BSc Horticulture Notes

(6th Dean Committee Syllabus)

Course No.: PATH-231 (New)

Course Title: Disease Management of Horticultural Crops

- All the notes provided in this file are based on the new 6th Dean Committee Syllabus.
- Students are required to take a print of this file to study for Semester End Examination.
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DISEASES OF HORTICULTURAL CROPS AND THEIR MANAGEMENT

LECTURE 1

CITRUS

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

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

Symptoms

- Disease starts as **water soaked patches on basal portions of the stem** near ground level
- Patches turn dark staining of bark brown
- Infection progresses into the wood
- Infected **bark dries, shrinks and cracks and shreds lengthwise** in to vertical strips
- **Reddish brown gum exudes from the bark** of infected trunk. Gum exudation is considerable in sweet oranges, but relatively little in grapefruit
- Infection extends to crown roots
- **Affected collar region is girdled** and finally the infected tree dies
- Prior to death, the tree usually blossoms heavily and dies before the fruits mature

Survival and spread

Primary: **Oospores** or as **dormant mycelium**

Secondary: **Sporangia** and **zoospores** spread by splashing rain water and irrigation water

Favourable conditions

- **Prolonged direct contact of trunk with water**, as in flood irrigation and water logging predisposes trees to 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
- **Low budded grafts** are mostly affected

Management

Preventive measures

- Selection of proper site with adequate drainage
- Selection **high budded** grafts (30 to 45 cm or above)
- Following **Double ring method of irrigation** by providing an **inner ring** about 45 cm around the tree trunk to prevent direct moistening of trunk
- Avoid injuries to crown roots or base of stem during cultural operations
- Use resistant **sour orange or trifoliate orange rootstocks** for propagating popular/commercial 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/chisel out the diseased portion
- Protect the cut surface with **Bordeaux paste** followed by spraying with **Fosetyl-Al 0.2%**
- Soil drenching with **0.2% Metalaxyl** (Metalaxyl+Mancozeb = Ridomil MZ 72)
- Apply ***Trichoderma viride*** multiplied on **neem cake**

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

- **Upper portions of the trunk, branches and twigs** are usually attacked
- Infection starts on growth cracks or ridges at **crotches**
- **Black gum oozes** out from the cracks developed on the diseased portion
- Infection spreads from bark to wood which dries and becomes discoloured
- Sometimes branches break at the infected portion
- **Dieback of tender twigs** and also profusely bearing branches occurs
- Large limbs are killed and if left unchecked the whole tree may be killed

Survival and spread

Primary: Black **pycnidial** bodies on the diseased bark

Secondary: **Pycnidiospores** or **conidia** by air, rain and insects

Favourable conditions

- Reduced tree vigour
- Insect damage
- Malnutrition
- Old age

Management

- Good orchard management to **maintain vigour of tress**
- Wound in the bark and gummed portions especially on limbs and forks should be scraped and protected with **Bordeaux paste**
- Spraying **Carbendazim 0.1%** on limbs and forks of affected and also on healthy trees

3) Dry root rot: *Fusarium solani*

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

Symptoms

- Affected trees blossom profusely bear a heavy crop of small sized fruits
- Disease is characterized by **sudden loss of turgidity yellowing and withering of leaves**
- Infected plants do not recover even when watered
- Moist decay of root bark in the early stages which later becomes dry and shredded with hard dead wood underneath

- **Peeling of bark** of the **affected roots** and formation of black sclerotia if *M. phaseolina is involved*, on the root surface is also common

Survival and spread

Primary: **Chlamydospres** in soil

Secondary: **Macro and micro conidia** through irrigation water and implements **Favourable conditions**

- Lack of sufficient **soil moisture**
- **Poor aeration** in defective soils with hard pan below leading to unfavourable soil-airmoisture relationship in the subsoil
- Nitrogen and other **nutrient deficiency**

Management

- Select soils of **sufficient depth** and **without hard pan** below
- Select **healthy grafts and seedlings** for raising new orchards
- Avoid **deep ploughing or digging** which are likely to injure roots
- Maintain **vigour of plants** correct nutrient and moisture deficiencies
- **Leaf mulch** in the tree basins during the dry season helps in **conserving soil moisture** and thereby reducing disease incidence
- Drench the soil with **Carbendazim 0.25%** or **Bordeaux mixture 1%** at the rate of 1 litre per m^2 of the tree basin in early stage of infection
- Apply ***Trichoderma viride*** multiplied in 10 kg of **neem cake** per tree annually

4) 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 than other citrus fruits. Total destruction of citrus orchards was done for eradication of canker in Florida State of USA

Symptoms

- Canker appears on leaves, petioles, twigs, 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
- On leaves minute water soaked round spots develop which enlarge slightly and turn **brown, eruptive and corky**
- On acid lime and sweet orange **leaves** spot measure about 2 to 3 mm in diameter and are surrounded by a characteristic **yellow halo**
- 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
- Canker lesions **on the fruit are not surrounded by yellow halo**. Several lesions on fruit coalesce to form a patch. The crater-like appearance is 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


Survival and spread

Primary

- **Bacterial cells** survive in **leaves** for 6 months on infected trees
- **Autonomous dispersal** through **infected seedlings**

Secondary

- **Bacterial cells** spread by **rain splashes**
- Citrus leaf miners (***Phyllocnistis citrella***) helps in the dissemination of the bacterium

Favourable conditions

- **Free moisture** for 20 minutes at 20-30°C and **high relative humidity (>85%)** favour initiation of disease
- Infestation by citrus leaf miners (***Phyllocnistis citrella*****)**

Management

- Select **healthy seedlings and grafts** for planting in new areas
- **Prune out and burn** all canker infected twigs before monsoon
- Periodical spraying of **Streptocycline (1 g) + Copper oxychloride (30 g) in 10 litres of water** at fortnightly interval in nurseries and at fortnightly interval in orchards during rainy season
- Use canker tolerant varieties like "**Tenali selection**" and "**Balaj**i"
- **Control leaf miner** when young flush is produced

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

Flexuous filamentous virion belonging to Closterovirus group with +ve ssRNA

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 prevalent in Andhra Pradesh, Tamil Nadu, Karnataka, Madhya Pradesh, Maharashtra, Punjab, Bihar, West Bengal and Sikkim.

It affects all citrus types but sweet orange, grapefruit and lime are more attacked. 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. **Kaghzi 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 flecking** (elongated translucent area) in young leaves of acid lime is visible when viewed against light (characteristic symptom)

- Characteristic **stem pittings** are formed on infected trees
- 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 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


Survival and spread

Primary

The virus particles spread through budwoods and grafts

Secondary

Virus particles transmitted by aphid vector, ***Toxoptera citricida***

Management

- **Strict quarantine** measures to be enforced. Use **certified budwood** free of CTV to prevent primary (vertical) spread of disease
- **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 **dimethoate or methyl S demeton** at 2 ml/l to reduce the secondary (horizontal) spread of the disease in the orchard

6) Greening or Huanglongbin (HLB): Candidatus Liberobacter 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. This disease affects almost all citrus varieties irrespective of root stock but more **severe on sweet orange** than on acid lime, mandarin and grapefruit. 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 mineral nutrient 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 with leaves that are short, upright and chlorotic having 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** in growth and **oblique (curved) 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

Survival and spread

***Primary*:** The **bacterial cells** spread through **budwoods and grafts**

Secondary*:** The **bacterial cells** transmitted through citrus **psylla, *Diaphorina citri. The bacterium is also transmitted from citrus to Periwinkle (*Catharanthus roseus*) through dodder

Management

- Select **certified disease-free seedlings**. Use pathogen free bud wood for propagation
- Raise virus free plants through shoot tip grafting
- Remove and destroy infected trees
- Control psyllids with insecticides like **dimethoate, or methyl s demeton**
- Tetracycline (500 ppm) spray though effective, requires fortnightly application and is also not advocated for human health reasons

7) Felt disease: ***Septobasidium pseudopedicellatum***

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 twigs and branches terminal to the point of infection

Management

- Prune the infected branches at least 2" below point of infection and destroy by burning
- Spray twice with Monochrotophos 0.05% and Zineb 0.25% with the onset of monsoon at monthly interval to prevent scale infestation and fungal infection

LECTURE 2

Mango

1. Powdery mildew: *Oidium mangiferae* (Perfect stage: *Eyrsiphe polygoni)*

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 is 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. Infected leaves become twisted, curled and fall
- 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 be as high as 70-80%

Survival and spread

Primary: **Dormant mycelium and conidia** in infected plant debris ***Secondary***: Wind borne **oidium type conidia**

Favourable conditions

Disease spread is favored by warm humid weather with cool nights

Management

- Two preventive sprays with wettable sulphur 0.3% before flowers open and after fruit set
- Dusting twice or thrice with fine sulphur
- Spraying with Karathane 0.1% before flowering and after fruit set (peanut stage).
- Resistant varieties: Neelum, Zardalu, Banglora, Torapari-khurd and Janardhan pasand

2) Anthracnose: ***Colletotrichum gloeosporioides*** **(PS: *Glomerella cingulata*)**

Economic importance: Reported from several districts of Punjab in 1939. Now prevalent in all mango – growing tracts of the country. The disease is a problem both in the field and storage. Neelum and Banglora are more susceptible.

Symptoms

- The fungus produces leaf spots, blossom blight, wither tip, twigs blight and fruit rot
- On leaves circular, light yellow brown spots are produced initially 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 causing them to wither
- On inflorescence stalks and flowers minute spots are produced which increase in size and cause flower drop – the symptom hence is called **blossom blight**
- **Sunken 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
- **Latent infection** is carried from the field and develops further which causes **rotting in the storage**

Survival and spread

Primary: **Saprophytic mycelium and conidia** in infected plant debris

Secondary: Wind borne **and rain splashed conidia**

Favourable conditions

- Temperature 25° C and R.H 95-97%
- Injuries to fruits at harvest and in storage

Management

- Avoid over-crowding in orchards
- Tree sanitation is important. Diseased twigs are to be pruned and burnt along with fallen leaves and fruits
- Spray carbendazim or thiophanate methyl (0.1%) or Chlorothalonil (0.2%) at 14 days intervals from fruit set until harvest
- Before storage, treat the fruits with hot water (50-55°C) for 15 minutes or dip in Benomyl solution (500 ppm) or Thiobendazole (1000 ppm) 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 Hyderabed & 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
- Coastal areas are free from the disease

Symptoms

There are two types of symptoms namely **vegetative** malformation and **floral** malformation because of hypertrophic effect of Gibberellic acid produced by the pathogen

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 compact bunch of hard flowers. **Individual flower is greatly enlarged** and has a large disc
- Based on compactness of the inflorescence three types of malformations have been described
  Light malformation – light compaction of inflorescence but bears fruits
  Medium malformation – moderately compact inflorescence with discontinuous growth and no fruit set
  Heavy malformation – entire inflorescence is converted in to a compact mass of sterile flowers. Inflorescence continues to grow with flowers having **hypertrophied bracts**. 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 Affected inflorescences generally are aborted and bear no fruit

Survival and spread

Primary: **Saprophytic mycelium and chlamydospores** in infected plant debris ***Secondary***: Wind borne and mite disseminated **micro** and **macro conidia**

Favourable conditions: and cool and

- Prevalence of eryophyid mite
- Misty wet and cool weather

Management

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

4) Sooty mould: *Capnodium ramosum*

Symptoms

- Black superficial encrustation of mass of spores of the fungus on upper surface of leaves affecting the photosynthetic activity. The fungus has no parasitic relationship with host
- Black encrustation forms on the fruits affects appearance and hence market price
- Pathogen grows and thrives on the sugary or honey dew secretions of **plant hoppers**

Survival and spread

Primary: **Saprophytic mycelium and spores** in infected leaves

Secondary: **Conidia** disseminated by wind and scale insects and aphids, *Lecanium hemisphaericum, L. viride, L. nigrum, Hemilecanium imbricans* and *Pulvinaria psidii*

Favourable conditions

Infestation by honey dew secreting sucking insects particularly plant hoppers

Management

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

5) 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

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 and become irregular
- The upper surface of the spot consists of numerous unbranched sterile or fertile filaments of the pathogen which project through the cuticle
- Initially the spots are greenish-grey in colour but later on the surface bears reddish-brown appearance because the algal cells are impregnated with pigment which masks the normal green chlorophyll

Survival and spread

Primary: **Algal filaments and sporangia** in infected leaves

Secondary: Rain splashed **sporangia** and **zoospores**

Favourable conditions

- High density planting
- Frequent rains with high humidity

Management

- Avoid close plantations
- Prune unproductive branches to improve air circulation within the canopy of a tree
- Spray Bordeaux mixture 1% or copper oxychloride 0.3%

6) Loranthus (Giant or true leafy mistletoes): *Loranthus longiflorus* or *Dendrophthoe falcata*

- Loranthus is a **partial stem parasite**. Loranthus seeds are disseminated by birds on to the stems of the host.

Symptoms

- Loranthus seeds do not require a host germination stimulus and will readily germinate
- The seedling radicle is negatively phototrophic 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 and removes water and mineral nutrients from the host
- When in **contact with the host cambium**, the **loranthus haustorium induces formation of additional wood** that enlarges into **fluted columns**
- Loranthus produces **long attractive tubular flowers** which **attract birds** that **disperse seeds**

Management

- Pruning of affected branches and burning them before the parasite flowers and sets seeds
- Bird scaring

LECTURE 3

DISEASES OF BER

Powdery mildew – *Oidium erysiphoides* f.sp. *zizyphi*
The disease is noticed generally at the end of October and prevails from **November to April**

Symptoms
- White to greyish powdery mass appears on young leaves and fruits
- Severely affected leaves shrink and defoliate
- White powdery growth appears on young fruits which later becomes profuse and finally turns brown to dark brown in colour
- Infected fruits become corky, crack, misshapen, underdeveloped and finally drop prematurely

Survival and spread
Primary: **Dormant mycelium and conidia** on infected plants
Secondary: Wind borne **conidia**

Favourable conditions
- Cool and dry conditions with morning R.H more than 90%

Management
- Spray Dinocap 0.1% or Wettable sulphur 0.2% during first and third weeks of November
- Two sprays of Carbendazim 0.1% 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

DISEASES OF GUAVA

1. Wilt – *Fusaium oxysporum* f.sp. *psidii, F. solani,*
Economic importance: It was first reported in 1935 from Allahabad. Area under guava cultivation in A.P was reduced to half due to the disease.

Symptoms
- The disease can be catagorized 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 a month
- Loss of turgidity in a branch or branches of one side of the tree is thee first external symptom. Leaves in tis branch wither turn pale and droop before finally dropping off
- Symptoms gradually appear on other branches also
- Infected and withered branches do not recover
- A few plants may show partial wilting, which is a common symptom of wilt in guava
- As all the branches have withered the tree wilts and dies
- The finer roots show black streaks which appear prominent on removal of bark. The roots also show rotting at the basal region and the bark is easily detachable from the cortex Light brown discoloration is noticed in vascular bundles

Survival and spread

Primary: **Chlamydospores** in soil
Secondary: **Macro and micro conidia** through irrigation water

Favourable conditions

- **pH 6.0** is optimum for disease development. Both pH 4.0 and 8.0 reduces the disease.
- Disease is more in loamy alluvial soils than in heavy soils
- Disease incidence increases in post monsoon period
- The nematode, ***Helicotylenchus dihystera*** aggravates the disease

Management

Cultural

- Layers or grafts for planting in new orchards should be procured from disease free areas
- 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 Bordeaux mixture and cover the pit for a few days before planting new plants
- While planting damage to the root of layers or grafts should b avoided
- Maintain proper tree vigour by timely and adequate manuring, inter-culture and irrigation
- Application of oil cakes like neem cake, mahua cake, kusum cake supplemented with urea
- Judicious amendments of Nitrogen and Zinc

Host Plant Resistance

- Resistant varieties: **Apple guava** and **Bhuvanagiri**
- Psidium species, *Psidium cattleianum var. lucidum* and *Syzigium cumini* (Jamun) are resistant to wilt ***Biological***
- *Aspergillus niger*, *Trichoderma viride, Trichoderma harzianum* and *Penicillium citrinum* can used as biocontrol agents

Chemical

- Drench the basins of trees in orchards with disease incidence with 0.2% Benomyl or Carbendazim, four times in a year

DISEASES OF SAPOTA

1. Flat limb – *Botryodiplodia theobromae*

First reported from Maharashtra and Gujarat. Now prevalent in all sapota growing areas of the country. The disease is a problem in orchards above 10 years age.

Symptoms

- Branches of affected trees become **flat and twisted at the terminus**
- Leaves become thin, small and yellow and are produced in clusters on the affected branches
- Very few flowers are produced on affected branches which will remain infertile
- Fruit set is rare and when set fruits are undersized, hard and fail to ripen
- Foliage and fruits fall prematurely

Survival and spread

Primary: **Conidia on infected plants**
Secondary: Wind borne C**onidia**

Management

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

DISEASES OF PAPAYA

1) Foot rot / stem rot: *Pythium aphanidermatum*

Symptoms

- Water soaked patches develop on the stem at the ground level
- Patches enlarge and diseased tissues turn brown and rot
- Because of rotting the basal portion of stem is girdled affecting the upward flow of water and nutrients and weakening the plant
- Internal tissues of bark appear dry and give **honey comb appearance**
- Infection spreads to roots and causes decay
- Terminal leaves turn yellow, wither and droop
- Fruits shrivel and drop off
- Entire plant topples over and dies

Survival and spread

Primary: **Oospores** and **saprophytic mycelium** in soil and infected seedlings transplanted in the main field
Secondary: Zoospores through irrigation water

Favourable conditions

- Appears from June to August

- Younger seedlings are more susceptible than older ones
- Severity increases with intensity of rainfall
- Ill drained conditions and high soil moisture

Management

- Seedlings should be raised in well drained nursery area or in protrays in modern nurseries in protected polyhouses
- Uproot the diseased seedlings and burn
- Drench the base of stem with COC@0.25% or metalaxyl + mancozeb @0.1% or Bordeaux mixture 1%

2) Mosaic: *Papaya mosaic virus* or *Papaya ringspot virus* or *Carica virus* 1

Virus is a potyvirus with long flexuous rod shaped particles having ssRNA as genome

- India In India 1st reported from Mumbai and Pune and occurs more in central India
- 90-100% damage occurs in severe cases

Symptoms

- **Mottling** and puckering of leaves, especially the young ones
- **Water soaked chlorotic** spots on tender stem and petioles
- The lamina is reduced and malformed and are often modified into tendril like structures giving a **shoestring** appearence
- Decline and marked reduction in growth of diseased plants
- Older leaves fall down and a small tuft of younger leaves is left at the top in upright position
- Fruits develop innumerable circular, water soaked spots with **concentric rings** Fruit size is severely reduced with deformed shape

Survival and spread

Primary: Virus particles on affected plants

Secondary: Aphids mainly ***Myzus persicae*** and other species *Aphis malvae, A. gossypii, A. medicaginis, Rhopalosiphum maidis, Microsiphum solonifolii*

- Other hosts: *Cucumis sativus, Cucurbita pepo, C. maxima, Citrullus vilgaris, Luffa acutangula, Lagenaria siceraria*, Safflower and some ornamental plants

Management

- Disease free seedlings raised in modern insect free nethouses or polyhouses
- Rouging and destruction of diseased plants
- Raising barrier crops like Sorghum on the boundaries of the field
- Vector control with systemic insecticides like dimethoate or methyl S demeton

- *Carica cauliflora* is resistant
- Growing transgenic (coat protein mediated) papaya varieties like Sun Up and Rainbow

3) Leaf curl: ***Tobacco leaf curl virus*** **or** ***Nicotiana virus*** **10**

Virus is a Geminivirus with geminate spherical particles having ssDNA as genome

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

Primary: Virus particles on affected plants

Secondary: Whitefly ***Bemisia tabaci***

- 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 and other host species
- Erecting yellow sticky traps for whitefly trapping
- Vector control with monochrotophos at 1.6 ml/l or Dimethoate or metasystox at 2 ml/l

4) Anthracnose – *Colletotrichum papayae*

Symptoms

- All aerial parts of the plant are attacked
- Reddish brown circular to irregular necrotic spots which later increase in size develop on leaves and stems. Older parts are more susceptible
- 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
- Fruit infection continues in storage and the pulp beneath the lesion rots **Survival and spread**

Primary: Mycelium on infected plant debris in the field. Incipient mycelia infection carried by fruits from the field

Secondary: Conidia by wind and rain splash

Favourable conditions

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

Management

- Field sanitation by removal and destruction of infected plant debris
- 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
- Avoid injuries at harvest, transport and storage
- Fumigation of fruits with **benzylisothiocyanate** and coating with groundnut oil controls post harvest spots and rots

LECTURE 4

DISEASES OF BANANA

1) Yellow Sigatoka – *Mycosphaerella musicola* (I.S: *Pseudocercospora musae*) Black sigatoka – *Mycosphaerella fijiensis* (I.S: *Paracercospora fijiensis*)

First observed in Java in 1902

- Epidemic in 1913 in *Sigatoka* valley in Fiji
- Wide spread in nature and occurs is many countries except in Egypt and Israel
- In India a serious threat in states of Assam, Tamil Nadu, Karnataka & A.P
- The most important commercial cultivars belonging to Cavendish group are highly susceptible
- Black Sigatoka is not prevalent in India

Symptoms

- Early symptoms appear on the lower leaves
- Initially small reddish brown specks develop on leaves near the tip or margin of lamina
- Specks may also be produced near the midrib
- Specks increase in size and turn in to **spindle shaped spots** with reddish brown margin and gray centre surrounded by a yellow halo
- Spots formed near the midrib enlarge and extend towards the margin of lamina
- Spots coalesce and the entire spotted area appears dried
- Disease gradually progresses on to upper leaves
- Infection becomes severe after bunch emergence with the entire foliage infected under favourable conditions
- Fruits in bunches of infected plants are under developed and may ripen prematurely


Survival and spread

Primary: Pathogen survives on dry infected leaves on the field soil and primary infection takes place through **ascospores** produced in the infected plant debris

Secondary: **Conidia** by wind and rain splash

Favourable conditions

- High humidity, heavy dew and rainy weather with temp above 21° C
- Prolonged leaf wetness periods
- Poor drainage and low soil fertility particularly of potassium

-
- Closer planting
- Susceptible cultivars like Grand Naine, Dwarf Cavendish and Giant Cavendish More suckers in a mat because of non removal

Management

- Planting banana in well drained soils
- Growing moderately resistant cultivars like Karpura Chakkerakeli
- Planting at recommended density (1000 plants/acre)
- Prunning suckers periodically to avoid overcrowding in the field
- Removal and destruction of affected leaves followed by spraying with BM 1% + linseed oil 2%
- Applying recommended dose of potassium fertilizer

Spraying mancozeb or cholorothalonil 0.2% suspended in mineral (paraffin) oil

Spraying chlorothalonil 0.2% with non ionic adhesive in pre-monsoon period and propiconazole 0.1% interspersed with tridemorph 0.1% at 20 days interval in rainy period

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 in the Latin American countries
- Cultivars **Rasthali (Amrutapani), Gros Michel, Karpooravalli** cultivars are susceptible
- Four races of the pathogen are known to exist but race 1 is mostly prevalent in India attacking Silk group of cultivars (Rasthali or Amritapani)

Symptoms

- Fungus attacks roots and finds its way in to the pseudostem
- Conspicuous symptoms usually appear on 3 to 5 months old plants, although 2-3 months old plants are also killed under highly favourable conditions
- Symptoms initially seen in **older plants** in a mat
- 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
- **Longitudinal splitting** of pseudostem is very common
- Light yellow to dark brown discolouration of vascular strands in pseudostem. Usually the **discolouration appears first in the outer or oldest leaf sheath and extends in to the inner sheaths**
- The fungus grows and blocks the vascular system resulting in wilting of the plant
- Vascular discolouration in cross sections of rhizome appears reddish brown towards periphery progressing in to centre of rhizome
- Rhizomes of affected plants give characteristic odour of rotten fish if infection is due to odoratum isolate of the pathogen
- Young suckers also develop the disease but 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

Survival and spread

Primary: **Chlamydospores** in soil and propagules in infected suckers used for planting
Secondary: **Micro and macro conidia** through irrigation water

Favourable conditions

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-
  Saturated poorly drained heavy soils
  Cultivation of susceptible cultivars like Amritapani
- Infection by burrowing nematode, *Radopholus similis*, predisposes the plants to disease

Management
- Use of disease free suckers for planting
- Avoid ill drained soils
- Flood fallowing for 6 to 24 months or crop rotation with puddle 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
- Neem cake + *Trichoderma viride* should be applied in planting pits
- Soil drench with 0.2% carbendazim or rhizome injection with 0.2% carbendazim
- Growing resistant Cavendish varieties, *viz*., **Basrai** (Vamanakeli or Dwarf cavendish), **Poovan** (Karpura chakkarakeli) etc.

3) Moko disease / Bacterial wilt: ***Ralstonia solanacearum* (race 2)**
(*Pseudomonas* or *Burkholderia*)

Gram negative bacterium with rod shaped cells that are motile by 1-4 flagella
Also infects collateral hosts like *Heliconia*
- First recorded in Guyana in 1840 in *Moko* plantain
- Not reported from India

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.

Survival and spread
Primary: Bacterial cells in soil and through diseased plant suckers used for planting

Secondary: Bacterial cells through irrigation water

Management
- Grow relatively resistant varieties like **poovan** and monthan
- Adopt strict plant quarantine and phytosanitary measures and plant healthy suckers
- Exposure of soil to sunlight during dry hot weather

- Eradicate infected plants and suckers by rouging or 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
  Drenching soil in infected pockets with bleaching powder solution (1.5%) and Bordeaux mixture 1% + streptocycline (0.02%)
- Biocontrol with *Pseudomonas fluorescens*

4) *Erwinia* rhizome rot: *Erwinia caratovora* sub.sp. *caratovora* and *Erwinia chrysanthemii*

Symptoms
- Usually young plants are attacked. Under favourable conditions even mature plants are infected
- In newly planted young sprouting sucker the rhizome is infected and infection progresses in to pseudostem leading to toppling or tipover of the germinating sucker
- In established plants water soaked spots develop on outer leaf sheaths on base of pseudostem near the soil line
- The spots turn brown and soft rotting of pseudostem tissue and rhizomes takes place
- Infected plants have scanty roots with dark brown lesions and necrotic tip
- Infection spreads to upper part of pseudostem and to rhizomes
- In many cases, the pseudostem tips over because of breaking caused by rotting at the ground level
- Mature plants are slow to exhibit symptoms and may produce small sized bunches which may fail to emerge from the shoot tip
- In infected rhizomes, pockets of dark water soaked areas develop. Infection may result in the production of cavities which resemble root borer tunnels
- Infection may predispose plants of otherwise Panama disease resistant cultivars to

Survival and spread
Primary: Bacterial cells in soil and through diseased plant suckers used for planting
Secondary: Bacterial cells through irrigation water

Favourable conditions
- Juvenile stage of the crop is highly susceptible
- Prevalence of high temperature (37^{o} C) in early stages of crop
- Water logging and high temperatures favour infection by *E. chrysanthemii* Growing susceptible cultivars the Cavendish and Tella chekkarakeli

Management
- Avoid planting susceptible varieties during periods of high rainfall or in water logged soils in problematic areas
- Crop rotation with rice or sugarcane for three to four years
- Ensure that only healthy suckers are planted. Dip the suckers in copper oxychloride (5g/lt) + monochrotophos (2.5ml/l) solution

-
- Maintain proper soil aeration by intercultivation
- Maintain optimum soil moisture by light and frequent irrigation
- Grow cowpea in interspaces to reduce soil temperature
- Remove and destroy infected plants along with roots
- Drench the infected suckers with bleaching powder (1.5%) solution
- Restrict to one or two ratoons based on disease incidence

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

- Banana bunchy top virus (BBTV)
- First reported from Fiji in 1889 in Cavendish varieties
  Around 1940, introduced into **India from Srilanka** through cyclone
- The virus is a domestic quarantine pest in India. Hence movement of planting suckers from North East, Tamil Nadu, Karnataka and Kerala to other parts of the country is banned

The virus is a **ssDNA** virus with isometric particles belonging to Babu virus group

Symptoms

- Infection may start at any stage of crop growth
- Paling of lamina with interveinal chlorosis that is evident against light
- Prominent dark green streaks on the petioles and along midrib and leaf veins that range from a series of dark green dots to a continuous dark green line (**Morse code**)
- Infected plants show marked stunting
- Leaves are reduced in size with narrowed lamina and shortened petiole, produced at shortened internodal length, become erect and brittle and crowded at the top (bunchy top)
- Leaf margins also show chlorosis and slight curling and necrosis
- Infection of young plants leads to failure of bunch emergence
- Tips of inflorescence bracts of infected plants remain green and do not turn to normal pink or purple

Survival and spread

Primary: Virus particles through diseased suckers used for planting

Secondary: Virus particles transmitted by banana black aphid, *Pentalonia nigronervosa* *Colocasia esculenta* serves as a latent reservoir host

Favourable conditions

- Progressively increasing temperature from February onwards favours virus spread and symptom expression
- Prevalence of infected reservoir host
- Prevalence of vector

Management

- Adoption of strict quarantine measures
- Use of only certified banana suckers or tissue culture plants for planting
- Periodical monitoring and rouging of infected plants with all suckers in the mat by rouging or killing by injecting herbicide, 2, 4-D
- Raising barrier crops like sunhemp in three to four rows on the field boundaries to check aphids from entering the fields from neighbouring infected fields
- Vector control with systemic insecticides, *viz*., Phosphomidon @ 1ml/l or Methyl demeton or Dimethoate @ 2 ml/l
- Discouraging intercropping with *Colocasiai* in disease endemic areas

6) Banana Mosaic / Infectious chlorosis / Heart rot: Cucumber Mosaic Virus (CMV)

- The virus is a domestic quarantine pest in India. Hence movement of planting suckers from Gujarat and Maharashtra to other parts of the country is banned

Cucumber mosaic virus (CMV) is a Cucumovirus with spherical particles having ssRNA

Symptoms

- Typical mosaic-like or discontinuous linear streaking in bands extending from margin to midrib running parallel to veins (**Mosaic**)
- Leaf size is reduced and leaves show thickened veins
- Chlorosis of newly emerged leaves (**Infectious chlorosis**)
- Occasionally rotting of central youngest leaf and leaf sheaths in severe cases (**Heart rot**) which progress into the pseudostem leading to death of plants
- Diseased plants do not reach maturity and may fail to produce bunch

Survival and spread

Primary: Virus particles through diseased suckers used for planting

Secondary: Virus particles transmitted by banana black aphids, *Aphis gossypii, A. maydis* *Cucumis sativus* serves as a latent reservoir host

Favourable conditions

- Late and post monsoon period favours virus spread and symptom expression
- Prevalence of infected reservoir host
- Prevalence of vector

Management

- Adoption of strict quarantine measures
- Use of disease free suckers for planting
- Dry heat treatment of suckers at 40^0 C for 1 day
- Avoid growing cucurbits as intercrop
- Raising barrier crops like sunhemp in three to four rows on the field boundaries to check aphids from entering the fields from neighbouring infected fields
- Vector control with Methyl demeton or dimethoate or Dimethoate @ 2 ml/l at 3 – 4 weeks interval

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

- The virus disease was first reported in Kerala as *Kokkan* disease
- Very rapidly spreading in all the banana growing states in the absence any regulation on movement of suckers

BBrMV is a potyvirus with long flexuous rod particles having ssRNA

Symptoms

- Symptom expression is clearly seen in Monthan (cooking banana) and Karpura Chakkerakeli cultivars
- In cooking bananas water soaked chlorotic streaks initially develop on sheaths and petioles of leaves at the top. The streaks later turn pinkish

- In Karpura Chakkerakeli and other commercial cultivars like the Cavendish the disease is characterised by continuous or discontinuous pinkish streaks along the pseudostem
- The most characteristic and confirmatory symptom is development of pinkish to purplish streaks that are either continuous or discontinuous on bracts of inflorescence
- In severe cases, pink streaks continue on the lower surface along the length of midrib
- Flattening at the top of the plants (crown) with leaves arranged as in travelers palm is common in cooking banana cultivars
- Unclasping of leaf sheaths from the pseudostem is a feature of the disease
- Pseudostems of infected plants bow or curve at an angle rendering them prone to break even at moderate wind speeds
- Infected plants generally do not flower or flower very late and produce a small bunch with elongated and brittle peduncle

Survival and spread

Primary: Virus particles vertically spread through diseased suckers used for planting

Secondary: Virus particles are horizontally transmitted by banana black aphids, *Aphis gossypii, A. maydis* and *Rhopalosiphum maidis*

Favourable conditions

- Disease spread and symptom expression is severe in winter months (low temperature)
- Prevalence of vector

Management

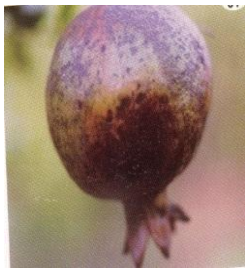
- Use of disease free suckers for planting
- Dry heat treatment of suckers at 40^0 C for 1 day
- Raising barrier crops like sunhemp in three to four rows on the field boundaries to check aphids from entering the fields from neighbouring infected fields
- Vector control with Methyl demeton or dimethoate@ 0.2% at 3 – 4 weeks interval

DISEASES OF POMEGRANATE

1) Anthracnose – *Colletotrichum gloeosporioides*

Symptoms

- Small circular to irregular dull violet or black spots on the leaves
- On fruits small circular to irregular brown spots with raised margins develop and produce acervuli
- Reduction in market value because of fruit infection



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@0.25% at fortnightly intervals

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

Symptoms

- Small irregular water soaked spots appear initially on leaves and later turn dark brown with yellow halo
- Spots coalesce and form large necrotic patches
- Leaves distorted and malformed
- Severely infected young leaves are 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 leading to break down of branches
- Brown to black oily spots are produced 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

Primary: Bacterial cells in infected cuttings and plant debris

Secondary: Rain splashed bacterial cells

Favourable conditions

- Severe during August-November
- Intermittent rains
- High humidity and temp ranging from 20 to 27° C

Management

- Clean cultivation and strict sanitation in orchard
- Securing disease free planting material
- Spray B.M @1% along with antibiotic, Streptomycin 100 ppm or 0.01%

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 have higher acid content than healthy fruits and are unsuitable for wine making.

Symptoms

- The disease attacks vines at any stage of 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 cause lesser damage than cluster or berry infection
- Infection of stem leads to dark brown discolouration

Survival and spread

Primary: Through **dormant mycelium** and **conidia** present in the infected shoots and buds
Secondary: Through air-borne **conidia**

Favourable conditions

- Cool dry weather
- Maximum temperature in the range of 27-31°C with R.H. up to 91% favour disease incidence (November and December).

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 Dinocap or Tridemorph @0.1%
- Oxythioquinox (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

2) Downy mildew: *Plasmopara viticola*

Economic importance

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

Symptoms

- Symptoms 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 limited by veins appear on upper surface of leaves
- Correspondingly on the lower surface dirty white, downy growth of fungus appears
- Affected leaves become yellow and brown and 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

Survival and spread

Primary: Oospores present in the infected leaves, shoots and berries. Also as dormant mycelium in infected twigs

Secondary: Sporangia or zoospores by wind, rain and insects

Favourable conditions

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

Management

- Field sanitation by collection and burning of fallen leaves and twigs
- Vine should be kept high above ground to allow circulation of air by proper spacing
- Pruning (April - May & September - 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 Bordeaux mixture 1% or **Fosetyl -Al (Aliette)** 0.2% or curative spray with **Metalaxyl + Mancozeb (Ridomil MZ 72)** 0.2% or Azoxystrobin 0.1%
- Spray schedule with Bordeaux mixture1% and other chemicals
  1 – Immediately after pruning of vines
  2 - When new flush is formed (3-4 weeks after pruning)
  3 – Before buds open
  4 - When bunches or berries are formed
  5 – During shoot growth

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

It is especially serious on new sprouts during rainy season. Among various foliar diseases of grapevine in India, anthracnose has longest spell spread over 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 on young leaves
- 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 may occur
- Infection on the stalk of bunches and berries result in the shedding of bunches and berries
- **Sunken spots with ashy grey centre and dark margin** appear on fruits (**bird's eye** symptom). In warm and wet weather, pinkish spore mass develops in the centre of spots **Mummification** and shedding of **berries**

Survival and spread

Primary: Survives as dormant mycelium in the infected stem-cankers

Secondary: Wind borne and rain splashed conidia

Favourable conditions

- Warm wet weather with continuous drizzle of rain and windy weather for 2-3 days Low lying and ill drained soils Anab-e-Shahi variety is susceptible.

Management

- Removal of infected twigs
- Selection of cuttings from disease free areas and dipping them in 3% $FeSO_4$ solution for 30 minutes before planting.
- Spraying Bordeaux mixture 1% or COC @ 0.25% or **carbendazim** @ 0.1%.
- Varieties like Banglore blue, **Golden Muscat**, Golden queen and Isabella are resistant

4) Alternaria leaf spot: *Alternaria vitis*

Symptoms

- 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
- Individual spots appear rarely in the middle of the leaves
- Appearance of patches of spots mostly along the margin of leaves
- In severe cases of attack, leaves dry completely and defoliation occurs

Survival and spread

Primary: Survives as mycelium or conidia in infected plant debris

Secondary: Wind borne conidia

Favourable conditions

- High humidity
- High rainfall and dew
- Heavy dose of nitrogenous fertilizers

Management

- Sanitation of the orchard
- Selection of disease free planting material
- Foliar spray of mancozeb@0.25%

5) Rust: *Phakopsora euvitis*

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

Symptoms

- Minute yellow coloured pustules are formed initially on lower surface and later on upper surface
- These pustules turn in to orange powdery spores on the underside of mature grapevine leaves
- Under severe infection, the entire leaf surface is covered by sori leading to premature defoliation
- The disease eventually weakens the vine due to poor shoot growth
- Reduction in quantity and quality of fruit

Survival and spread

Primary: Teliospores in infected plant debris. *Meliosma myriantha* is the alternate host on which pycnia and aeciospores are produced

Secondary: Wind borne uredospores

The pathogen also infects *Ampelocissus* spp in Australia

Management

- Field sanitation
- Destruction of alternate host
- Spray zineb@0.2% or dust sulphur@25Kg/ha or Oxycarboxin 0.2% or Triadimefon 0.1%
- Breeding resistant varieties

LECTURE 6

DISEASES OF APPLE

1) Scab – *Venturia inaequalis* (I. S: *Spilocaea pomi*)

- 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
- Pulp beneath scabby lesion may rot
- Infection spreads and causes damage in transport and storage also
- Severely affected young fruit may drop

Survival and spread

Primary: Ascospores formed in pseudothecia in leaf litter

Secondary: Wind borne conidia

Management

- Clean cultivation
- Spraying **urea** 5% on leaf litter and 2% on twigs as nitrogen inhibits **pseudothecial formation** and thereby reduces primary inoculum production
- **Resistant varieties**: Emira, red free, Ambstraking, Ambroyal, Ambrich and Ambred
- Spray **Dodine** 0.25% or captan 0.2% 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% Captofol (or) 0.3% Captan
  - IInd spray pink bud - 0.2% Captan (or) 0.3% Mancozeb
  - IIIrd spray at petal fall – 0.2% Dodine 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* (I. S: *Oidium* spp)

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

Survival and spread
Primary: Dormant mycelium in diseased vegetative buds and fruits
Secondary: Wind borne conidia

Management
- Sanitation of orchard
- Pre-bloom spray of lime sulphur (1:60)
- Spray Dinocap @ 0.15% or Wettable Sulphur
- 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** 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 giving a burnt appearance
- Tips of shoots may wilt rapidly. 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 amber coloured on exposure to air



Survival and spread

Primary: The bacteria overwinter at the margins of the cankers and possibly in buds and apparently healthy woody tissue

Secondary: 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 30 cm below the point of visible infection
- Disinfect the tools after each cut with 10% sodium hypochlorite Insect control
- Resistant varieties
- Dormant sprays with Bordeaux mixture
- Bordeaux mixture + streptomycin is effective as blossom spray

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
- *Agrobacterium radiobacter* (Strain K1026) should be applied to fresh wounds

LECTURE 7

DISEASES OF CHILLI

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

- Disease of nursery beds and young seedlings resulting in reduced seed germination and poor stand of seedlings.
- Very high seedling mortality 25-75%

Symptoms

- **Pre-emergence** damping off: Seedlings disintegrate before they come out of soil surface leading to poor seed germination
- **Post-emergence** damping off is characterised by development of disease after seedlings have emerged out of soil but before the stems are lignified

- **Water soaked lesion** formation at collar region
- Infected areas turn **brown and rot**
- Plants shrivel and **collapse** as a result of softening of tissues
- In *Rhizoctonia solani* attack infected stems become hard, thin (**wire stem** symptoms) and infected seedlings topple Disease appear in patches both in nursery and field beds.

Survival and spread

Primary: **Oospores** in soil in case of *Pythium*
Sclerotia in soil in case of *Rhizoctonia*

Secondary: **Zoospores** through irrigation water in case of *Pythium*
Mycelial growth in soil and **sclerotia** through irrigation water in case of *Rhizoctonia*

Favourable conditions For
Pythium

- Heavy rainfall
- Excessive and frequent irrigation
- Poorly drained soil and close spacing
- High soil moisture with temp around 25-30^{o} C

For *Rhizoctonia*
High soil moisture with temp around 30 – 35^{0} C

Management

- Raising nursery in **light soil with proper drainage**
- **Rabbing** – burning farm trash on the surface of the beds
- Sowing seed on **raised beds** of 6-8" high (15cm)
- Using **optimum seed rate of 650 g/cent**
- Seed treatment with Thiram or Captan @ 2-3 g/kg.
- Soil drenching with Bordeaux mixture 1% or Copper oxychloride 0.3% or Metalaxyl (Ridomil) 0.2%
- Biocontrol with *Trichoderma viride* and *T. harzianum*
- Raising modern nurseries in portrays under controlled conditions in polyhouses **2) Die-back and fruit rot – *Colletotrichum capsici*** *(Tel: Glomerella cingulata)*

- Severe in Guntur and Krishna districts

Dieback Symptoms

- Disease is more in 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 vulnerable to attack than 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.
- Tissues around lesions will be bleached and turn 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

Survival and spread

Primary: **Mycelium and conidia in acervuli** in infected seeds and diseased crop debris
Secondary: **Conidia** dispersed by rain splash and wind

Favourable conditions

- Temp, 28^0 C with RH more than 97%
- Humid weather with rainfall at frequent intervals
- Intercropping with **turmeric** which is an other host of the fungus

Management

- **Seed treatment with Captan or Thiram 3-4g/kg**
- Collect **seeds** only **form fruits without infection**
- **Avoid intercropping** with susceptible **turmeric** cultivars
- Collect and destroy all infected plant parts
- Removal and destruction of Solanaceous weed hosts and infected plant debris
- Spray three times 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

- Plants from seedling to early flowering stage are susceptible
- Being a **weak parasite** the fungus colonises **dead or dying tissues** before it actively invades living tissues
- **Fruit infection** is observed **predominantly around calyx**
- The pathogen attacks flowers through the **senescing petals** and overgrows on flowers resulting in brown or black mass of rotten tissue
- Flower stalks, buds and leaves will be attacked subsequently
- On infected tissues **stiff silvery mass of whisker-like or hairy strands** of the fungal growth develops on which black mass of spores is produced which is the **chief diagnostic feature**
- Infected young fruits may abort
- Individual branches of plants may be attacked which show dieback
- **Stems** of infected plants appear **wet and green** and the **bark peels of in to shreds**

Survival and spread
Primary: **Zygospores** on seeds and diseased crop debris in soil
Secondary: **Conidia** (**sporangiospores**) dispersed by rain splash and wind

Favourable conditions
- Temp, 28^0 C with RH more than 97%
- Extended periods of high rainfall followed by warm weather

Management
- Adopt recommended spacing to maintain adequate air circulation
- Field sanitation by destroying infected debris
- Select the seeds from healthy fruits and treat the seed with Captan or Thiram 3g/kg seed
- Spray Mancozeb 0.25% or Copper oxychloride 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. However, in Andhra Pradesh TMV and CMV are pedominant

TMV is a rigid rod shaped particle with ssRNA as its genome
CMV is a spherical particle with ssRNA as its genome

Symptoms: Symptoms vary with the virus

TMV

- 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
- Reduction in leaf size and narrowing of lamina
- Chlorosis leading to mosaic symptoms
- Downward curling along with midrib
- Fruit may be small and distorted

Survival and spread
TMV
Primary: Externally **seed borne** virus **particles**
Secondary: **Mechanically** transmitted virus **particles**

CMV
Primary: Externally **seed borne** virus **particles** to some extent **and vector transmitted** from **other** and **collateral hosts**
Secondary: Virus **particles** transmitted by **aphid vectors,** *Myzus persicae, Aphis gossypii, A. craccivora*

Management
- Collection of seeds from healthy fields
- Seed treatment with trisodium orthophosphate 16% for 15-30 minutes followed by washing clean water
- Rouging and destruction of infected plants to remove foci of inoculum
- Raising barrier crops around the fields to intercept aphid vectors from neighbouring fields
- Spraying systemic insecticides Methyl demetan 2 ml/l or Dimethoate 2 ml/l for vector management
- Growing resistant varieties

5) Powdery mildew – *Leveillula taurica*
- Usually seen from December - February

Symptoms

- White powdery coating appears mostly on the lower surface and occasionally on 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 branches and young fruits
- Diseased fruits do not grow further and may drop down prematurely

Survival and spread
Primary: Dormant mycelium in the infected crop debris
Secondary: Wind dispersed conidia

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

Management
- Spraying wettable Sulphur 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** and **grey centre** 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

Survival and spread
Primary: **Dormant mycelium** in the infected crop debris, seeds and volunteer plants
Secondary: **Wind** dispersed **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

Survival and spread
Primary: **Seed borne** bacterial **cells**
Secondary: Bacterial **cells** spread by **rain splash**

Favourable conditions
- Moderate temperature
- High relative humidity
- Intermittent rains

Management
- Seeds should be collected from healthy fruits
- Seed treatment with Copper oxychloride 2g/kg seed
- Field sanitation by removal and destruction of infected plant debris
- Spray twice with Streptocycline 0.1g (100ppm) mixed with Copper oxychloride 3g per litre of water at 15 days interval

LECTURE 8

DISEASES OF EGG PLANT (BRINJAL or AUBERGENE)

1) Little leaf – Phytoplasma

Symptoms
- Infection is initially observed in one branch and later the entire plant shows symptoms
- Reduction in size of newly formed leaves
- Reduction in petiole length making the leaves appear to be sticking to the stem

- Affected plants have narrow, soft, smooth and yellow shorter leaves
- 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

Survival and spread

Primary: The pathogen survives in collateral weed hosts like ***Datura fastuosa, D. stramonium, Catheranthus roseus, Argemone mexicana*** and transmitted to egg plant by jassids ***Secondary***: Jassid - ***Hishimonas phycitis***

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 Dimethoate 2 ml/l

2) Bacterial wilt – *Ralstonia solanacearum* (Race 1)

Symptoms

- Sudden wilting and death of infected plants is the characteristic symptom. The petioles 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 ooze comes out

Survival and spread

Primary: The bacterium (cells) is both seed and soil borne in nature and overwinters in infected plant parts in soil, in wild host plants and weeds

Secondary: Bacterial cells spread through irrigation water or infested soil and agricultural implements

Favourable conditions

- Relatively high soil moisture and soil moderate temperature favour the disease development
- Continuous cultivation of Solanaceous crops in the same field

Management

- Growing 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 in nurseries
- Biological control with *Pseudomonas fluorescens, P. cepaciae, Bacillus sp. & Erwinia* spp

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 showing concentric rings** 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

Survival and spread

Primary: Pathogen is **seed borne** and also survives in **plant debris** as **mycelium** and **pycnidia**

Secondary: 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 26^0C under wet weather conditions

Management

- Procuring seeds from healthy fruits followed by seed treatment with thiophanate methyl at 1g/kg seed or hot water treatment of seed at 50^0C for 30 minutes
- Practicing crop rotation and summer ploughings helps in reducing initial inoculum
- Removal and destruction of diseased crop debris
- Spray twice with thiophanate methyl or carbendazim@0.1% at 20 days interval
- Resistant variety: Florida Beauty. *Solanum gilo*, *S. macrocarpa* and *S. integrifolium* are wild resistance donors

DISEASES OF BHENDI

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

- Very serious constraint in bhendi production through out the country
- Geminivirus having spherical bipartite particles with ssDNA as genome

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, turn smaller, harder and rough. Loss in fruit yield ranges from 50-100% based on disease incidence

Survival and spread

Primary: Virus particles in infected plants and collateral hosts like ***Hibiscus tetraphyllus*, *Croton sparsiflora*** and ***Ageratum* spp**

Secondary: Virus particles transmitted by **whitefly *Bemisia tabaci***

Management

- ***Tolerant varieties***: **Parbhani Kranti**, Pusa savani, Janardhan, Haritha, Arka Anamika and Arka Abhay
- Removal and destruction of infected **volunteer plants** and **collateral hosts** in the vicinity of the field
- Erection of **yellow sticky traps in the field** to trap the whiteflies
- Vector management for restricting spread by spraying systemic insecticides like Monocrotophos, 1.5 ml/l, Dimethoate or Methyl S Demetan 2 ml/l

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

Symptoms

- ***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

Survival and spread

Primary: The fungi survive through **conidia** and **stromata** on crop refuse in soil

Secondary: Wind dispersed **conidia**

Management

- Field sanitation to the extent possible
- Spray **Mancozeb** or **Zineb** 0.2% or **Carbendazim** 0.1% at fortnightly intervals based on disease incidence and severity

3) Powdery mildew: *Erysiphe cichoracearum* (IS: *Oidium* spp)

Symptoms

- Grayish powdery growth occurs on the under as well as on the upper surface of the leaf
- Affected leaves turn yellow and drop off leading to severe yield loss

Survival and spread

Primary: **Dormant mycelium** and **cleistothecia** in crop residue

Secondary: Wind dispersed **conidia**

Management

- Field sanitation to the extent possible
- Dust finely ground sulphur at 30 kg/ha or spray Wettable sulphur 0.3% or Dinocap 0.2% , three to four times at 15 days interval

LECTURE 9

DISEASES OF POTATO

1) Late blight – *Phytophthora infestans*

- Usually infection starts on **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 water soaked or faded green patches on upper surface of leaf which turn brown
- Spots enlarge and zonations as concentric rings develop in them
- Downy growth of the pathogen correspondingly on 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 from surface to the centre
- Decay of plant parts under favourable weather which emits foul smell



Survival and spread

Primary: **Mycelium** in infected seed tubers or **oospores** in soil. The fungus can also survive on collateral hosts like tomato

Secondary: Wind dispersed and rain splashed **sporangia** or **zoospores**

Favourable conditions

- Cool moist conditions
- RH: >90% and with suitable temperature (12-24^0 C)

***Dutch rules* for predicting disease epidemic**

- 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

Forecasting system for late blight disease: **BLITECAST**

Management

- Regulatory measures restricting movement of infected tubers specially for seed purpose
- Select healthy tubers for planting
- Delayed harvesting
- High ridging to about 10-15 cm height reduces tuber infection
- Grow resistant varieties such as **Kufri Jyothi, Kufri Badshah, Kufri Jeevan, Kufri Sherpa**
- Resistant (R genes) sources: ***Solanum demissum*** and ***S. pimpillifolium Prophylactic measures***
- Copper oxychloride 0.3% or Mancozeb 0.25% or chlorothalonil 0.2% or BM 1% Metalaxyl +Mancozeb 0.2% 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 before

2) Early blight: *Alternaria solani*

Symptoms

- Disease occurs early in the season on 3 weeks old plants
- Dark brown necrotic spots with yellow halo develop on older leaves
- Spots characteristically show zonations or concentric rings that give a target board look
- Chlorosis and necrosis extend beyond the infected tissue because of alternaric acid toxin produced by the pathogen
- Under favourable conditions, spots become hard and shots holes may develop
- Severer infection may result defoliation and stem rotting

Survival and spread

Primary: **Conidia** in infected debris, and collateral host ***Solanum nigrum*** and **tomato**
Secondary: Wind dispersed and rain splashed **conidia**

Favourable conditions

- **Previous crop** either **potato** or **tomato**
- Temperature 13 to 26 ^{0} C
- RH: >80% for prolonged periods
- **Infrequent rains**
- Shorter photoperiods

Forecasting system for early blight in tomato: **FAST – Forecast for *A. solani* in Tomato**

Management

- **Crop rotation not involving potato or tomato** for two years
- Field sanitation to the extent possible
- Select healthy tubers for planting
- Sparying Zineb 0.25 or Mancozeb 0.25% or Propineb 0.2% or Captan 0.2% or Copper oxychloride 0.25% two to three times at 7 to 14 days interval
- Grow resistant varieties such as **Kufri Naveen, Kufri Sindhuri, Kufri Jeevan,** Resistant sources: ***Solanum andegena***

3) Common scab – *Streptomyces scabies*

- Important in Punjab and Himachal Pradesh

Symptoms

The bacterium enters through unsuberized lenticels and causes infection of tubers. Produces a toxin called thaxtomin which is of significance in pathogenesis

- Two types of scabs are produced: shallow scab and deep lesions scab
- In shallow scab, tubers shallow superficial roughened areas often slightly sunken below the plane of healthy skin. Small brownish and slightly raised spots on tubers may develop
- In deep lesion scab, lesions may be as deep as 3 mm or more and darker than shallow lesions. These lesions enlarge, coalesce and become corky
- Infected tubers will become unfit for consumption and lose their market value

Survival and spread

Primary: **Conidia or spores** formed by fragmentation of mycelium and **mycelium** in seed tubers and soil

Secondary: Wind dispersed, rain splashed and irrigation water borne **conidia** or **spores**

Favourable conditions

- **Soil pH (5.2-8.0). Increasing pH favours disease development**
- Soil temperature of 20-22^0 C
- Low soil moisture

Management

- Use of disease free tubers
- Crop rotation with wheat-oat or potato-onion-maize (4yrs)
- Green manuring before planting potato
- Dipping of seed tubers in **3% boric acid** for 30 minutes before planting
- Maintaining soil pH at about 5.2 by addition of **sulphur**
- Biocontrol with ***Bacillus subtilis***

4) Wart – *Synchytrium endobioticum*

- Losses seen in temperate regions
- In India, the disease is endemic to Darjeeling hills and is under domestic quarantine

Symptoms

- All underground parts except roots and base of the stem show symptoms
- Buds on underground stems, stolons and tubers are the parts from which abnormal outgrowth starts and lumps of warts that resemble **cock's comb** develop
- On tubers warts are more typical and conspicuous, distorted and branched, sometimes covering the entire tuber surface and may grow bigger than the tuber itself
- As the crop matures, warts become black and rot and may emit smell because of putrefaction due to attack of secondary saprophytic organisms
- Also attacks other solanaceous crops like tomato and Datura but warts are not produced

Survival and spread

Primary: Thick walled **resting spores** in soil and infected tubers (viable in soil for 40 years)
Secondary: Water borne and autonomous **zoospores**

Favourable conditions

- High soil moisture
- Optimum temperature of 21^0 C (12 to 28°C)
- Slightly acidic to neutral pH

Management

- Strict quarantine measures and use of pathogen free seed tubers
- Grow resistant varieties such as **Kufri Jyoti, Kufri Jeevan, Kufri Muthu** and **Kufri Kanchan**

5) Black leg (Soft rot) – *Erwinia caratovora* sub sp. *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

- Infection starts in field or/and storage
- 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 odourless 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

- ***Primary***: Bacterial cells survive in diseased and contaminated tubers and in soil
- ***Secondary***: Bacterial cells spread through contaminated soil, water and maggot flies

Favourable conditions

- High humidity (94 – 100%)
- Temperature (30º C)
- Late blight and *Fusarium* tuber rot infections predispose tubers to soft rot

Management

- Crop rotation with cereals
- Healthy seed tubers should be planted after treating with Streptocycline 100ppm and $CuSo_4$ 40ppm for 30 min
- Crop should be planted in well drained areas and at sufficient distances to allow adequate ventilation
- Avoid wounding of plants during intercultivation and tubers at harvest, transport and storage
- Remove all debris from warehouses and disinfect the walls with formaldehyde or copper sulphate
- Products to be stored should be dry, and the humidity and temperatures of warehouses should be kept low
- Control flies in field and storage

6) Brown rot – *Ralstonia solanacearum* (race 1) (*Burkholderia 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 disease
- Occurs in Deccan and Central plateau, Assam, West Bengal, Orissa, hills of Uttar Pradesh and Nilgiris
- Bacterium infects other solanaceous crops like egg plant and tomato causing wilt

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
- Infected tubers may rot at harvest or during storage

Survival and spread

- ***Primary***: Bacterial cells survive in diseased and contaminated tubers and in soil
- ***Secondary***: Bacterial cells spread through contaminated soil and irrigation water

Favourable conditions

- High soil temperature (25-35^0 C)

-

Soil moisture >50%
- Previous crop in the same field either egg plant or tomato

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% streptocycline for 30 min giving 4 mm deep sharp cut
- Disinfestation of cutting knives with sodium hypochlorite (10%) or mercuric chloride

7) Viral diseases

a) Mild mosaic/Interveinal mosaic – (Potato virus X) PV X Flexuous rod shaped virions with ssRNA

Symptoms
- Often referred as latent potato mosaic
- Light yellow mottling with slight crinkling on potato plants
- Interveinal necrosis of top foliage
- Stunting of diseases plants

Survival and spread
- ***Primary***: Virus particles in infected tubers
- ***Secondary***: Virus particles transmitted mechanically through i) root clubbing of healthy and diseased plants ii) rubbing of leaves in field and iii) implements during intercultivation

Management
- Disease free seed tubers for planting
- Wider spacing
- Rouging of diseased plants
- Restricted movement in the field

b) Severe mosaic – Potato virus Y (PVY)
- Also called **potato leaf drop streak or potato acropetal necrosis potato veinbanding**
- Potyvirus with flexuous rod shaped virions with ssRNA

Symptoms
- Mild to severe mottle and streak or 'leaf drop streak'
- Necrosis along veins of underside of leaflets
- Leaves become completely necrotic but remain hanging

- Top leaves are generally not affected by necrosis but are mottled and slightly crinkled
- Interveinal necrosis and stem/petiole necrosis
- Plant remain stunted in growth with brittle and crinkled leaves

  Simultaneous or combined infection of potato plants with PVX and PVY leads to a synergistic effect resulting in **rugose mosaic**: severe mosaic with puckering and twisting and reduction in size of leaves

Survival and spread

- ***Primary***: Virus particles in infected tubers
- ***Secondary***: Virus particles transmitted by aphids, *Myzus persicae* and *Aphis gossypii*

Management

- Disease free seed tubers for planting
- Rouging of diseased plants
- Aphid control through raising barrier crops and spraying systemic insecticides

c) Leaf roll – *Potato leaf roll virus*

Luteovirus with spherical particles having ssRNA

Symptoms

- Upward and inward rolling of leaves, which have a stiff leathery texture
- Leaves show mild or diffused mottling
- Leaves become soft and droop
- Plants stunted and have a stiff upright growth
- Phloem necrosis of tubers in some varieties

Survival and spread

- ***Primary***: Virus particles in infected tubers
- ***Secondary***: Virus particles transmitted by aphids, *Myzus persicae*

Management

- Disease free seed tubers for planting
- Rouging of diseased plants
- Aphid control through raising barrier crops and spraying systemic insecticides

7) Potato spindle tuber – Viroid (PSTVd)

Occurs in Canada, USA, Russia and South Africa

Reported from Shimla hills in India

Symptoms

- Plants appear erect, spindly and dwarfed
- Leaves small, erect and leaflets dark green
- Tubers **elongated with cylindrical; middle and tapering ends**
- Infected tubers are more **smooth** than normal tubers and have more tender skin and flesh
- Tuber eyes are numerous and more conspicuous and shallower

Survival and spread

- ***Primary***: Virus particles in infected tubers and mechanically through tuber cutting knives from infected to healthy tubers
- ***Secondary***: Virus particles transmitted by pollen and contaminated mouth parts of beetles, fleas and bugs

Management

- Use of PSTVd free potato seed tubers
- Disinfestation of cutting knives by dipping them on sodium hypochlorite solution

LECTURE 10

DISEASES OF TOMATO

1) 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
- Spots coalesce and leaves are blighted
- Complete defoliation of affected leaves
- Stems and flowers are sometimes attacked
- Fruits are rarely attacked

Survival and spread

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

Favourable conditions

- Poor vigour of plants due to nutrient inadequacy or in late season
- High humidity or persistent dew at 25^0 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

2) Tomato spotted wilt – Tomato Spotted Wilt Virus (TSWV)
Phytorhabdovirus with enveloped particles having both + and – stranded ssRNA

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



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

Management
- Removal and destruction of infected plants & weed hosts
- Growing *Crotolaria juncea* as a barrier crop reduces vector migration
- Vector control with dimethoate or methyl demeton at 10 days interval. **Fepronil** 1.5 ml/l is specific to thrips management

3) Bacterial fruit canker: *Clavibacter michiganense* sub sp. *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 leaves do not fall off
- Leaflets on one side of rachis show withering initially
- Light coloured streaks on stems and petioles at the joints
- Cracks develop in streaks and form cankers
- Slimy bacterial ooze through the cracks in humid weather
- Small, shallow, water soaked, spots with white halo develop on fruits

- The centers of spots become slightly raised, tan coloured and rough - Vascular discolouration is seen in split open stems

Survival and spread

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

Favourable conditions

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

Management

- Extraction of seed through fermentation of pulp at room temperature for 72 hours eradicates the bacterium from the seed. Anaerobic conditions in fermentation leads to production of several organic acids which will inactivate he bacterium resulting in extraction of healthy seed
- Hot water treatment of seed at 52^0 C
- Three year crop rotation
- Protective sprays with COC 3000 ppm + streptomycin sulphate 100 ppm

4) Root knot nematode – *Meloidogyne* spp. (*M. javanica, M. incognita* etc.)

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

- Indistinct external symptoms
- Infected plants in patches in the field
- Formation of galls on host root system is the primary symptom
- Roots branch profusely starting from the gall tissue causing a '**beard root**' symptom

- Infected roots become knobby and knotty
- 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
- Nematode infection predisposes plants to fungal and bacterial root pathogens

Survival and spread

Primary: Cysts and egg masses in infected plant debris and soil or collateral and other hosts **Solonaceous, Malvaceous and Leguminaceous** plants act as sources of inoculum ***Secondary***: Autonomous second stage juveniles that may also be water dispersed

Favourable conditions

- Loamy light soils

Management

- Crop rotation with graminaceous crops
- 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 or solarized 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/m^2 or Carbofuran @ 0.39g a.i/m^2
- Bare root dip treatment in EC formulation of systemic insecticides like Dimethoate or Phenemiphos for 6-8 hours before transplantation
- Grow resistant varieties like Hissar Lalit, PNR-7, Nematex, NTDR 1 and VFN 8
- Spot application of carbofuran @1 kg a.i/ha at transplanting stage in the main field

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
Once infected, fields become unfit for cultivation of crucifers for several years

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 **spindle like, spherical, knobby, or club-shaped swellings**
- The swellings may be few, or they coalesce and cover the entire root system

Survival and spread

Primary: Soil borne resting spores, which survive for longer periods in soil (10years)
Secondary: Autonomous zoospores, also carried through irrigation water or by root contact

Favourable conditions

- It occur at a temperature range of 12-27^0 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)
- Add hydrated lime to soil to increase pH to 7.2 (6 weeks before planting @ 2.5t/ha)
- Avoid excess irrigation
- Treat the soil of seed bed areas with chloropicrin, methyl bromide or vapam two weeks before sowing.

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


Survival and spread

Primary: Oospores in infected plant debris or in soil ***Secondary***:
Wind borne and rain splashed sporangia

Favourable conditions

- It occur at a moderate temperature range of 12-27^0 C
- High soil moisture
- Neutral to acidic soils 5-7.0 pH

Management

- Destruction of infected plant debris
- Avoidance of thick sowing and excessive moist conditions
- Spray Metalaxyl + Mancozeb (Ridomil) 0.2% or Coper oxychloride 0.3% at 10 days interval

3) Powdery mildew – *Erysiphe polygoni*

Infects mostly cabbage and cauliflower

Symptoms

- White powdery spots on the upper surface of leaves, stems, flower parts etc.
- Finally the mildew may cover the entire surface
- Infected plants may show rotting and do not have normal growth

Survival and spread

Primary: Dormant mycelium in infected plant debris
Secondary: Wind borne conidia

Favourable conditions

- It occur at a moderate temperature range of 12-27^0 C
- Dry conditions with morning relative humidity of 80%

Management

- Destruction of infected plant debris
- Spray Dinocap 0.2%

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

- Common on cabbage and cauliflower

Symptoms

- Symptoms usually on older leaves
- Spots are small, dark coloured

- They enlarge, soon become circular
- 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
- Shot holes may be formed due to falling off of infected spot tissue
- The fungus is seed borne and cause shriveling of seeds and poor germination Linear spots also appear on petioles, stems and pods

Survival and spread

Primary: Dormant mycelium or conidia on seed or in infected plant debris

Secondary: Wind borne conidia

Favourable conditions

- Relative humidity > 80%
- Less vigorous plants
- Late in the season

Management

- Hot water treatment at 50^0c for 30min
- Seed treatment with Thiram or Mancozeb
- Foliar spray with Mancozeb 0.25% or Coper oxychloride 0.2% twice

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

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

Symptoms

- First appear as chlorotic or yellow (angular) areas near the leaf margins
- Yellow area extends to veins and midrib forming characteristic 'v' shaped chlorotic spots which later turn black
- Veins and veinlets turn brown and finally black
- 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 occurs. Bacterial ooze can also be seen on affected parts
- If the infection is early, the plants wilt and die
- If the infection is late plants succumb to soft rot and die


Survival and spread

Primary: Bacterial cells **internally seed borne** and soil borne

Secondary: Bacterial cells dispersed through irrigation water and rain splashes

Favourable conditions

- Relative humidity > 90%

- High soil moisture
- Frequent rains

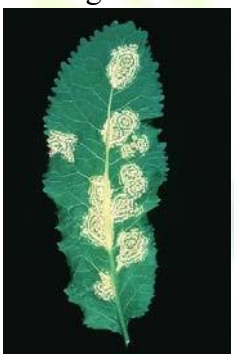
Management

- Hot water treatment at 50 ^{0}c for 30min, for killing seed borne inoculum followed by a 30min dip in streptocycline 100 ppm
- Spray Agrimycin or Streptocycline 100 ppm at transplanting, curd formation and pod formation
- Crop rotation for 2-3 years with non cruciferous crops
- Drenching seed bed with antibiotic solution in nursery beds
- Resistant varieties: 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 and 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




Survival and spread

Primary: Oospores in soil and sporangia from perennial weed hosts in the vicinity
Secondary: Wind borne and rain splashed **conidia (sporangia)** or autonomous **zoospores**

Favourable conditions

- Relative humidity > 90%
- High soil moisture
- Frequent rains

Management

- Sanitary measures
- Crop rotation
- Destruction of weeds
- Spray 0.8% Bordeaux mixture or Copper oxychloride 0.3%

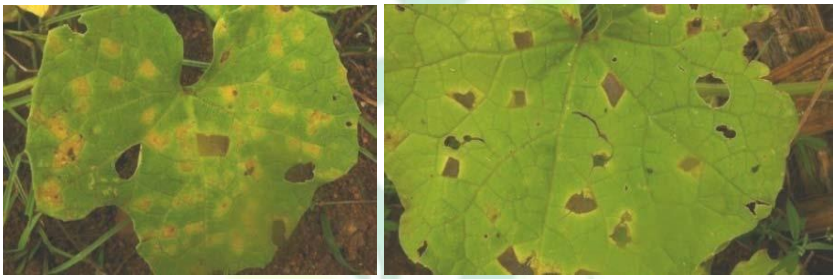
DISEASES OF CUCURBITS

1) Downy mildew – *Pseudoperonospora cubensis*

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

Symptoms

- Yellow, angular spots restricted by veins resembling mosaic mottling 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



Survival and spread

Primary: **Oospores** in soil and sporangia from perennial collateral weed hosts in the vicinity

Secondary: Wind borne and rain splashed **conidia (sporangia)** or autonomous **zoospores**

Favourable conditions

- Relative humidity > 90%
- High soil moisture
- Frequent rains

Management

- Destruction of cucurbitaceous weeds around field
- Spray Metalaxyl + Mancozeb (Ridomil) 0.2% or Copper oxychloride 0.3%

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

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

Symptoms

- Whitish or **dirty grey, 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 leading to premature defoliation and death
- Fruits remain underdeveloped and are deformed

Survival and spread

Primary: **Dormant mycelium** or **cleistothecia** in infected plant debris or conidia from collateral hosts

Secondary: Wind borne **conidia**

Favourable conditions

- Morning relative humidity > 90%
- Cool and dry weather

Management

- Field sanitation
- Removal and destruction of collateral weed hosts from the vicinity of the field
- Spray Tridemorph 0.1% or Dinocap 0.2%

3) Cucumber Mosaic*: Cucumber mosaic virus*

Wide host range: Cucumber, Pumpkin, gourds, Cowpea, tomato, chilli, etc. *Cucumovirus* with spherical particles having ssRNA

Symptoms

- Symptoms appear on the youngest and still expanding leaves when infection occurs at 6 – 8 leaves stage
- Typical mosaic pattern develops on young leaves
- Leaves curl downwards and become mottled, distorted, wrinkled and reduced in size
- Veins appear bunchy because of shortening of internodes
- When infection occurs at midseason previous growth remains normal and produces normal fruit
- Fruit set is very less if infection occurs early in crop growth
- Fruits are often misshapen, mottled, warty and reduced in size

Survival and spread

Primary: **Virus particles** on collateral and other weeds, ornamentals or crops

Hosts: Banana, clover, corn, passion fruit, safflower, spinach, sugarbeet, wild cucumber, *Commelina communis, C. diffusa, C. nudiflora, Solanum elaegnifolium, Phytolacca* sp., periwinkle, *Gladiolus* sp., *Impatiens* sp. and *Phlox*

Secondary: **Virus particles t**ransmitted by aphids (*Aphis craccivora, Myzus persicae*) and spotted and striped cucumber beetles

Management

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

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

- Common on watermelon, muskmelon and cucumber

Symptoms

- Minute water soaked spots or yellow specks develop initially 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 Fruits are also occasionally attacked

Survival and spread

Primary: **Dormant mycelium** or **conidia** on infected plant debris or collateral hosts
Secondary: **Wind borne conidia**

Management

- Maintain good soil drainage and good aeration between vines
- Field sanitation
- 2 - 3 protective sprays with mancozeb 0.25% or carbendazim 0.1%

LECTURE 12

DISEASES OF BETELVINE

1) Root and stem rot – (*Phytophthora*, *Sclerotium* and *Fusarium)*

***Phytophthora parasitica* (Foot rot, root rot and leaf spot)**

Symptoms

- On leaves near soil line water soaked lesions develops from tip margins and proceed inward covering major portion of lamina
- Spots become necrotic, turn brown and exhibit clear concentric zonations
- Vines lose lustre when roots are attacked
- Suppression of adventitious roots
- Small brown water soaked lesions develop on the vine stem near soil line and progresses upward and downward
- The disease is characterized by darkening of basal stem. Soon the wine wilts accompanied by yellowing of leaves and drooping of vines
- Narrow brown streaks develop on in the regions of vascular bundles

- The central core of the stem also becomes brown or black
- Infected tissues rot and the infected vine can be pulled out easily

Survival and spread
Primary: **Oospores** in infected plant debris and soil
Secondary: **Sporangia** and **zoospores** by irrigation water and rain splashes

Favourable conditions
- Low lying fields with poor drainage
- High soil moisture
- Frequent rains

Management
- Selection of healthy cuttings for new plantings
- Field sanitation by collection and destruction of infected vines and debris
- Providing good drainage
- Crop rotation with non host crops like rice or maize or sugarcane
- Drenching bases of infected vines with Bordeaux mixture 1%
- Spraying Metalaxyl + Mancozeb (Ridomil MZ 72) 0.2% on infected and surrounding healthy vines
- Biocontrol with neem cake + *Trchoderma viride*

2) *Sclerotium rolfsii*
Symptoms
- Plants are susceptible at any stage of growth
- 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 withers and totally dries off

Survival and spread
Primary: **Sclerotial bodies** in infected plant debris or soil
Secondary: **Autonomous growth** of the fungus or water dispersed **sclerotial bodies**

Favourable conditions
- High soil moisture and soil temperature
- High relative humidity and warm weather

Management
- Selection of healthy cuttings for new plantings
- Field sanitation by collection and destruction of infected vines and debris
- Providing good drainage
- Drenching bases of infected vines with Bordeaux mixture 1%
- Spraying Carbendazinm 1% on infected and surrounding healthy vines
- Biocontrol with neem cake + *Trchoderma viride*

3) *Fusarium solani*

Symptoms

- The disease is characterized by darkening of basal stem. Soon the wine withers accompanied by yellowing of leaves and drooping of vines, starting from tip downwards Infection from soil level spread upwards reaching second or third internodes.
- Roots of plants are discoloured, rot, starting from smaller roots and spread to stem

Survival and spread

Primary: **Chlamydospores** in infected plant debris or soil

Secondary: **Autonomous growth** of the fungus or water dispersed **micro** and **macro conidia**

Favourable conditions

- Dry superficial soil conditions
- High relative humidity and warm weather

Management

- Selection of healthy cuttings for new plantings
- Field sanitation by collection and destruction of infected vines and debris
- Providing good drainage
- Drenching bases of infected vines with Bordeaux mixture 1%
- Spraying Carbendazinm 1% on infected and surrounding healthy vines
- Biocontrol with neem cake + *Trchoderma viride*

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

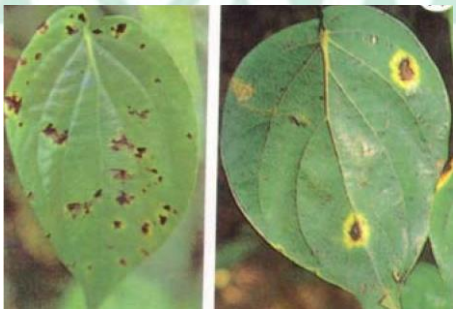
Symptoms

- Only aerial parts of the plant are attacked
- Light to dark brown irregular spots surrounded by diffuse chlorotic halo develop on leaves
- Spots become sunken, enlarge and coalesce
- 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

Survival and spread

Primary: **Dormant mycelium** in infected plant debris

Secondary: Rain splashed **conidia**



Management

- Field sanitation by collection and destruction of infected leaves

- Spray Bordeaux mixture 1% or Copper oxychloride 0.3% or Carbendazim 0.1% 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 and 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
Primary: **Conidia** in infected plant debris or seed bulbs ***Secondary***: wind borne **conidia**

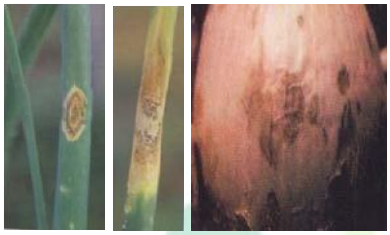
Favourable conditions
- Warm humid weather with rains or dew
- Thrips infesation

Management
- Select healthy bulbs for planting and bulb treatment with mancozeb or thiram 0.25% solution
- Seed treatment with Thiram 3g/kg of seed
- Spray Mancozeb 0.2% or Chlorothalonil 0.2%
- Manage thrips by insecticides

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



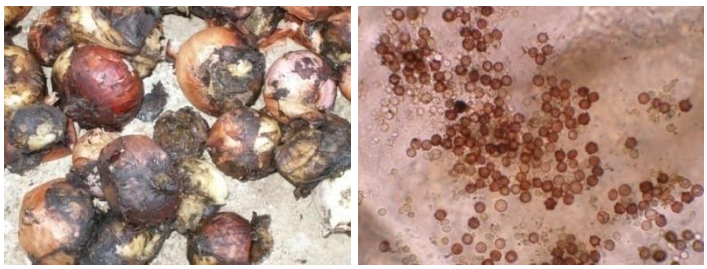
Survival and spread
Primary: **Stromata** in infected plant debris or soil
Secondary: Wind borne **conidia**

Favourable conditions
- Wet soils with a temperature of 26^0 C

Management
- Resistant varieties: **Nasik red, Pusa Ratna, Pusa Red**
- Protection of bulbs from rains after harvest
- Bulbs should be dried properly before storage by hot air at 37 – 48^0C
- 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

Primary: **Spore balls** in soil and seed bulbs
Secondary: Wind blown soil and surface water having **Smut spores**

Favourable conditions
- Optimum temperature of 10-20^0 C
- Plant is susceptible for 2-3 weeks from sowing

Management
- Seed treatment with thiram 3 g/kg seed before sowing in nursery
- Crop rotation and use of disease free seedlings and seed bulbs
- Furrow application of sulphur dust 100 kg/ha
- Cultivar, **Hardy white bunching** is resistant
- Spray with captan 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
- **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
Primary: **Mycelium** or **conidia** on seed and collateral hosts: cowpea, mungbean, blackgram

Secondary: Wind blown and rain splashed **conidia**

Management
- Use healthy seed for planting
- Periodically harvest all mature pods and sort and destroy infected ones
- Seed treatment with Carbendazim 2g/kg seed
- Protect the crop by spraying Benomyl or Carbendazim 0.1% or Zineb or Mancozeb 0.25% at 10-15 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 found on petiole and stem of some hosts The rust pustules appear on either side of leaves but more common on lower surface.
- The uredosori are minute, roundish, slightly raised and reddish brown in colour. 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

Survival and spread

Primary: Survives through **teliospores** in cooler regions and on collateral hosts

Secondary: Wind borne **uredospores**

Management

- Early sowing to avoid severe infection of plants in the field
- Protect the crop with mancozeb or zineb 0.25% or wettable sulphur 0.3%

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

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 and may exhibit mottling when green

Survival and spread

Primary: Virions in collateral hosts french bean, soybean, redgram, *Xanthium strumarum, Eclipta alba*, *Croton* spp, blackgram, greengram etc.

Secondary: Virions transmitted by **whitefly, *Bemisia tabaci***

Management

- Remove collateral hosts and destroy from the vicinity of the field Use resistant varieties
- Manage vector by erecting yellow sticky traps and spraying systemic insecticides Methyl demeton or Dimethoate 2 ml/l

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

Potyvirus with long flexuous rods having ssRNA

Symptoms

- Affects only beans (*Phaeolus vulgaris* and 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

Primary: Virions in seed and collateral hosts

Secondary: Virions transmitted by **aphids, *Aphis craccivora, Macrosiphum pisi, Aphis gossypi***, *A. medicaginis, Myzus persicae* and *Brevicoryne brassicae*

Management

- Use of disease free seed collected from healthy plants
- Vector management by raising barrier crops and spraying systemic insecticides methyl demeton or dimethoate 2 ml/l or acephate 1.5 g/ml or imidacloprid 0.2 ml/l either alone or mixed with neem oil

LECTURE 14

DISEASES OF COCONUT

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

- Also called *Ganoderma* wilt or Thanjavur wilt
- Most serious and destructive disease of coconut. Prevalent in light soils in Srikakulum, Visakhapatnam, Vizianagaram, East Godavari and West Godavari districts

Symptoms

- All stages of the palm growth are attacked by the pathogen
- The fungus infects the roots and spreads upwards killing the entire root system
- Infection spreads to the trunk and junction of root and shoot systems is also affected
- The trunk tissues internally rot and reddish brown gummy fluid exudes out from natural growth cracks
- As a result reddish brown lesions are formed on trunk starting from base
- Infection progresses and lesions extend linearly and radially on trunks of infected palms
- Because of rotting of internal tissues including the cortex and the vascular system water and nutrient transport will be impeded
- Older leaves droop and wither and remain suspended around the trunk. Withering and drooping of leaves progresses in to the upper whorls
- Infected palms are predisposed to infestation by shot hole borer *Xyleborus testaceous* which bores infected trunks from which dry powder comes out.
- Infected trees die in a few months or two years. Shot hole borer infestation hastens the death of the infected palms
- On palms with advanced infection and on dead palms the fungus produces fruiting bodies (**basidiocarps** or **brackets**) along the sides of the basal trunk particularly during periods of heavy rains *i.e*. in the monsoon


Survival and spread

Primary: **Basidospores** or saprophytic **mycelium** in soil and infected debris or several host tree species like mango, jackfruit, citrus, arecanut, poplar and several forest trees ***Secondary***: **Mycelium** and **basidiospores** through irrigation water or root contact

Favourable conditions

- Dry soil and weather conditions
  Light textured soils particularly by the side of river beds
  Newly cleared forest lands planted with either coconut or other susceptible tree crops

Management

- Dig isolation trenches of about 50cm wide and 1m deep, 2-3 m away from diseased palm to prevent spread of fungus by root contact or scattering of infected parts of the palm
- Dig out infected palms with entire root system and destroy by burning. Disinfect the pit formed due to removal of infected palms by burning trash and drenching with Bordeaux mixture 1%
- Trenches dug for replanting should be filled with FYM, 5 kg neem cake and *Trichoderma viride*
- Incorporate green manure crops like sunhemp and daincha to improve moisture retention capacity of soil and multiplication of antagonistic microflora
- Avoid deep ploughing or digging which are likely to injure roots and scatter inoculum in the field
- Arrange separate irrigation channel to each palm basin from channels made between rows of palms to prevent spread of fungus
- Apply FYM (200 kg) and neem cake (5-10 kg) inoculated with *Trichoderma viride* to each palm during June – July months
- Also apply 2 kg superphosphate and 3 kg muriate of potash and 1 kg urea to each bearing palm, in two splits, one in July and other in November to maintain the vigour of the palm
- Treat basin of each palm with 40 liters of Bordeaux mixture 1%, once every year during August – September
- Root feeding infected palms with Tridemorph 6 ml/l twice a year
- Control bark eating caterpillar by smearing the infected trunks with Chlorpyriphos 5 ml/l

2) Bud rot - *Phytophthora palmivora*

- First reported by butler in 1906
- **Coconut, arecanut** and **palmyrah palm** (*Borassus flabellifer*) are attacked 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 seedlings in nursery and young palms in the main field
- **Loss of lustre and yellowish green discoloration of the heart leaf or spear leaf**
- Water soaked lesions develop on the base of petioles of youngest leaves. Lesions turn brown and the basal tissues of the leaf rot quickly
- 
- At this stage the spear leaf appears dried and withered
- Irregular, water soaked spots develop on the petioles of older leaves

- 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 base of the pulled out infected spear leaf shows watery rot and emits a foul smell
- The growing point in central crown (cabbage) may rot and in few months the tree may wilt
- Fungus also attacks female buttons and causes button drop particularly in periods of high relative humidity and rainfall
- Fungus attacks tender nuts causing fruit rot. Infected nuts become heavier because of water soaked fibre and fall down

Survival and spread

Primary: **Oospores** or dormant **mycelium** in soil and infected debris

Secondary: **Sporangia** and **zoospores** disseminated through rain splash, wind and rhinoceros beetle, *Oryctes rhinoceros*

Favourable conditions

- Seedlings and tender palms
- More infected palmyrah palms in the vicinity
- Rhinoceros beetle infestation
- High and frequent rainfall
- High relative humidity (>90%) and temperature of 18-20 ^{0}C

Management

- Removal and burning of badly infected palms
- Infected trees can be saved if the disease is detected early by removing the infected tissues (surgery) and protecting by smearing the growing cabbage with Bordeaux paste
- Spray copper fungicides, Bordeaux mixture 1% or Copper oxychloride 0.3% three times at the beginning, middle and cessation of monsoon as a prophylactic measure
- Keep a mixture of $CuSO_4$ + NaCl (1: 3-5 parts) in a cloth bag in the crown or above bud
- Manage rhinoceros beetle

3) Stem bleeding – *Ceratocystis paradoxa* (IS: *Thielaviopsis paradoxa*) Syn: *Ceratostomella paradoxa, Ophiostoma paradoxa*

Symptoms

- Trunks of tender palms are more attacked
- **Water soaked patch on trunks** appears initially which later increases in size
- **Reddish brown ooze from the cracks** in the patch is a characteristic symptom
- The fluid dries up to form black encrustations with brownish orange margins
- The patch progresses linearly upward usually in a direction that is opposite to phyllotaxis
- The tissues, except vascular bundles, below infected patch show yellowish brown discolouration and decay

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When the severely decayed patches are pierced a **yellowish fermented fluid gushes out** Large **cavities are formed in diseased trunk**

- Infected trunks are usually infested with *Diocalandron* beetle
- Growth of affected palms is arrested and yield reduced
- Infected trunks are weakened because of decay of tissues and are prone to be felled by moderate winds

Survival and spread

Primary: **Perithecia** and **chlamydospores** in cracks and cavities of infected stem and petioles of fallen leaves

Secondary: **Conidia** dispersed by irrigation water, insects, wind

Favourable conditions

- Heavy rainfall followed by drought
- High water table and highly alkaline soils
- Cracks and insects wounds and wounds caused during harvest and leaf removal
- Physiological imbalances
- Poor fertilization and poor maintenance of orchard

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 should be filled with a mixture of tar coal, sand and cement to strengthen the trunks and to prevent secondary damage
- Coat the lower part of trunk with coal tar or Bordeaux paste to prevent the disease
- Along with 50 kg 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 litre

4) Tatipaka disease – Phytoplasma

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

Symptoms

- Palms above 15 years age only were found infected
- Infected palms initially bear nuts heavily
- Leaves of infected palms show chlorosis and newly emerging leaves become smaller
- Subsequently the crown becomes smaller in size and **trunk below crown begins to taper**
- Leaflets of fronds of infected palms do not unclasp after emergence and hence leaves give a fasciated appearance due to improper unfolding of leaflets


Leaves turn pale and **bend abnormally resembling a bow** Leaves shed pre-maturely

- Affected palms produce smaller bunches with **atrophied or barren nuts or bear very few nuts that have soft pericarp**
- Severely infected palms are barren with sickly crowns and slight tapering trunk
- Infected palms survive in spite of infection for a few years. Hence the disease is debilitating than lethal

Management

- Remove and destroy affected palms
- Avoid raising seedlings in endemic 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 spot turns grayish white with dark brown margins and a yellow halo
- Spots coalesce into irregular necrotic patches
- Infected leaf blade completely dries up and shrivels giving a blighted or burnt appearance.
- Large number of globose or ovoid black acervuli appears on upper surface of affected leaves

Survival and spread

Primary: **Conidia** in infected plant debris
Secondary: **Conidia** dispersed by rain splash and wind

Favourable conditions
- Neglected gardens with palms suffering from potassium deficiency
- Heavy weed infestation in the basins of palms

Management
- Remove older affected leaves and burn
- Correct potassium deficiency by applying recommended dose of potassium @ 3 kg /palm
- Keep basins of palms weedfree
- Spray foliage with BM 1% or Copper Oxychloride or Captan 0.25%

DISEASES OF OILPALM

1) Bunch rot: *Marasmius palmivora*

Symptoms
- Strands of mycelium spread 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 fibrous oily pericarp and causes 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:
- Infected palms show reduced leaf emission
- Size of newly emerging leaves is reduced
- Disease is characterized by chlorosis of young whorl of leaves followed by necrosis
- Rotting of spear leaves
- As the disease advances the trunk gradually tapers
- Emergence of inflorescence is arrested leading to loss in productivity

Spread:
The disease is infectious and lethal, and suspected to be vector borne. However the vector is not known

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Management:

- Avoid obtaining seedlings from infected areas to healthy areas
- Tetracycline injection 500ppm to trunk reduces the disease. However it should be sparingly used in view of its use in human medicine
- Rogueing of affected palms.

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

Survival and spread
Primary: **Basidiospores** in infected plant debris
Secondary: **Basidiospores** dispersed by rain splash and wind

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 bushes with new flush is highly susceptible

Management
- Seedlings should be protected in nursery by weekly sprays of Copper oxychloride 0.3%
- Spray, a mixture of 210g Copper oxychloride + 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**) offer 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 develop on upper surface of the leaves usually around margins
- Later masses of orange uredospores appear on the under surface
- 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 underside of 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 bush 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


Survival and spread
Primary: **Mycelium** or **uredospores** in infected leaves
Secondary: **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

- Collect diseased leaves and destroy
- Spray the bushes once with Bordeaux mixture 0.5% or Copper oxychloride 0.25% 2-3 times during monsoon
- Spray Triadimefon 0.05%

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 in field.
- Water soaked lesions develop on leaf sheaths at the base of plants
- Lesions increase in size turn brown and extend upward and downward causing rotting of tissues. The spear leaf also shows withering as it rots and can be easily pulled out
- Infected plants show progressive drying up of the leave, 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


Survival and spread
Primary: **Oospores** in soil and seed rhizomes
Secondary: **Zoospores** dispersed by irrigation water

Favourable conditions

- Infected rhizomes
- Low lying fields, high soil moisture and high humidity
- Monoculture of turmeric in the same field
- Rainy weather
- Fly, *Mimegrella coerulifrons* infestation aggravates the disease

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 + Mancozeb (Ridomil MZ 72) 2.5g/l for 40 minutes before planting to reduce seed rhizome borne infection
- Drench the soil at root region with Bordeaux mixture 1% or Copper oxychloride 0.5% g or Metalaxyl + Mancozeb (Ridomil MZ 72) 2.5g/l in the initial stages of the disease
- Turmeric varieties, PCT-13 (Sudarshan) and PCT-14 (Suguna) are resistant

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, **elliptical 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 4-5 cm and breadth of 2-3 cm
- 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
- Usually infection progresses from bottom to top leaves

Survival and spread

Primary: **Mycelium** or **conidia** in seed rhizomes or infected plant debris
Secondary: **Conidia** dispersed by wind

Favourable conditions

- Infected rhizomes

Intermittent rains

- High humidity

- Planting long duration CLL (*Curcuma longa* Long duration) varieties like Duggiral, Mydukur, Tekurpet etc

Management

- Remove and destroy infected plant debris
- Treat rhizomes with Copper oxychloride 0.25% solution
- Spray Carbendazim 0.1% or Mancozeb 0.25% mixed with non ionic adhesive (Sandovit or Chipko or Velvet or Add on or Triton or Apsa) 0.05% during August – December
- Avoid excess shading
- Resistant varieties – Sudarshan, Suguna and CLI 327

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 or orange brown
- Spots lie between leaf veins and are rectangular, coalesce to form big irregular blotchede patches
- Infection usually starts on lower leaves and spreads to upper leaves

Survival and spread

Primary: **Desiccated ascospores and conidia** in seed rhizomes soil and infected leaves
Secondary: **Conidia** dispersed by wind, irrigation water and rain splash

Favourable conditions

- Intermittent rains leading longer leaf wetness period
- Temperature of 21-28º C with 80% R.H
- Cultivation of susceptible CLI (*C. longa* Intermediary duration) varieties like CLI 327

Management

- Collect and destroy diseased leaves
- Spray Mancozeb 0.25% or Chlorothalonil 0.2% or Propiconazole 0.1% at 20 days interval
- Resistant varieties: China (*Curcuma domestica)* and Jaweli (*C. amada*) or CLL varieties

DISEASES OF ZINGER

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

Rhizome rot of zinger is common in all zinger growing areas

Symptoms

- When infection takes place through contaminated seed rhizomes, sprouts fail to grow resulting in pre-emergence damping off
- If the disease strikes after sprouting it manifests as a translucent brown lesion at collar region and later becomes water soaked and soft, extends to whole shoots
- Infected plants can be easily pulled out
- Leaves turn to pale yellow wither and dry up
- The spear leaf and young upper leaves also wither and the entire plant dies

- Soft rot extends from collar region to rhizomes which initially become discoloured and gradually decompose, forming a watery mass of putrifying tissues enclosed by tough skin The fibrovascular strands are rarely affected. Roots arising from affected rhizome rot and soften. Rotting is also noticed in rhizomes collected from infected crop during storage

Survival and spread

Primary: **Oospores** in soil and seed rhizomes

Secondary: **Zoospores** dispersed by irrigation water

Favourable conditions

- Infected rhizomes
- Low lying fields, high soil moisture and high humidity
- Monoculture of turmeric or zinger in the same field
- Rainy weather
- *Mimegrella* flies play a role in the spread of the pathogen and aggravation of disease

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 + Mancozeb (Ridomil MZ 72) 2.5g/l for 40 minutes before planting to reduce seed rhizome borne infection
- Drench the soil at root region with Bordeaux mixture 1% or Copper oxychloride 0.5% g or Metalaxyl + Mancozeb (Ridomil MZ 72) 2.5g/l in the initial stages of the disease
- Control the *Mimegralla* insects by insecticide application as spray and baits

2) Leaf spot – *Phyllosticta zingiberi*

Symptoms

- 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

Primary: **Mycelium** and **conidia** in infected plant debris

Secondary: **Conidia** spread by splashing rain

Management

- Growing zinger in partial shade reduces the disease incidence
- Spray Mancozeb 0.25% or Copper oxychloride 0.25% during monsoon

LECTURE 16

DISEASES OF MULBERRY

Powdery mildew – *Phyllactinia corylea, P. guttata, P. suffulata*
(IS: *Ovulariopsis corylea*) Symptoms

Lesions appear as white to greyish powdery patches on the lower surface of the leaves

- Gradually they turn yellowish brown to black patches
- Powdery patches cover entire leaf surface and make leaves unfit for feeding silk worms
- The whitish powdery material seen on the leaves consists of the fungal hyphae, conidia, conidiophores and cleistothecia

Survival and spread
Primary: **Dormant mycelium** or **cleistothecia** in infected plant debris
Secondary: Wind borne **ovulariopsis type 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 for feeding silk worms

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
Primary: **Dormant mycelium** or **cleistothecia** in dormant buds and shoots
Secondary: Wind borne **oidium type conidia**

Management

- Collect and destroy infected plant debris

- Four sprays with wettable suphur 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
Primary: **Pycnidia** or **ascospores** in infected plant debris
Secondary: Wind borne **conidia**

Management
- Affected parts should be collected and destroyed
- Spray Tridemorph 0.1% 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
- Cv Radiance escapes infection due to waxy surface

3) Die-back – *Diplodia rosarum*

Symptoms
- Infection starts from the pruned surface of the twigs
- 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
Primary: **Pycnidia** in infected and dead twigs
Secondary: **Conidia** spread through irrigation water and wind

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*

- Autoecious rust (**Demicyclic** rust/ **Ospis** type rust) in which **Uredial** stage is absent

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

Survival and spread

Primary: Teliospores in infected plant
Secondary: Wind borne **aeciospores**

Favourable conditions

- Rust initiates in June- July and persists till March

Management

- Remove and destroy affected plants or plant parts to avoid further spread
- Dust sulphur (20-25kg/ha) or spray Oxy-carboxin (Plantavax) or Mancozeb 0.2% or Tridemorph (0.05%) or Triadimefon (Bayleton) 0.05%

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
Primary: **Pycnidia** in infected plant debris in soil
Secondary: **Conidia** spread through wind

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 leaves and flowers
- Some flowers appear bleached and are inferior in quality
- Flowers from diseased plants open 7 to 10 days earlier than that of healthy plants

Axillary buds grow prematurely and produce number of branches and stolons that give rise to stunted plants
- White specks and yellow blotches appear on leaves of some varieties
- Cuttings from diseased plants root poorly

Survival and spread
Primary: **Viroid** surviving in infected plants and spread through planting material
Secondary: **Viroid** Spread through sap and knives or tools used during pruning or pinching plants and cutting the flowers

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

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

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

Primary: **Chlamydospores** in soil and **mycelium** or **conidia** in infected planting material
Secondary: **Micro** and **macro conidia** spread through irrigation water

Management

- Cuttings should be obtained from disease free plants
- Long crop rotation
- Drenching soil at base of plants with Bordeaux mixture 1%
- Neem cake + *Trichoderma viride* application at planting

DISEASES OF CROSSANDRA

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

Primary: **Chlamydospores** in soil and **mycelium** or **conidia** in infected seedlings ***Secondary***: **Micro** and **macro conidia** spread through irrigation water

Favourable conditions

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

Management

- Crop rotation with on host crops
- Neem cake + *Trichoderma viride* application at planting
- 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 Copper Oxychloride 0.25% twice at 3 to 4 weeks interval