quarantine measures
- Grow resistant varieties such as **kufri Jyoti**, **kufri Jeevan** and **kufri Muthu**

4) Black leg (Soft rot) – *Erwinia caratovora* subsp. *caratovora*

- Introduced into India through seed stocks from Italy



Symptoms

- Disease occurs in two phases – Blackleg of shoots and soft rot of tubers

Blackleg

- Plants are stunted with a stiff, erect growth habit.
- Foliage becomes chlorotic and the leaflets tend to roll upward at the margins.
- Stems of infected plants exhibit an inky [black decay](#).
- The base of the stem is often completely rotted.
- Plants may wilt.
- In relatively dry soil, only the pith may show blackening

Soft rot symptoms

- Soft rot include rotted tissues that are wet, cream to tan in color, and soft.
- Rot begins on the tuber surface and progresses inward.
- Infected tissues are sharply delineated from healthy tissue by dark brown or [black margins](#).

- Shallow necrotic spots on the tubers result from infections through lenticels
- Rotting tissue is usually odorless in the early stages of decay, but develops a foul odor as secondary organisms invade infected tissue.
- Soft rot also infects wounded stems and roots

Survival and spread

- Survive in diseased and contaminated tubers
- Spread through contaminated soil, tubers and maggot flies

Favourable conditions

- High humidity (94 – 100%)
- Temperature (21 – 29⁰ C)
- Late blight and *Fusarium* tuber rot infections predispose soft rot

Management

- Remove all debris from warehouses and disinfect the walls with formaldehyde or copper sulphate
- Avoid wounding of plants and storage organs
- Products to be stored should be dry, and the humidity and temperatures of warehouses should be kept low
- Crop rotation with cereals
- Crop should be planted in well drained areas and at sufficient distances to allow adequate ventilation
- Insect control
- Dip cut seed pieces of potato in a solution of Streptocycline 100ppm and CuSO₄ 40ppm for 30 min

5) Brown rot – *Ralstonia solanacearum*

- **First bacterial disease reported in India**
- First recorded in 1891 from Pune district of Maharashtra
- Also referred as bacterial wilt or ring disease or bangle blight
- Occurs in Deccan and Central plateau, Assam, West Bengal, Orissa, hills of Uttar Pradesh and Nilgiris

Symptoms

- Wilting, stunting and yellowing of foliage followed by collapse of entire plant
- Browning of xylem in vascular bundles
- Stems, petioles of the lower leaves and roots become brown and on cutting of infected materials slimy mass of bacteria oozes out
- Brown ring is formed in the tubers due to discolouration of vascular bundles (ring disease)
- Formation of pockets or cavities around vascular bundles in the pith and cortex
- When pressed slimy bacterial ooze emerge.
- The tubers may rot at harvest or during storage.

Survival and spread

- Survive in infected soil and seed tubers
- Spread through wind blown soil and water
- Infection occurs through wounds

Favourable conditions

- High soil temperature (25-35⁰ C)
- Soil moisture >50%

Management

- Crop rotation with maize or soybean for 3 yrs
- Use disease free tubers for sowing
- Deep summer ploughing
- Treat seed tubers with 0.02% streptomycin for 30 min giving 4mm deep sharp cut
- Disinfection of cutting knives with sodium hypochlorite (10%) or mercuric chloride

6) Viral diseases

a) Mild mosaic/Interveinal mosaic – (Potato virus X) PV X

Symptoms

- Often referred as latent potato mosaic
- Light [yellow mottling with slight crinkling](#) on potato plants
- Interveinal necrosis of top foliage
- Stunting of diseased plants
- Leaves may appear slightly rugose where strains of PV Y combines



Spread

- Spreads mechanically through rubbing of leaves, contact of infected plants, seed cutting knives, farm implements.
- Root clubbing of healthy and diseased plants in field

Management

- Disease free seed tubers for planting
- Rouging of diseased plants

b) Severe mosaic – Potato virus Y (PV Y)

- Also called **potato leaf drop streak**

Symptoms

- Chlorotic streaks on leaves which become necrotic
- Necrosis of leaf veins and leaf drop streak
- Interveinal necrosis and stem/petiole necrosis
- Plant remain stunted in growth
- Rugosity and twisting of the leaves occurs in combination with PV X and PV A

Survival and spread

- Infected tubers
- Spread by aphids, *Myzus persicae* and *Aphis gossypii*

Management

- Disease free seed tubers for planting
- Rouging of diseased plants
- Aphid control

c) Leaf roll – *Potato leaf roll virus*

Symptoms

- Upward rolling of leaves, which have a stiff leathery texture
- Plants stunted and have a stiff upright growth
- Phloem necrosis of tubers in some varieties



Spread

- Infected seed tubers or by **aphids**

Management

- Disease free seed tubers for planting
- Aphid control

7) Potato spindle tuber – Viroid

Symptoms

- Plants appear erect, spindly and dwarfed
- Leaves small, erect and leaflets dark green
- **Tubers elongated with tapering ends**
- Tuber eyes are numerous and more conspicuous



Spread

- Infected seed tubers
- Mechanically spread by knives used to cut seed tubers

- Also transmitted by pollen and seed and contaminated mouth parts of grasshoppers, flea beetles and bugs

Management

- Use of PSTVd free potato seed tubers
- Disinfestation of cutting knives

LECTURE 10

DISEASES OF TOMATO

1) Early blight – *Alternaria solani*

Symptoms

- Small, isolated, scattered pale brown spots on the leaf
- Fully developed spots are irregular, brown to dark brown in colour, and with **concentric rings** inside the spot
- Spots coalesce to form large patches resulting in the leaf blight
- Lowest leaves are attacked first and the disease progresses upwards
- In severe attacks the entire plant may be defoliated
- Zonate lesions may also develop on **stems** and petioles, which break at the point of infection
- Brown spots are also seen on **calyx**
- Slightly dark, sunken, round to irregular lesions on fruit at the calyx end



Disease cycle

- P.I: Mycelium or conidia in infected plant debris
- S.I: Conidia dispersed by wind, water or rain splashes

Epidemiology

- Dry warm weather alternating with the intermittent rains
- Reduction in plant vigour and senescence

Management

- Maintain proper vigour of the plant
- Use of disease free seed
- Removal and burning of diseased crop debris
- [Mancozeb@0.25%](#) or [chlorothalonil@0.2%](#) or Zineb@ 0.25% spray at weekly intervals

2) Stemphylium leaf spot – *Stemphylium lycopersici*

Symptoms

- Small brownish **black specks** on the underside of leaves
- Later these specks develop on both leaf surfaces into grayish brown, glazed lesions of 3 mm or less in size
- On older leaves lesions dry up, crack and the centers drop out leaving a shot hole appearance.
- Yellowing of the leaf occurs followed by defoliation of the plant

Disease cycle

- P.I: Mycelium or conidia in infected plant debris
- S.I: Air borne conidia

Favourable conditions

- Warm, moist weather

Management

- Rouging and burning of infected plant debris
- Foliar application of [mancozeb@0.25%](#)

3) Septoria leaf spot – *Septoria lycopersici*

Symptoms

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

Disease cycle

- P.I: Infected plant debris or seed or Solanaceous weeds
- S.I: Rain splash, wind-blown water, insects and on hands and clothing's of tomato pickers

Favourable conditions

- High humidity or persistent dew at 25⁰ C
- Moist weather with intermittent showers

Management

- Crop rotation with non hosts
- Destroy infected crop debris
- ST with Mancozeb or zineb@2g/kg seed
- Spray [zineb@0.2%](#) or [mancozeb@0.2%](#) at 10 d interval
- Tomato line **PI 422397** is resistant

4) Tomato spotted wilt – Tomato Spotted Wilt Virus (TSWV)

Symptoms

- Symptoms vary among hosts and in a single host species
- **Stunting** is a common symptom of TSWV infection
- **Chlorotic or necrotic rings** form on the leaves of many infected hosts
- **Pale red or yellow areas with concentric circular marking** in the normal red skin of ripe tomato are formed
- Discoloration of seed
- Thickening of veins and **bronzing** of young leaves
- Growing tips may die-back and terminal branches may be streaked
- Affected plants may have a one sided growth habit or may be entirely stunted and have drooping leaves, suggesting a wilt



Mode of spread and Survival

- **Thrips**, *Frankliniella schultzei*, *Scirtothrips dorsalis*.
- Adult thrips transmit the disease, only when the larvae acquire the virus from infected plants.
- Collateral hosts: *Acanthospermum hispidum*, *Aster sp.*, *Boerhaavia diffusa*, *Chrysanthemum sp.*, *Cleome gynandra*, cowpea, *Dahlia variabilis*, egg plant, French bean, *Gerbera sp.*, groundnut, *Lagasca mollis*, lettuce, marigold, pea, **pepper**, pineapple, potato, *Trianthema portulacastrum*, water melon and *Zinnia elegans*.

Management

- Removal and destruction of infected plants & weed hosts
- Vector control with dimethoate or methyl demeton at 10 days interval
- Growing *Crotalaria juncea* as a barrier crop reduces vector migration
- Spraying of sorghum or coconut leaf extract

5) Tomato Mosaic – *Tomato mosaic virus*

Symptoms

- The virus causes a light and dark green mosaic mottle with raised dark green area and distorted crinkled younger leaves.
- The plants are stunted and leaves may be distorted to a **fan leaf or tendril like**
- The symptoms vary depending on the strain of the virus. Some strains cause yellowing or leaf mottling which may also affect the fruit.
- Some other strains produce **streak symptoms** consisting of longitudinal necrotic streaks on stem or petioles. Such diseased plants are killed
- **Necrotic sunken lesions also appear on fruits** and sometimes internal necrosis or browning of mature fruit occurs.

Mode of spread and Survival

- The virus is **seed borne** and is sap transmissible
- The virus is spread easily by man and implements in cultural operations or by animals and by leaf contact. Infection is through roots
- Collateral hosts: *Capsicum annum*, *C. frutescens*, *Chenopodium armanticolor*, *C. murale*, *C. quinoa*, *Cucumis melo*, *C. sativus*, *Cucurbita pepo*, *Datura metel*, *Lycopersicon pimpinellifolium*, *Nicotiana benthamiana*, *N. clevelandii*, *N. glutinosa*, *N. megalosiphon*, *N. rustica*, *N. tabacum*, *Petunia hybrida*, *Physalis floridana*, *P. peruviana*, *Vigna unguiculata*, brinjal, cowpea, French bean and night shade

Management

- All collateral hosts in the vicinity should be destroyed before planting new crop
- Rouge out and destroy diseased plants
- Virus free seed should be obtained and used for sowing
- Soak the seeds in 10% Tri-sodium orthophosphate for 15 to 20 minutes prior to sowing
- Heat treatment for 2-4 days at 70°C
- Cross protection of tomato seedlings by inoculating with mild strains
- Field workers should avoid using tobacco products while working in the field

6) Bacterial fruit canker: *Clavibacter michiganense subsp. michiganense*

Symptoms

- Disease appears as **spots** on leaves, stems and fruits and as **wilting** of leaves and shoots
- White blister like spots in the margins of leaves
- Spots become brown with age and coalesce, but do not fall off
- Leaves wilt and curl upward
- Light coloured streaks on stems and petioles at the joints
- Cracks develop in streaks and form cankers
- Slimy bacterial ooze through the cracks in humid weather
- Small, shallow, water soaked, white spots on fruits
- The centers of white spots become slightly raised, tan coloured and rough
- **Birds eye** like appearance of spots, which have brownish centers and white halos
- Vascular discolouration
- Large cavities in pith and cortex which extend to outer surface of stem and cause cankers



Survival and spread

- Survive in or on seeds and on plant debris in soil
- Spreads through the seed and Solanaceous weeds such as *Solanum nigrum*

Epidemiology

- Soil temperature of 28°C and humid weather

Management

- Extraction of seed through fermentation of pulp at room temperature for 72 hours eradicates the bacterium from the seed.
- Hot water treatment of seed at 52°C
- Three year crop rotation
- Protective sprays with COC and streptomycin sulphate
- Soil solarization

7) Root knot nematode – *Meloidogyne sp.*

Root knot is the most important group of phytonematodes and was first recorded in green house vegetables in England in the year 1855. Of the four predominant species of *Meloidogyne*, *M. incognita* and *M. javanica* are commonly found in the tropics, whereas *M. arenaria* is more common in the sub-tropics. *M. hapla* is common in the temperate region and can occasionally found in the cooler uplands of tropics.

Symptoms

- Formation of galls on host root system is the primary symptom
- Roots branch profusely starting from the gall tissue causing a 'beard root' symptom
- In severely infected plants the root system is reduced and the rootlets are almost completely absent. The roots are seriously hampered in their function of uptake and transport of water and nutrients
- Plants wilt during the hot part of day, especially under dry conditions and are often stunted.
- Seedlings infected in nursery do not normally survive transplanting and those surviving have reduced flowering and fruit production

Mode of spread and Survival

- Juveniles and eggs survive periods of moisture stress in a state of anhydrobiosis
- Irrigation water and soil adhering to animal feet and implements help in dissemination of juveniles and eggs of nematodes

Management

- Crop rotation with graminaceous hosts
- Inclusion of non-preferred hosts like mustard, sesame, maize, wheat, etc., in the cropping system
- Intercropping of marigold with tomato reduces nematode population
- Nursery should be raised in nematode free sites or fumigated beds
- Deep ploughing of infested fields during summer. Three summer ploughings at 10 days interval reduces juvenile population
- Flooding the field for prolonged periods
- Use of biocontrol agents like *Paecilomyces lilacinus* (egg parasite)
- Nursery bed treatment with metham sodium (Vapam)@25ml/m² or Carbofuran@0.39g a.i/m²
- Bare root dip treatment in EC formulation of systemic pesticides like Dimethoate or Phenemiphos for 6-8 hours before transplantation
- Grow resistant varieties like Hissar Lalit and PNR-7
- Integration of three summer ploughings or use of treated nursery with spot application of carbofuran @1 kg a.i/ha at transplanting stage have been found successful to manage nematode population in tomato.

LECTURE 11

DISEASES OF CRUCIFERS

1) Club root of crucifers or Finger and toe disease: *Plasmodiophora brassicae*

Fairly severe in hilly regions on cabbage, cauliflower and other crucifers. Fields once infested with the club root pathogen remain so indefinitely and become unfit for cultivation of crucifers.

Symptoms

- Infected plants have pale green to yellowish leaves initially. Later, infected plants show wilting in the middle of hot, sunny days, recovering during the night
- Stunting of above ground parts and reduction in size of heads
- Characteristic symptoms become apparent in advanced stage of root infection as **spindlelike, spherical, knobby, or club-shaped swellings**.
- The swellings may be few, or they coalesce and cover the entire root system



Disease cycle

- P.I: Soil borne resting spores, which survive for longer periods in soil (10yrs.)
- Collateral hosts: Broccoli, Brussels sprout, cabbage, cauliflower, Chinese cabbage, mustard, raddish, turnip
- S.I: Resting spores or zoospores carried through irrigation water or by root contact

Favourable conditions

- It occur at a temp range of 12-27⁰ C (25⁰ C)
- High soil moisture
- Neutral to acidic soils 5-7.0 pH

Management

- Use of seedlings from disease free fields
- Plant cabbage and other susceptible cruciferous crops in well drained fields that have a pH slightly above neutral (usually about pH 7.2)
- Crop rotation does not work since pathogen persists long in soil.
- Add hydrated lime to soil to increase pH to 7.2 (6weeks before planting @ 2.5T/ha)
- Avoid excess irrigation
- Treat the soil of seed bed areas with chloropicrin, methyl bromide or vapam two weeks before planting. Drenching soil with a solution of Brassicol (Pentachloronitrobenzene)

2) Downy Mildew – *Peronospora parasitica*

- Severe in raddish, cabbage, cauliflower, mustard, and knol-khol.

Symptoms

- Small purplish brown spots on under surface of leaves
- Small, pale yellow angular spots on upper surface of leaves, with downy growth on the under surface.
- The spots coalesce and the leaves shrivel and dries up prematurely
- In cabbage, these spots expose the heads to soft rot
- Cauliflower curds look brownish at the top
- Stems show dark brown and depressed lesions or streaks which later develop downy growth of fungus



Disease cycle

- P.I: Oospores in infected plant parts or in soil
- S.I: Wind borne sporangia

Management

- Destruction of infected plant debris
- Avoidance of thick sowing and excessive moist conditions
- Spray metalaxyl@0.25% or COC@ 0.3% or Mancozeb@ 0.2% at 10 days interval

3) Powdery mildew – *Erysiphe polygoni*

Symptoms

- Seen on cabbage & cauliflower

Symptoms

- White powdery spots on the upper surface of leaves, stems, flower parts etc.
- Finally the mildew may cover the entire surface.

Disease cycle

- P.I: Mycelium in infected plant debris
- S.I: Wind borne conidia.

Management: Application of [Dinocap@0.2%](#)

4) Alternaria leaf spot: *Alternaria brassicola*, *A.brassiccae*, *A.raphani*

- Common on cabbage, cauliflower and mustard.

Symptoms

- Spots are small, dark coloured
- They enlarge, soon become circular & 1mm. in diameter
- Under humid conditions groups of conidiophores will be formed in the spot
- Spots develop concentric rings
- Finally the spots coalesce leading to blighting of leaves.

- The fungus is seed borne and cause shriveling of seeds and poor germination
- Linear spots also appear on petioles, stems, pods & seeds

Disease cycle

- P.I: Mycelium persisting in the seed or as spores on seed or from debris
- S.I: Wind or insect borne conidia

Management

- Hot water treatment at 50⁰c for 30min
- Seed treatment with agrosan
- Foliar spray with Mancozeb@0.2% or COC@ 0.3% twice

5) Black rot – *Xanthomonas campestris pv. campestris*

- Serious on cabbage, cauliflower, knol-khol, mustard, raddish



Symptoms

- 1st appear near the leaf margins as chlorotic or yellow (angular) areas
- The yellow area extends to veins & mid rib forming characteristic 'v' shaped chlorotic spots
- Veins and veinlets turn brown and finally black
- The vascular blackening extend beyond affected veins to midrib, petiole and stem
- In advanced stages, infection may reach the roots system and blackening of vascular bundles occur
- Bacterial ooze can also be seen on affected parts
- If the infection is early, the plants wilt and die
- If the infection is late plant succumb to soft rot & die

Disease cycle

- Bacterium is internally seed and soil borne. It also survives on plant debris
- Collateral host: *Centella asiatica*
- Bacteria enter through stomata of cotyledons.
- Also enters through hydathodes on leaf margin and also through wounds
- S.I: Bacterium through irrigation water or wind splashed rain and also by mechanical means

Management

- ST with Hg Cl₂ solution for 30 min or Agrimycin or Aureomycin 0.01%
- Hot water treatment at 50⁰c for 30min, for killing seed borne inoculum followed by a 30min dip in streptocycline 100ppm
- Spray Agrimycin-100 or Streptocycline-50ppm at transplanting, curd formation and pod formation
- Crop rotation for 2-3 yrs with non cruciferous crop
- Drenching seed bed with 5% formalin or any antibiotic solution in nursery beds
- R.V: Cabbage: Cabaret, Defender, Gladiator, Pusa Muktha
- Cauliflower: Pusa ice, Pusa snow ball-K-I-F, Sel-12

6) White rust – *Albugo candida* (Syn: *Cystopus candidus*)

Symptoms

- White, shiny raised blisters (pustules) on the lower surfaces of leaves, stems & flowers.
- Pustules coalesce to form irregular patches
- The epidermis ruptures exposing white spore mass which gives the pustule a powdery appearance
- Distortion of the floral parts including petals, pistils and anthers due to hypertrophy and hyperplasia
- Plants malformed beyond recognition



Disease cycle

- P.I: Oospores in soil and Perennial weeds hosts
- S.I: Sporangia & Oospores carried by wind

Management

- Sanitary measures
- Crop rotation
- Destruction of weeds
- Spray 0.8% B.M or any copper fungicide

DISEASES OF CUCURBITS

1) Downy mildew – *Pseudoperonospora cubensis*

- Host range: Musk melon, Sponge gourd and Bitter gourd etc.

Symptoms

- Yellow, angular spots appear on upper surface of leaves
- The corresponding lower surface of these spots shows a purplish downy growth in moist weather
- The spots turn necrotic with age
- The diseased leaves become yellow and fall down
- Diseased plants get stunted and die
- Fruits produced may not mature and have a poor taste



Disease cycle

- P.I: Collateral hosts or fungus surviving in plant debris
- S.I: Wind borne sporangia or splashing rain water

Management

- Destruction of cucurbitaceous weeds around field
- Spray [metalaxyl@0.2%](#) or [chlorothalonil@0.2%](#)
- Spray [zineb@0.3%](#) at 10 days interval

2) Powdery mildew: *Erysiphe cichoracearum*, *Sphaerotheca fuligena*

- Host range: Pumpkins, bottle gourd, *Coccinia*, cucumber, ridge gourd
- Bitter gourd is less effected



Symptoms

- Whitish or dirty grey, tiny powdery growth on foliage, stems and young growing parts
- The superficial growth ultimately covers the entire leaf area
- The diseased areas turn brown and dry. This leads to premature defoliation and death
- Fruits remain undeveloped and are deformed

Disease cycle

- P.I: Collateral hosts or through Cleistothecia
- S.I: Wind borne conidia

Management

- Spray Calixin 0.1% or Karathane @0.2%

3) Cucumber Mosaic: *Cucumber mosaic virus*

- Host range: Cucumber, Pumpkin, gourds, Cowpea, tomato, chilli, etc.



Symptoms

- Leaves curl downwards and become mottled, distorted, wrinkled and reduced in size
- Stunting and rosetting of young leaves
- Fruits are often misshapen, mottled, warty and reduced in size
- Fruits may be bumpy or deformed in late infections

Survival and spread

- Survive on weeds, ornamentals or other crops
- Transmitted by aphids (*Aphis craccivora*, *Myzus persicae*) and spotted and striped cucumber beetles
- Collateral hosts: Banana, clover, corn, passion fruit, safflower, spinach, sugarbeet, wild cucumber, *Commelina communis*, *C. diffusa*, *C. nudiflora*, *Solanum elaeagnifolium*, *Phytolacca* sp., periwinkle, *Gladiolus* sp., *Impatiens* sp. and *Phlox*.

Management

- Rogue out infected plants
- Eliminate perennial weed hosts
- Vector control by spraying monochrotophos or phosphamidon, 1.5 ml per liter of water

4) Cercospora leaf spot: *C. citrullina*, *C. melonis*, *C. lagenarium*

- Common on watermelon, muskmelon and cucumber

Symptoms

- Minute water soaked spots mostly on leaves
- Spots enlarge rapidly and becomes circular to irregular with pale brown, tan or white centers and purple to almost black margins
- Spots coalesce to form large blotches
- The leaf may dry and die presenting the leaf a scorched appearance
- Stems and fruits are also attacked

Disease cycle

- P.I: Collateral hosts or plant debris
- S.I: Wind borne conidia

Management

- Maintain good soil drianage and good aeration between vines
- 2 - 3 protective sprays with [zineb@0.2%](#)

LECTURE 12

DISEASES OF BETELVINE

1) Wilt – (*Phytophthora*, *Sclerotium* and *Fusarium*)

Symptoms

Sclerotium

- Collar region is usually infected
- White mycelial growth over the infected area of stem on which small mustard seed like sclerotia appear
- Shredding of infected bark
- Vine wilts and totally dries off

Phytophthora parasitica

- The disease is characterized by darkening of basal stem. Soon the wine wilts accompanied by yellowing of leaves and drooping of vines, starting from tip downwards.
- Infection from soil level spread upwards reaching 2nd or 3rd internode.
- Roots of affected plants are discoloured, rotted, starting from smaller roots and spreading to the stem

Management

- Destruction of dead vines
- Long crop rotation with non hosts
- Deep summer ploughing
- Green manuring before planting
- Application of *Trichoderma viride*, 2kg mixed in 50 kg of FYM
- Drench the soil with 1% BM

2) Anthracnose/Leaf spot/Marginal blight: *Colletotrichum capsici*

Symptoms

- Light to dark brown irregular spots on leaves surrounded by diffuse chlorotic halo
- Marginal leaf tissue becomes black, necrotic and gradually spreads towards the centre
- Circular, black lesions may girdle the stem culminating in death of the vine

Management

- Spray 1% BM or [COC@0.3%](#) at 15 days interval

LECTURE 13

DISEASES OF ONION

1) Purple blotch – *Alternaria porri*

Symptoms

- Minute whitish dots on the leaves with irregular chlorotic areas on tip portions
- Circular to oblong, **concentric velvety rings** appear in the chlorotic area
- Sometimes yellow halo is seen around lesions
- Spots coalesce and leaves die from tip backwards
- Diseased leaves break at point of infection & hang down
- Infection also seen on outer scales of bulb, seed stalk and neck
- Severely infected crop dries up
- Bulbs become dry and papery

Survival and spread

- P.I: Plant debris and seed bulb
- S.I: Air-borne conidia

Favourable conditions

- Warm humid weather with rains or heavy dew

Management

- Select disease free bulbs for planting
- ST with thiram @3g/kg seed
- Spray [mancozeb@0.2%](#) or [chlorothalonil@0.2%](#)

2) Smudge – *Colletotrichum circinans*

Symptoms

- Chiefly a disease of **scales** of bulb. **Red scaled onions** are usually resistant to the smudge due to the presence of protocatechuic acid and catechol
- Damping off in seed bed under wet and warm conditions
- Disease appears at all stages and also during storage and transportation
- Sub-cuticular, dark green to almost black smudge appear on the bulb, neck or green leaves that are clinging to bulb after digging
- Circular lesions with **concentric rings of dark stromata** and mycelium appear on leaves
- Small, sunken and yellow lesions on inner scales
- Pinkish mass of fungal growth on lesions under humid conditions



Survival and spread

- P.I: Soil and on infected onions as stromata
- S.I: Wind borne conidia

Favourable conditions

- Wet soils with a temperature of 26⁰ C

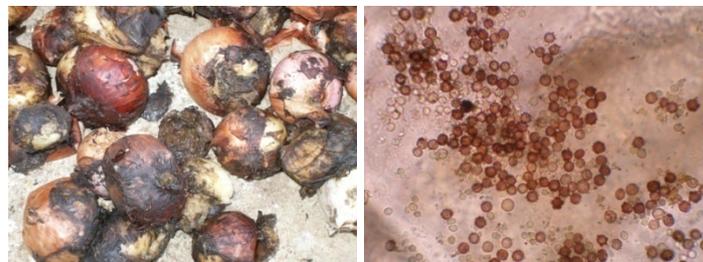
Management

- Resistant varieties: **Nasik red, Pusa Ratna, Pusa Red**
- Protection of bulbs from rains after harvest
- Dry bulbs properly before storage by hot air at 37 – 48⁰C
- Spray zineb or captan @0.2% before harvest of crop

3) Smut – *Urocystis cepulae*

Symptoms

- Fungus attacks cotyledons of young plants soon after their emergence causing dark, elongated eruptive spots
- On older leaves, the lesions may extend from base to the tip and appear as blisters
- Lesions develop into thickened areas of several mm in size
- Lesions burst open releasing masses of black smut spores
- Severely affected plants killed within 3-4 weeks of emergence
- Surviving plants are stunted with stout, brittle, distorted leaves bearing lesions throughout their length
- Numerous blisters appear on leaves and bulb scales of mature plants which rupture to expose masses of black powdery spores



Survival and spread

- P.I: Spore balls in infected soil
- S.I: Wind blown soil and surface drainage water, onion bulbs and onion transplants

Favourable conditions

- Optimum temperature of 10-20⁰ C
- Plant is susceptible for 2-3 weeks from the DOS

Management

- ST with thiram@3 g/Kg seed
- Crop rotation and use of disease free seedlings
- Cultivar, **Hardy white bunching** is resistant
- Spray with captan or ferbam @0.2% along with a sticker

DISEASES OF BEANS

1) Anthracnose – *Colletotrichum lindemuthianum*

Symptoms

- All the above ground parts are affected at any stage of crop growth. However, the characteristic symptoms appear on pods
- On cotyledons spots are sunken dark brown or black with pink spore mass
- Seedling infection results in collapse of seedling
- Spots on leaves appear on lower side and are black. Later these may also appear on upper surface. When the infection is severe, the affected plants wither off.
- **Black, sunken, circular spots of varying sizes appear on pods with bright red, yellow or orange margins**
- The centre of these spots later turns grey or pink due to sporulation of the pathogen. The border of these spots appear raised

Survival and spread

- P.I: Through **seed** and collateral hosts
- S. I: Conidia by splashing rain water or air borne conidia
- Host range: All vegetable beans and cowpea, mungbean, blackgram etc.

Management

- Use healthy seed for planting
- Seed treatment with Carbendazim@2g/kg seed
- Protect the crop by spraying 0.2 % Benlate or Bavistin or Zineb or Maneb @2Kg/ha at 7-10 days interval

2) Rust

- On Beans: *Uromyces phaseoli typica*
- On cowpea and others: *U. phaseoli vignae*
- On dry bean: *Uromyces appendiculatus*
- **Autoecious** macrocyclic rust, *i.e.*, produces all the stages on bean plant

Symptoms

- The symptoms mostly appear on leaves, though often they are found on petiole and stem of some hosts
- The rust pustules appear on either sides but more common on lower surface.
- The Uredosori are minute, roundish, slightly raised and reddish brown coloured. These contain rust spores and appear in groups
- Later in the season with the formation of teliospores, the sori turn dark brown or black.
- Diseased leaves may wither or fall off under severe infection

Pathogen

Uredospores are echinulate, oval and yellowish brown in colour and the teliospores are dark brown coloured, elliptical and ovate, pedicillate, smooth walled, single celled with warty papillae at the top.

Survival and spread

- P.I: Survives through teliospores in cooler regions and on collateral hosts
- S.I: Wind borne Uredospores
- Host range: French beans, green gram, black gram and cowpea

Management

- Adjust sowing dates to avoid severe infection of plants in the field
- Protect the crop with mancozeb or zineb @ 2 kg/ha or wettable sulphur @0.3%

3) Yellow mosaic: Bean Yellow Mosaic Virus, Mungbean yellow virus or Phaseolus virus-2 (*ss DNA virus*)

Symptoms

- Bright yellow patches appear on leaves. Yellow areas alternate with dark green areas of the leaf blade.
- Younger leaves show more severe mottling and chlorosis.
- Leaves completely turn yellow and gradually becomes necrotic
- Plants are stunted and flower and pod set is reduced
- Pod formation is reduced and if produced, they are deformed having shrivelled and undersized seeds

Survival and spread

- P.I: Collateral hosts
- S.I: Whitefly, *Bemisia tabaci*
- Not transmitted by sap, seed and pollen
- Host range: French bean, Soybean, Red gram, *Xanthium strumarum*, *Eclipta alba*, etc.

Management

- Remove collateral hosts and destroy
- Use resistant varieties
- Spray [metasystox@0.1%](#) for vector control

4) Common bean mosaic virus/ Green mosaic – *Bean common mosaic virus (ss RNA)*

Symptoms

- Affects only beans (*Phaseolus vulgaris* & other *Phaseolus* species)
- Symptoms vary according to the variety of bean affected, time of infection and environmental conditions
- Leaves show mosaic pattern, *i.e.*, light green areas alternate with dark green areas.
- Diseased leaves become rough, and show **blisters** on the leaf lamina
- Leaf size, petiole length and plant height reduced. Leaves curl downward
- Diseased plants produce fewer pods which are smaller in size
- Seeds become smaller, malformed and aborted

Survival and spread

- Seed, sap, graft and aphid transmissible. **Infected seeds** are primary means of spread.

- *Aphis craccivora*, *Macrosiphum pisi*, *Aphis gossypi*, *A. medicaginis*, *Myzus persicae* and *Brevicoryne brassicae* transmit the virus in a non-persistent manner

Management

- Use of disease free seed
- Vector control with insecticides

LECTURE 14

DISEASES OF COCONUT

1) **Ganoderma basal stem rot**– *Ganoderma lucidum*, *G. applanatum*

- Most serious and destructive disease of coconut. Present in the districts of Srikakulam, Visakhapatnam, Vizianagaram, East and West Godavari districts.
- A recurring loss of Rs. 10 lakhs occur every year in A.P. alone. The disease is severe in lighter soils and on young palms.

Symptoms

- The fungus infects the roots and spreads upwards killing the entire root system
- Older leaves droop and wither and remain suspended around the trunk for several months
- Younger leaves remain green for sometime
- Tree become barren due to suppression of inflorescence
- Diseased tree dies slowly and often the stem cracks, giving out a dark brown ooze
- The cortical tissues disintegrate and stem turn brown.
- Extensive rotting of roots and peeling of stem tissues
- In advanced cases the fungus produces the fruiting structures (**brackets**) along the sides of the basal trunk
- Diseased tree dies in about two years



Pathogen

Pathogen produces hyaline mycelium with frequent clamp connections. It produces ellipsoid, slightly thick walled chamydospores which may be terminal or intercalary. The fruiting body is perennial, usually lateral and is corky at first becoming woody later. **Basidiospores** are thick walled brown and truncated at one end.

Disease cycle

- P.I: The fungus is soil borne (Basidiospores)
- Wide host range: Mango, jack, citrus, Arecanut, coffee and tea
- S.I: Through irrigation water and by root contact (Mostly from March-August)

Management

Preventive measures

- Dig isolation trenches of about 50cm wide and 1m deep, 2-3 m away from diseased palm to prevent spread of fungus
- Trenches dug for replanting should be filled with FYM, 5kg neem cake and *Trichoderma viride*

- Incorporate green manure crops like sunhemp and *Sesbania* for moisture retention and multiplication of antagonistic fungi
 - Avoid deep ploughing or digging which are likely to injure roots
 - Arrange separate irrigation to each tree to prevent spread of fungus
 - Apply FYM (200 kg) and neem cake (5-10 kg) to each tree during June – July months
 - Also apply 2 kg superphosphate and 3 kg MOP in two splits, one in July and other in November
 - Apply 40 liters of 1% BM in basin of each tree, yearly once, during August – September
- Curative measures**
- Destroy infected palms
 - **Root feeding with tridemorph** (6ml in 25 ml of water), 3-4 times an year, in early stages of infection
 - Control bark eating caterpillar

2) Bud rot - *Phytophthora palmivora*

- First reported by butler in 1906
- **Coconut** and **toddy palm** (*Borassus flabellifer*) suffer badly
- Also infects Palmyrah & Arecanut.
- Datepalm is immune to the disease
- Bud rot affects the palms at various stages of growth.
- As the name indicates, the ultimate effect is rotting of terminal bud due to infection in or near the bud.

Symptoms

- Severe on young palms
- **Yellowish green discoloration of the heart leaf or crown leaf**
- The basal tissues of the leaf rot quickly and can be easily separated from the crown
- Spindle withers and droop down
- Older leaves develop irregular, water soaked spots which are sunken in nature
- The leaves and sheath in the central spindle fall off leaving an outer whorl of green leaves
- The withered central shoot can be pulled out very easily from the crown
- The central crown may rot and in few months the tree may wilt
- Young nuts fail to mature and fall

Disease cycle

- P.I: Through dormant mycelium oospores or chlamydospores carried over summer months on the host debris. With the onset of monsoon rains, the fungus becomes active producing cottony mycelium that infects tender host tissue.
- S.I: Through sporangia with numerous zoospores which spread rapidly in the rain water or sporangia spread through wind and insects also

Favourable conditions

- High R.H., Temperatures of 18-20 °C, presence of insect wounds and heavy rainfall aggravates the disease

Management

- Cutting and burning of badly infected palms.
- If the disease is detected early remove the infected portions and protect with Bordeaux paste (Tree surgery)
- Spray copper fungicides (B.M@1% or COC@0.3%) after on set of monsoon to prevent infection
- Keep a mixture of $\text{CuSO}_4 + \text{NaCl}$ (1: 3-5) parts in a cloth bag in the crown or above bud

3) Stem bleeding – *Ceratocystis paradoxa*

- Syn: *Ceratostomella paradoxa*, *Ophiostoma paradoxa*

Symptoms

- Characterized by reddish brown ooze from the cracks near the base of the trunk (2-3 cm above soil line).
- The fluid dries up to form black encrustations with brownish orange margins
- Infection can occur anywhere on the trunk.
- The tissues, except vascular bundles, below infected patch show yellowish brown discoloration and decay
- Large **cavities are formed in diseased stem** from which yellowish to whitish fluid oozes out
- Growth of affected palms is arrested and yield reduced



Pathogen

The fungus produces two types of conidia. Macroconidia are produced on conidiophores, either singly or in chains. They are spherical or dark green in colour. Microconidia (endoconidia) are produced endogeneously inside the long cells of conidiophores and cell ruptures when mature and release the microconidia in long chain. The pathogen also produces hyaline perithecia with clavate asci and hyaline ascospores.

Disease cycle

- P.I: **Perithecia** and chlamydospores in cracks and cavities of infected stem
- S.I: Conidia dispersed by irrigation water, insects, wind

Favourable conditions

- Heavy rainfall followed by drought
- Cracks and insect wounds on stem
- Physiological imbalances
- Poor fertilization and poor maintenance of orchard
- Damage by *Diocalandra* and *Xyleborus* beetles

Management

- Avoid any mechanical injury to the stem

- Provide proper drainage during rainy season
- Chisel out affected tissues and dress the wound with hot coal tar or Bordeaux paste
- In older trees, after draining the fluid, cavities can be stuffed with a mixture of tar coal and sawdust
- Cover the lower part of trunk with coal tar or Bordeaux paste to prevent the disease
- Along with 50kg of organic manure, apply 5 kg neem cake containing the antagonistic fungi, *Trichoderma* to the basin during September
- Coconut stem boring insects should be controlled by applying Carbaryl 50% WP on the trunk at 3g per liter

4) Tatipaka disease – Phytoplasma

The disease was first observed during the year 1952 in the village ‘Tatipaka’ of East Godavari District. Since then reported from in and around of ‘Razole’ of East Godavari district.

Symptoms

- Plants between 25 – 60 years are most susceptible
- Development of abnormally large crown with dark green inner leaves and higher yield
- The palms continues to yield for 2-3 years
- Subsequently the crown becomes smaller in size and **stem begins to taper**
- The leaves give a fasciated appearance due to improper unfolding of leaflets



- Leaves turn pale and **bend abnormally**
- Leaves shed pre-maturely
- Affected tree produces smaller bunches with **atrophied barren nuts**
- Nuts get atrophied become spongy and round and contain no kernel (Copra).
- Severely damaged palms are barren with sickly crowns and slight tapering trunk
- Such trees never recover but die in few years

Management

- Remove and destroy affected trees
- Avoid using nuts from infected tree for raising seedlings
- Avoid transport of nursery seedlings from infected areas

5) Grey blight – *Pestalotiopsis palmarum*

Symptoms

- Disease symptoms develop in mature leaves of outer whorl

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

Pathogen

The fungus produces conidia inside the **acervuli**. The acervuli are black in colour, cushion shaped, sub-epidermal and break open to expose conidia and black sterile structures, setae. The conidiophores are hyaline, short and simple, bear conidia at the tip singly. The conidia are five celled, the middle three cells are dark coloured, while the end cells are hyaline with 3-5 slender, elongated appendages at the apex of the spore.

Disease cycle

- P.I: Conidia in plant debris
- S.I: Conidia carried by wind splashed rain water

Management

- Remove older affected leaves and burn
- Apply heavy dose of potash and improve drainage condition of soil
- Spray foliage with BM@1% COC or captan @0.2%

DISEASES OF OILPALM

1) Bunch rot: *Marasmius palmivora*

Symptoms:

- Strands of mycelium are seen spreading over the bunch surface in initial stages
- Mycelium is profuse at the back of the bunch.
- Mycelium grows over the fruit surface and penetrates the mesocarp and leads to wet rot.
- Disease spreads rapidly within 2 to 3 months after initiation of monsoon rains.

Management:

- Crown cleaning by removing aborted and dried bunches and inflorescences.
- Spraying of Carbendazim 0.1% or Bordeaux mixture 1%.

2) Spear rot: *Phytoplasma* disease

Spear rot is an endemic disease in Kerala state.

Symptoms:

- Disease is characterized by chlorosis of young whorl of leaves followed by necrosis.
- Rotting of spear leaves
- Reduction in leaf size

- As the disease advances the trunk gradually tapers.
- Emergence of inflorescence is arrested leading to loss in productivity.

Spread:

The disease is infectious, vector borne and lethal.

Management:

- Avoid obtaining seedlings from infected areas to healthy areas.
- Tetracycline injection 500ppm to trunk reduces the disease.
- Rouging of affected plants.
- Planting of barrier trees to isolate the infection source of other palms.

3) Curvularia leaf spot - *Curvularia lunata*, *C. geniculata*

Symptoms

- Small circular translucent yellow spots appear on both the leaf surfaces
- Lesions turn dark brown with sunken centre and yellowish orange halo
- A narrow rim of raised tissue with oily appearance is produced around the lesions
- Persistence of primary lesions within the dead tissue is a diagnostic feature for distinction from other leaf spots.

Management

- Prophylactic spray with Thiram @ 2g/lit

LECTURE 15

DISEASES OF TEA

1) Blister blight of tea – *Exobasidium vexans*

Symptoms

- Initially oily, yellowish, translucent spots appear on the tender leaf and turn to deep **red shiny blisters**
- The circular spot gradually enlarges to 3 to 13mm diameter, bulged on the under surface of the leaf with a **concave trough like depression on the upper surface**
- Leaves become curled and distorted
- First flush of 2-3 young leaves are attacked and the young shoots and buds are killed
- Mature leaf is not affected
- In nursery infection, seedlings are stunted with many thin stems instead of a single stalk
- Repeated attacks cause death of seedlings
- Badly affected nurseries will have to be abandoned
- Succulent leaves and green shoots of newly pruned tea are most susceptible
- Basidiospores cause secondary infection

Favourable conditions

- Relative humidity > 83% for 7 to 10 days favours disease
- Temperature above 35°C inhibit the disease
- Bushes in low, moist and shady localities suffer more
- Pruned trees with new flush is highly susceptible

Management

- Seedlings should be protected in nursery by weekly sprays of [COC@0.3%](#)
- Spray, a mixture of 210g COC + 210g **Nickel chloride** per ha at 5 days intervals from June-September and 11 day intervals in October-November
- Mancozeb, Tridemorph, Triadimefon and **Pyracarbolid (Sicarol)** offers good disease control under field conditions

DISEASES OF COFFEE

1) Coffee rust/Oriental leaf disease – *Hemileia vastatrix*

- Severe epidemics in Srilanka in 1868

Symptoms

- The fungus confines itself to the leaf blade, rarely occurs on the berries
- Small, pale yellow spots on the upper surfaces of the leaves usually around the margins
- Later masses of orange uredospores appear on the under surfaces
- The fungus sporulates through the stomata rather than breaking through the epidermis, so it does not form the pustules typical of many rusts
- The powdery lesions on the undersides of the leaves can be orange-yellow to red-orange in color

- The centers of the spots eventually dry and turn brown, while the margins of the lesions continue to expand and produce uredospores
- Infection slowly progresses upward in the tree and host tissue becomes dark brown, then black and dries up
- The infected leaves drop prematurely, leaving long expanses of twigs devoid of leaves
- The damage to the plant is severe when it affects the young flush, causing defoliation and considerable reduction in yield



Pathogen

The fungus is mostly intercellular drawing food from cells through haustoria. It produces uredospores and teleutospores on club-shaped erumpent stalks rising through the stomata. Uredospores are reniform, with an orange segment like appearance, the convex side echinulate and the lower or concave side smooth. Telial stage develops in the same spot producing turnip like, hyaline thick walled teleutospores.

Survival and spread

- P.I: Survive as mycelium or uredospores in infected leaves
- S.I: Uredospores dispersed by wind and water
- **Pycnial and aecial stages are not known**

Favourable conditions

- Uredospores germinate only in free moisture
- Thick canopy of shade prevents the ready spread of the spores and thus secondary spread of the disease
- Rainy weather and heavy dew
- Severe from July to Dec

Management

- Spray the bushes once with [BM@0.5%](#) or [COC@0.25%](#) and subsequently 2-3 times during monsoon
- Spray [Triadimefon@0.05%](#)
- Collect diseased leaves and destroy

DISEASES OF TURMERIC

1) Rhizome rot – *Pythium aphanidermatum*, *P. graminicolum*

The disease is common in Andhra Pradesh, Karnataka, Kerala and Tamil Nadu.

Symptoms

- The disease occurs in patches. Infected plants show progressive drying up of the leaf, which first proceeds along the margins and later the entire leaf dries up
- The root system is adversely affected. It gets reduced leaving few decaying brown roots. Infection gradually spreads to rhizomes which begin to rot and become soft.
- The bright orange colour of the rhizome is changed into different shades of brown.



Disease cycle

- P.I: The fungi survive in soil and infected rhizomes as oospores
- S.I: Spreads through irrigation water as zoospores

Management

- Crop rotation with non-hosts
- Grow turmeric in light soils with good drainage
- Use disease free rhizomes for planting
- Rhizomes should be dipped in [Metalaxyl@2.5g/l](#) or Bordeaux mixture@1% solution for 40 minutes
- Drench the soil at root region with captan@2 g or COC@2.5 g or metalaxyl@1 g per liter in the initial stages of the disease
- Turmeric varieties, PCT-13 and PCT-14 are resistant to this disease.

2) Leaf spot – *Colletotrichum capsici*

Symptoms

- Fungus attacks only leaves and usually infection is confined to leaf blades and occasionally extend to leaf sheaths
- On leaves, **elliptic to oblong spots** of different sizes appear on both the surfaces, but more on upper surface
- Spots gradually increase in size and attain a length of 4-5cm and breadth of 2-3cm
- Mature spots have grayish center with dark brown margins surrounded by a yellow halo
- Central portion of the spot becomes thin and papery
- Several spots coalesce to form irregular necrotic patches



Disease cycle

- P.I: Infected plant debris
- S.I: Air borne conidia

Management

- Remove and destroy infected plant debris
- Treat rhizomes with [COC@0.25%](#) solution
- Spray [Carbendazim@0.1%](#) or [Mancozeb@0.25%](#). during Aug-Dec along with [sandovit@0.5](#) ml/lit
- Avoid excess shading
- Tolerant varieties: **TS-2, TS-4, TS-9, TS-88**

3) Leaf blotch – *Taphrina maculans*

Symptoms

- Appearance of large number of spots on both surfaces of leaf
- Spots first appear as pale yellow discolouration which gradually turn to reddish brown
- Spots lie between leaf veins and are rectangular, coalesce to form big irregular patches



Survival and spread

- Infected plant debris
- Collateral hosts: *Curcuma amada*, *C. angustifolia*

Favourable conditions

Temperature of 21-23⁰C with 80% R.H.

Management

- Collect and destroy diseased leaves
- Spray [Mancozeb@0.25%](#) or [COC@0.25%](#) at 20 days interval
- Resistant varieties: China (*Curcuma domestica*) and Jaweli (*C. amada*)

DISEASES OF ZINGER

1) Rhizome rot/soft rot – *Pythium sp.*

Symptoms

- Rhizome rot of zinger is common in all zinger growing areas. When infection takes place through contaminated seed, sprouts fail to grow resulting in pre-emergence damping off.
- If the disease strikes after sprouting it manifests itself on the leaves, which turn pale green in colour.
- Yellowing is noticed on the top leaves, gradually spreading downwards of the leaf blade and leaf sheath along the margin.
- Yellowing is followed by withering and drying of the dead area gradually extending to leaf sheath. Dead leaves ultimately drop off and hang down along the stem till the entire shoot becomes dry.
- On stem, a translucent brown lesion develop at collar region and later becomes water soaked and soft, extends to whole shoots and can be easily pulled out from this point.
- Soft rot extends from the collar region to rhizomes which first become discoloured and gradually decompose, forming a watery mass of putrifying tissues enclosed by tough ring of rhizome.
- The fibrovascular strands are rarely affected. Roots arising from affected rhizome undergo rotting and softening. Rotting is also noticed in rhizomes collected from infected crop during storage.

Disease cycle

- P.I: Survive in soil and infected rhizomes as oospores
- S.I: Spreads through irrigation water as zoospores

Favourable conditions

- Mimegralla flies play a role in the spread of the pathogen

Management

- Crop rotation for 3-5 years with non-host crops
- Avoid water stagnation
- Collect the seed from disease free plots
- Rhizome treatment with [Metalaxyl@0.2%](#)
- Drench the field with [COC@0.3%](#) or [Metalaxyl@0.2%](#)
- Control the Mimegralla insects by 0.05% methyl parathion

2) Leaf spot – *Phyllosticta zingiberi*

Symptoms

- In A.P., the disease is common during monsoon months.
- Initially disease appears as small, yellowish oval to elongated spots on the leaves measuring 0.5 to 1 mm.
- The spots enlarge; turn to white and papery at the centre with dark brown margin surrounded by a yellow halo.
- Spots are usually isolated but under humid conditions they coalesce with one another developing towards margin forming a big lesion

- Black minute pycnidia develop in the white papery centre of the spots which is conspicuous in the later stages of the disease.

Survival and spread

- Infected plant debris
- Conidia spread by splashing rain

Management

- Growing zinger in partial shade reduces the disease incidence
- Spray [Mancozeb@0.25%](#) or [COC@0.25%](#) during monsoon

LECTURE 16

DISEASES OF MULBERRY

1) Powdery mildew – *Phyllactinia guttata*, *P. corylea*, *P. suffulata*

Symptoms

- Lesions appear as whitish patches on the lower surface of the leaves
- Gradually they turn yellowish brown to black patches
- Powdery patches cover the entire leaf surface which is unsuitable for feeding the silk worms
- The whitish powdery material seen on the leaves consists of the fungal hyphae, conidia, conidiophores and cleistothecia

Survival and spread

- Mycelium or cleistothecia in infected plant debris
- Wind borne conidia

Management

- Remove and destroy infected plant debris
- Spray wettable [sulphur@0.2%](#) or [Dinocap@0.1%](#)
- Waiting period of 15 days after spray may be allowed before harvesting the leaves

DISEASES OF ROSE

1) Powdery mildew – *Sphaerotheca pannosa var. rosae*

Symptoms

- The infected leaves show grayish powdery fungal growth
- Rolling of leaf margins with the onset of sprouting season
- Affected leaves become curled and distorted
- Badly infected flower buds fail to open
- Infected floral parts become discoloured, dwarfed and dried

Survival and spread

- P.I: Mycelium in dormant buds and shoots or as cleistothecia
- S.I: Wind borne conidia

Management

- Collect and destroy infected plant debris
- Four sprays with wettable S@0.3% or carbendazim@0.1% or Dinocap@0.1% at 10 days interval
- Resistant varieties: **Ashwini, Ambika, Angeles, American pride, Surabhi**

2) Black spot – *Diplocarpan rosae* (Anamorph: *Marssonina rosae*)

Symptoms

- Dark brown tar coloured spots with fringed borders
- Spots coalesce forming large patches
- Infected leaves turn brown and defoliate
- Fungus may also attack stems and flowers of rose bushes

- On stems, infected areas are blackened with blistered appearance dotted with pustules



Survival and spread

- Pycnidia or ascospores in infected plant debris
- Wind borne conidia

Management

- Affected parts should be collected and destroyed
- Spray Tridemorph @0.025% or benomyl @0.1% at weekly intervals starting with the sprouting of the plants till new foliage appears.
- Shade and extensive irrigation should be avoided.
- Resistant varieties: Bebe bune, coronado ,Grand opera, sphinx.
- Radiance - escape infection due to waxy surface

3) Die-back – *Diplodia rosarum*

Symptoms

- Infection starts from the pruned surface of the twigs.
- The infected portion become brown to dark brown or black
- Infected twig dries from tip downwards
- Infection spreads from twig to main stem and roots and finally whole plant is killed
- Older plants and neglected bushes are more frequently attacked



Survival and spread

- **Pycnidia** present in dead twigs
- Conidia through irrigation water

Management

- Diseased twigs should be carefully removed and destroyed
- After pruning the cut end should be protected with chaubattia paste
- Spray [Difolatan@0.2%](#) or [mancozeb@0.2%](#) or [Chlorothalonil@0.2%](#) in early September and late October
- Resistant varieties: **Blue moon, Red gold, Summer queen**, etc.

DISEASES OF JASMINE

1) Rust – *Uromyces hobsonii*

Symptoms

- Leaves, stems and inflorescence are affected
- Blisters or tumors and other abnormalities may be produced on the infected plant parts
- Infected portions become hypertrophied
- Orange coloured pustules on both surfaces of leaf but predominantly on lower surface
- Chlorosis & defoliation of leaves under severe conditions
- Yellow or orange coloured cankers on stems and twigs
- Splitting of bark of affected branches and subsequent death of branches
- Infected flower buds are swollen and deformed
- Flower production is highly reduced

Disease cycle

- P.I: Teliospores in infected plant
- S.I: Wind borne **aeciospores**

Pathogen

- Autoecious rust (**Demicyclic** rust/ **Opsis** rust)
- **Uredial stage is absent**
- Pustules are initially yellow (aeciospores) and later turn dark (teliospores)

Favourable conditions

- Rust initiates in June- July and persists till March

Management

- Remove and destroy affected plants or plant parts to avoid further spread.
- Spray Oxy-carboxin (plantavax) or Mancozeb @0.2%
- Dust sulphur (20-25kg/ha) or spray tridemorph (0.05%) or triadimefon (Bayleton) @ 0.05%

2) Cercospora leaf spot – *Cercospora jasminicola*

Symptoms

- Conspicuous, circular to irregular, reddish brown spots with a darker border and whitish centers appear on both the leaf surfaces and other aerial parts of the plant
- Severe infection results in defoliation and die back symptoms
- Flowering is adversely affected

Management

- Spray [carbendazim@0.1%](#) or [COC@0.3%](#)
- Monthly sprays of Benomyl or thiophanate methyl @0.1%
- Collect and burn diseased plant debris
- **Pari Mullai** is moderately resistant

DISEASES OF CHRYSANTHEMUM

1) Blotch – *Septoria chrysanthemella*

Symptoms

- Blackish brown circular to irregular spots on leaves which later form large patches covering major portion of the leaf
- Patches are surrounded by chlorotic halo
- Later the centers turn greyish and the leaves remain small and curl
- Dead leaves hang on stem for some time
- Dead leaves hang on stem for some time



Survival and spread

- P.I: Infected plant debris in soil
- S.I: Wind borne conidia

Management

- Collect and burn diseased plant material
- Spray [carbendazim@0.1%](#)
- Tolerant varieties: Alpana, Sarad and flirt

2) Chrysanthemum stunt - Viroid

Symptoms

- Small plants with paler plants and flowers
- Some flowers appear bleached and are inferior in quality
- Flowers from diseased plants open 7 to 10 days earlier than healthy ones
- Axillary buds grow prematurely and produce number of branches and stolons and plants are stunted in appearance
- White specks and yellow blotches appear on leaves of some varieties
- Cuttings from diseased plants root poorly

Survival and spread

- P.I: Viroid survives in infected plants
- S.I: Spread through sap and knives or tools used during pruning or pinching plants, taking cuttings and cutting the flowers

Management

- Use certified Viroid free stocks
- Remove and destroy infected plants

3) Fusarium wilt – *Fusarium oxysporum f.sp. chrysanthemi*

Symptoms

- Disease is characterized by chlorosis of one or more leaves
- Drooping of leaves and wilting of the affected plants
- Black necrotic spots appear on the stem
- Vascular discolouration
- Creamy mycelial growth of the pathogen is seen on the collar region under humid conditions

Survival and spread

- P.I: Soil borne fungus or through cuttings
- S.I: Conidia dispersed through irrigation water

Management

- Cuttings should be obtained from disease free plants
- Long crop rotation

DISEASES OF CROSSANDRA

1) Wilt – *Fusarium solani*

Symptoms

- Usually observed one month after transplanting in patches
- Leaves of infected plants become pale and droop
- Leaf margins show pinkish brown discolouration
- Discolouration spreads to midrib in 7 to 10 days
- Stem portion gets shrivelled
- Dark lesions noticed on the roots extending upto collar region which results in sloughing of cortical tissue



Disease cycle

- P.I: Chlamydospores survive in soil
- S.I: Microconidia dispersed through irrigation water

Favourable conditions

- Incidence is more in presence of root lesion nematode, *Pratylenchus* sp., and *Helicotylenchus dihystra*

Management

- Remove and destroy affected plants
- Soil application of phorate @1g/plant on 10th day of transplanting for nematode management
- Soil drench with [Carbendazim@0.1%](#) or [COC@0.25%](#). Repeat soil drenching after 3-4 weeks