

LECTURE-1 DISEASES OF RICE

1.1 BLAST

Causal organism: *Pyricularia oryzae* (Sub-division: Deuteromycotina)

Perfect stage - *Magnaporthe grisea*

Symptoms

The fungus attacks the crop at all stages from seedlings in nursery to heading in main field. The typical symptoms appear on leaves, leaf sheath, rachis, nodes and even the glumes are also attacked.

- **Leaf blast:** On the leaves, the lesions start as small water soaked bluish green specks, soon enlarge and form characteristic spindle shaped spots with grey centre and dark brown margin. The spots join together as the disease progresses and large areas of the leaves dry up and wither.
- **Node blast:** In infected nodes, irregular black areas that encircle the nodes can be noticed. The affected nodes may break up and all the plant parts above the infected nodes may die (Node blast).
- **Neck blast:** At the flower emergence, the fungus attacks the peduncle which is engirdled, and the lesion turns to brownish-black. This stage of infection is commonly referred to as rotten neck/neck rot/neck blast/panicle blast. In early neck infection, grain filling does not occur and the panicle remains erect like a dead heart caused by a stem borer. In the late infection, partial grain filling occurs. Small brown to black spots also may be observed on glumes of the heavily infected panicles.



Fig 1.1: Leaf Blast of Rice



Fig 1.2: Node Blast of Rice

Disease Cycle

Primary Infection – Mycelium & Conidia in the infected straw & seeds

Secondary Infection – Conidia spread by wind and rain splashes.

Favourable Condition

Application of excessive doses of nitrogenous fertilizers, intermittent drizzles, cloudy weather, high relative humidity (93-99 per cent), low night temperature (between 15-20 °C or less than 26 °C).

Management

- Use of seeds from a disease free crop.
- Grow resistant varieties Jaya, Vijaya, Ratna, IR 36, and IR 64.
- Remove and destroy the weed hosts in the field bunds and channels.
- Split application of nitrogen and judicious application of nitrogenous fertilizers.
- Treat the seeds with Carboxin + Thiram (Vitavax Power) @ 2 g/kg.
- Spray the nursery and main field with **Tricyclazole** @0.06%.

1.2 BROWN SPOT

Causal Organism: *Helminthosporium oryzae* (Deuteromycotina)

(Sexual stage: *Cochliobolus miyabeanus*)

Symptoms

The fungus attacks the crop from seedling in nursery to milk stage in main field.

Symptoms appear as lesions (spots) on the coleoptile, leaf blade, leaf sheath, and glumes, being most prominent on the leaf blade and glumes. The disease appears first as minute brown dots, later becoming cylindrical or **oval to circular**. The several spots coalesce and the leaf dries up.



Fig 1.3: Brown spot of rice

Disease Cycle

Primary infection – Infected Plant parts and seeds (Externally seed borne)

Secondary infection – Conidia spread through wind and water.

Favourable Conditions

Temperature of 25-30°C with relative humidity above 80 per cent are highly favourable. Excess of nitrogen aggravates the disease incidence.

Management

- Treat the seeds with Carboxin + Thiram (Vitavax Power) @ 2 g/kg.
- Spray the crop in the main field twice with Carbendazim + Mancozeb @0.2%, once after flowering and second spray at milky stage.

1.3 BACTERIAL BLIGHT

Causal organism: *Xanthomonas oryzae* pv. *oryzae*

Symptoms

The bacterium induces either wilting of plants or leaf blight. Wilt syndrome known as **Kresek** is seen in seedlings within 3-4 weeks after transplanting of the crop. Kresek results either in the death of whole plant or wilting of only a few leaves. In grown up plants water soaked, translucent lesions appear usually near the leaf margin. The lesions enlarge both in length and width with a **wavy margin** and turn straw yellow within a few days, covering the entire leaf.

As the disease progresses, the lesions cover the entire leaf blade which may turn white or straw coloured and finally blighted. Lesions may also be seen on leaf sheaths in susceptible varieties. Milky or opaque dew drops containing bacterial masses are formed on young lesions in the early morning. They dry up on the surface leaving a white encrustation. The affected grains have discoloured spots surrounded by water soaked areas. If the cut end of leaf is dipped in water, bacterial ooze makes the water turbid.



Fig 1.4: Bacterial blight of rice

Disease Cycle

Primary infection - Bacterium overwintering in seed

Secondary infection – Bacterial ooze

Favourable Condition

Clipping of tip of the seedling at the time of transplanting, heavy rain, heavy dew, flooding, deep irrigation water, severe wind, and temperature of 25-30°C and application of excessive nitrogen, especially late top dressing.

Management

- Grow resistant cultivars like Swarna, Ajaya, IR 20, IR 42, IR 50, IR 5.
- Affected stubbles are to be destroyed by burning or through ploughing
- Judicious use of nitrogenous fertilizers
- Avoid clipping of tip of seedling at the time of transplanting.
- Avoid flooded conditions or drying of the field (not at the time of flowering)
- Avoid flow of irrigation water from infected to healthy field.
- Seed treatment with Streptocycline @ 0.01 %.
- Spray Streptocycline @ 0.01 % and Copper oxychloride @ 0.3%.

1.4 SHEATH BLIGHT

Causal organism: *Rhizoctonia solani*

(Sub-division: Deuteromycotina)

(Sexual stage: *Thanetophorus cucumeris*)

Symptoms

The fungus affects the crop from **tillering** to **heading** stage. Initial symptoms are noticed on leaf sheaths near water level. On the leaf sheath oval or elliptical or irregular greenish grey spots are formed. As the spots enlarge, the centre becomes greyish white with an irregular blackish brown or purple brown border. Lesions on the upper parts of plants extend rapidly coalescing with each other to cover entire tillers from the water line to the flag leaf. The presence of several large lesions on a leaf sheath usually causes death of the whole leaf, and in severe cases all the leaves of a plant may be blighted in this way.



Fig 1.5: Sheath blight of rice

Disease Cycle

Primary infection – Sclerotia present in the soil

Secondary infection – Irrigation water

Favourable Condition

- High relative humidity (96-97 per cent),
- High temperature (30-32 °C),
- Closer planting and heavy doses of nitrogenous fertilizers.

Management

- Avoid excess doses of fertilizers.
- Adopt optimum spacing.
- Eliminate weed hosts.
- Apply organic amendments.
- Avoid flow of irrigation water from infected fields to healthy fields.
- Deep ploughing in summer and burning of stubbles.
- Grow disease tolerant varieties like **Shiva** (WGL 3943)
- Spray **Validamycin@0.2%**.
- Seed treatment with *Pseudomonas fluorescens* @ of 10g/kg of seed followed by seedling dip @ of 2.5 kg of product/ha dissolved in 100 litres and dipping for 30 minutes.
- Soil application of *P.fluorescens* @ of 2.5 kg/ha after 30 days of transplanting (This product should be mixed with 50 kg of FYM/Sand and then applied).
- Foliar spray at 0.2% concentration commencing from 45 days after transplanting at 10 days interval for 3 times depending upon the intensity of disease.

1.5 FALSE SMUT

Causal organism: *Ustilaginoidea virens*

(P.S: *Claviceps oryzae - sativa*) (Basidiomycotina)

Symptoms

The fungus transforms individual grains into yellow or greenish spore balls of velvety appearance which are small at first and 1 cm or longer at later stages. At early stages the spore balls are covered by a membrane which bursts with further growth.



Fig 1.6: False smut of rice

Disease Cycle

Primary infection – Sclerotia

Secondary infection – Chlamydospores

Favourable Condition

Rainfall and cloudy weather during the flowering and maturity periods are favourable.

Management

- Spray Carbendazim + Mancozeb @0.2% at panicle emergence stage

1.6 TUNGRO

Causal organism: Rice Tungro Bacilliform Virus (RTBV) and Rice Tungro Spherical Virus (RTSV)

Symptoms

Infection occurs both in the nursery and in the main field. Plants are markedly **stunted**. Stunting is more severe on susceptible varieties and slight on more resistant varieties. Leaves show **yellow to orange discoloration** and interveinal chlorosis. Yellowing starts from the tip of the leaf and may extend to the lower part of the leaf blade. Young leaves are often mottled with pale green to whitish. Interveinal stripes and the old leaves may have rusty streaks of various sizes. The plants may be killed if infected early.



Fig 1.8: Tungro disease of Rice

Disease Cycle

Primary infection – Collateral hosts (*Eleusine indica*, *Echinochloa colonum*, *Echinochloa crusgalli*)

Secondary infection - leafhoppers viz, *Nephotettix virescens*, *N. nigropictus*, *N. parvus*, *N. malayanus* and *Recilia dorsalis* transmit the virus in a non-persistent manner.

Management

- Destroy weed hosts of the virus and vectors.
- Grow disease tolerant cultivars like MTU 9992, 1002, 1003, 1005, Suraksha, Vikramarya, Bharani, IR 36, IET 2508, RP 4-14, IET 1444, IR50 and Co45.
- Control the vectors in the nursery by application of carbofuran granules @170 g/cent, 10 days after sowing and @10kg/ac in main field
- Spray Dimethoate @ 0.2% in the main field 15 and 30 days after transplanting to control leaf hoppers.

1.7 KHAIRA (Zn Deficiency)

Symptoms

Usually in nursery; chlorotic/ yellow patches at leaf base on both sides of the midrib; restricted root growth and usually main roots turn brown.



Fig 1.9: Khaira disease of rice

Management

- Use 25kg $ZnSO_4$ /ha before transplanting or sowing at time of land preparation.
- If crop is infected then use 5 kg $ZnSO_4$ + 25 kg lime in 600-700 litre water per hectare.

LECTURE-2 DISEASES OF MAIZE

2.1 STALK ROT

Causal organism: *Cephalosporium acremonium*/ *Cephalosporium maydis*

Symptoms

Infection caused by *C. acremonium* becomes apparent when maize has reached the dough stage. One of the first symptoms is the purpling of leaves and stalks. The most characteristic symptom is the restricted blackening of vascular bundles in the stalk with shredding of the intermodal pith region. Blackening of the vascular bundles extends through several internodes. Barren plants, excessive tillering and multiple ears are the other diagnostic symptoms.

Symptoms caused by *C. maydis* appear only after flowering stage and plants start wilting basipetally giving a dull green appearance of the leaves which later dry up. The lower internode turns discoloured, become reddish brown, shrunken and soft, and subsequently becomes dry and hollow. When diseased stalks are split open, reddish brown vascular bundles are seen.



Fig 2.1: Stalk rot of maize

Disease Cycle

Primary infection – Soil, Plant debris and seed

Secondary infection – Conidia

Favourable condition

High temperature and low soil moisture (drought) favour the disease.

Management

- Crop sanitation
- Crop rotation
- Avoid water stress at flowering
- Seed treatment with Carboxin + Thiram (Vitavax Power) @ 2g/kg of seed.
- Grow resistant varieties like DHM-103, DHM 105, Hi-Starch and Ganga Safed-2.
- Soil drenching and foliar spray of carbendazim + Mancozeb @ 0.2%.

2.2 DOWNY MILDEW (Sub-division: Mastigomycotina)

Causal organism:

Sorghum DM - *Peronosclerospora sorghi* / *P. philippinensis*

Crazy top DM – *Sclerophthora macrospora*

Brown stripe DM – *Sclerophthora rayssiae* var *zeae*

Sugarcane DM – *Peronosclerospora sacchari*

Symptoms

The most characteristic symptom is the development of **chlorotic streaks** appears on the leaves and the plants exhibit a stunted and bushy appearance due to the shortening of the internodes. White downy growth can be seen not only on the lower surface of leaf but also on the chlorotic streaks. Affected leaves often tear linearly causing leaf shredding. The important symptom of the disease is the partial or complete malformation of the tassel into a mass of narrow, twisted leafy structures. Proliferation of axillary buds on the stalk of tassel as well as the cobs is very common (Crazy top).



Fig 2.2: Crazy top of maize

Disease Cycle

Primary infection – Oospore remaining in soil

Secondary infection – Zoospore spread by water

Favourable condition

High relative humidity (90 per cent), water logging condition, light drizzles with a temperature of 20-25⁰C favours the disease development. Young plants are highly susceptible.

Management

- Destruction of plant debris
- Removal and destruction of collateral hosts
- Grow resistant hybrids like DHM-1, DHM-103, DMR-5 and Ganaga II.
- Seed treatment with Metalaxyl at 6g/kg
- Deep summer ploughing
- Crop rotation with pulses
- Spray the crop, 3-4 times, with Metalaxyl + Mancozeb (Ridomil gold) @0.2% starting from 20th day after sowing.

2.3 LEAF SPOT/BLIGHT

Causal organism: *Helminthosporium maydis* (Syn: *H. turcicum*)
(Sub-division: Deuteromycotina)

Symptoms

The fungus affects the crop at young stage. Small yellowish round to oval spots are seen on the leaves. The spots gradually increase in area into bigger elliptical spots and are straw to grayish brown in the centre with dark brown margins. The spots coalesce giving blighted appearance. The surface is covered with olive green velvety masses of conidia and conidiophores.



Fig 2.3 Leaf spot of maize

Disease cycle

Primary infection – Seed

Secondary infection - Conidia

Favourable condition

Optimum temperature for the germination of conidia is 18 to 27°C provided with free water on the leaf. Infection takes place early in the wet season.

Management

- Crop rotation
- Grow resistant hybrids like DHM-1
- Treat the seeds with Carboxin + Thiram @ 2 g/kg
- Spray Carbendazim + Mancozeb @ 0.2.

LECTURE-3 DISEASES OF SORGHUM

3.1 SMUT (Sub-division: Basidiomycotina)

- **Grain smut/Kernel smut / Covered smut / Short smut**

Causal organism: *Sphacelotheca sorghi*

Symptoms

the individual grains are replaced by smut sori. The sori are oval or cylindrical and are covered with a tough creamy skin (peridium) which often persists unbroken up to thrashing. Ratoon crops exhibit higher incidence of disease.



Fig 3.1: Grain smut of sorghum

- **Loose smut/ kernel smut**

Causal organism: *Sphacelotheca cruenta*

Symptoms

The affected plants can be detected before the ears come out. They are shorter than the healthy plants with thinner stalks and marked tillering. The ears come out much earlier than the healthy. The glume are hypertrophied and the ear head gives a loose appearance than healthy. The sorus is covered by a thin membrane which ruptures very early, exposing the spores even as the head emerges from the sheath.



Fig 3.2: Loose smut of Sorghum

Long smut

Causal organism: *Tolyposporium ehrenbergii*

Symptoms

This disease is normally restricted to a relatively a small proportion of the florets which are scattered on a head. The sori are long, more or less cylindrical, elongated, slightly curved with a relatively thick creamy-brown covering membrane (peridium). The peridium splits at the apex to release black mass of spores (spore in groups of balls) among which are found several dark brown filaments which represent the vascular bundles of the infected ovary.



Fig 3.3: Long smut of Sorghum

Head smut

Causal organism: *Sphacelotheca reiliana*

Symptoms

The entire head is replaced by large **sori**. The sorus is covered by a whitish grey membrane of fungal tissue, which ruptures, before the head emerges from the boot leaf to expose a mass of brown smut spores. Spores are embedded in long, thin, dark colored filaments which are the vascular bundles of the infected head.



Fig 3.4: Head smut of Sorghum

Disease cycle

Primary infection – Seeds

Secondary infection – Smut spores spread by wind

Management for all smuts

- Treat the seed with Carboxin +Thiram (Vitavax power) @ 2g/kg of seeds.
- Use disease free seeds.
- Follow crop rotation.
- Collect the smutted ear heads in cloth bags and bury in soil.

3.2 HEAD MOULD/GRAIN MOULD/HEAD BLIGHT

More than thirty two genera of fungi were found to occur on the grains of sorghum.

Symptoms

If rain occurs during the flowering and grain filling stages, severe grain moulding occurs. The most frequently occurring genera are *Fusarium*, *Curvularia*, *Alternaria*, *Aspergillus* and *Phoma*. *Fusarium semitectum* and *F.moniliforme* develop a fluffy white or pinkish coloration. *C. lunata* colours the grain black. Symptom varies depending upon the organism

involved and the degree of infection.



Fig 3.5: Head mould of Sorghum

Disease Cycle

Primary infection – Infected plant debris

Secondary infection – Conidia

Favourable condition

Wet weather following the flowering favours grain mould development and the longer the wet period the greater the mould development. Compact ear heads are highly susceptible.

Management

- Adjust the sowing time.
- Grow resistant varieties like GMRP 4, GMRP 9, GMRP 13 and tolerant varieties like CSV 15.
- Seed disinfestation with Captan + Thiram @ 2g/kg of seeds.
- Spray Carbendazim + Mancozeb @ 0.2% in case of intermittent rainfall during earhead emergence, a week later and during milky stage.

3.3 ANTHRACNOSE AND RED ROT

Causal organism: *Colletotrichum graminicolum*
(Sub division: *Deuteromycotina*)

Symptoms

The fungus causes both leaf spot (anthracnose) and stalk rot (red rot). The disease appears as small red coloured spots on both surfaces of the leaf. The centre of the spot is white in colour encircled by red, purple or brown margin. Numerous small black dots like acervuli are seen on the white surface of the lesions. Red rot can be characterized externally by the development of circular cankers, particularly in the inflorescence. Infected stem when split open shows discoloration, which may be continuous over a large area or more generally discontinuous giving the stem a marbled appearance.



Fig 3.6: Anthracnose of sorghum

Disease Cycle

Primary infection – Infected plant plants

Secondary infection – Air borne conidia

Favourable condition

Continuous rain, temperature of 28-30°C and high humidity aggravates the disease.

Management

- Destruction of infected plant debris and collateral hosts.
- Crop rotation with non-host crops
- Grow resistant varieties like SPV 162, CSV 17, Texas Milo and Tift sudan etc.
- Treat the seeds with Carboxin + Thiram @ 2g/kg of seeds.
- Spray the crop with Carbendazim + Mancozeb @ 0.2%.

LECTURE-4 DISEASES OF BAJRA

4.1 DOWNY MILDEW

Causal organism: *Sclerospora graminicola*
(Sub-division: Mastigomycotina)

Symptoms

Infection is mainly systemic and symptoms appear on the leaves and the ear head. The first symptoms can appear in seedlings at three to four leaf stage. The affected leaves show patches of light green to light yellow colour on the upper surface of leaves and the corresponding lower surface bears **white downy growth** of the fungus. The infected plants tiller excessively and are dwarfed. In affected plants, ears fail to form or if formed, they are completely or partially malformed into twisted green leafy structures; hence the name **green ear** disease.



Fig 4.1: Green ear of Bajra

Disease cycle

Primary infection – Oospore present in soil

Secondary infection – Zoospore

Favourable condition

Formation of sporangiophores and sporangia is favoured by very high humidity (90 per cent), presence of water on the leaves and low temperature of 15-25 °C.

Management

- Deep ploughing to bury the oospores.
- Rouging out infected plants.
- Adopt crop rotation.
- Grow resistant varieties WCC-75, Co7 and Co (Cu) 9.
- Treat the seeds with Metalaxyl at 6g/kg.
- Spray Metalaxyl + Mancozeb (Ridomil gold) @ 0.2% on 20th day after sowing in the field.

4.2 ERGOT OR SUGARY DISEASE

Causal organism: *Claviceps fusiformis*

(Sub-division: Ascomycotina)

Symptoms

The symptom is seen by exudation of small droplets of light pinkish or brownish honey dew from the infected spikelets. Under severe infection many such spikelets exude plenty of honey dew which trickles along the earhead. This attracts several insects. In the later stages, the infected ovary turns into small dark brown sclerotium which projects out of the spikelet.



Fig 4.2: Ergot of Bajra

Disease cycle

Primary infection – Sclerotia

Secondary infection – Conidia and insects

Favourable conditions

Flowers are susceptible to the infection only after stigma emergence and before pollination and fertilization. Overcast sky, drizzling rain with a temperature of 20-30°C during flowering period, favour the disease development.

Management

- Adjust the sowing date so that the crop does not flower during September when high rainfall and high relative humidity favour the disease spread.
- Immerse the seeds in 10 per cent common salt solution and remove the floating sclerotia.
- Remove collateral hosts.
- Spray with Carbendazim + Mancozeb @ 0.2% when 5-10 per cent flowers have opened and again at 50 per cent flowering stage.

LECTURE-5 DISEASES OF GROUNDNUT

5.1 TIKKA LEAF SPOTS (Sub-division: Deuteromycotina)

Causal organism:

Early leaf spot: *Cercospora arachidicola* (Sexual Stage: *Mycosphaerella arachidis*)

Late leaf spot: *Phaeoisariopsis personata* (Sexual stage: *Mycosphaerella berkeleyi*)
(Syn: *Cercosporidium personatum*)

Early leaf spot (*Cercospora arachidicola*): Symptoms usually appear within 35 DAS. The most conspicuous symptoms are observed on the leaflets. But symptoms may also appear on rachis, petioles, stipules and stalks etc, as elongated, elliptical spots with definite border. The disease usually appears early (before 35 DAS) than the *Cercosporidium personatum* and hence is known as early spot. The leaf spots are irregularly circular (1-10 mm in diameter), reddish brown or dark brown on the upper surface and are surrounded by a bright yellow halo. On the under surface, spots are light brown to tan coloured. Several spots coalesce and result in drying of the leaves.

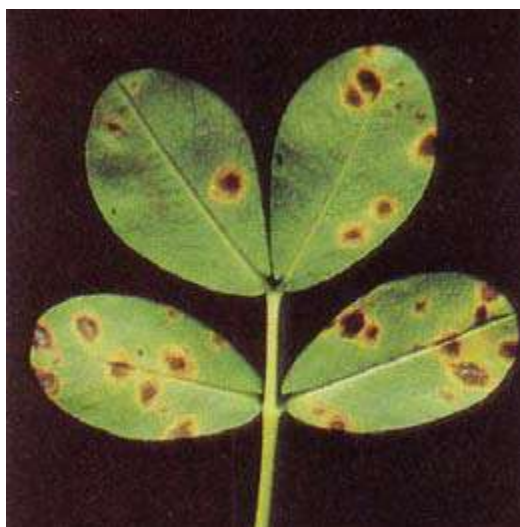


Fig 5.1: Early Tikka of Groundnut

Late leaf spot (*Cercosporidium personatum*): Leaf spots due to *C. personatum* appear (after 35 DAS) later than those due to *Cercospora arachidicola* and hence the symptoms are called late spots. The spots on leaves are circular with bright yellow halo around mature spots, usually **darker** than early leaf spots. On the under surface of the leaves the halo is not seen. The spots are deep black in colour with clusters of conidiophores bearing conidia, arranged in concentric manner. Severely diseased leaves dry up and results in heavy defoliation.

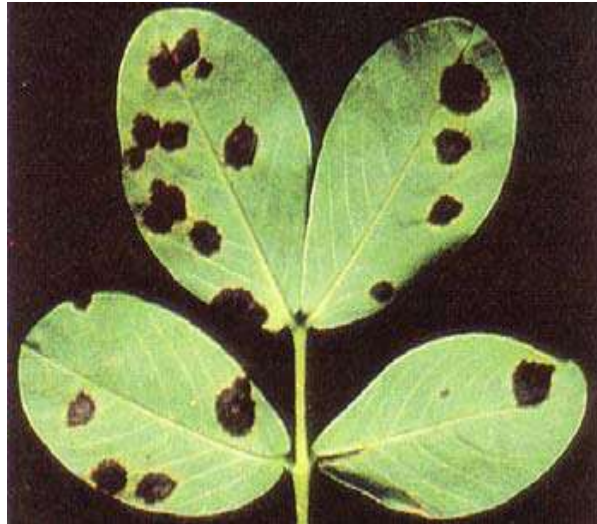


Fig 5.2: Late Tikka of Groundnut

Disease cycle

Primary infection – Infected plant parts

Secondary infection – Conidia

Favourable condition

- Prolonged high relative humidity for 3 days.
- Low temperature (2° C) with dew on leaf surface..
- Heavy doses of nitrogen and phosphorus fertilizers.
- Deficiency of magesium in soil.

Management

- Remove and destory the infected plant debris.
- Eradicate the volunteer groundnut plants.
- Keep weeds under control.
- Treat the seeds with Carboxin + Thiram (Vitavax power) at 2g/kg.
- Spray Carbendazim +mancozeb @ 0.2 % or Chlorothalonil @ 0.2% and if necessary, repeat after 15 days.
- Grow moderately resistant varieties like ALR 1.

5.2 WILT

Causal organism: *Pseudomonas solanacearum*

Symptoms

Infected plants appear unhealthy, chlorotic and wilt under water stress. Dark brown discolouration of xylem is seen. Grey slimy liquid ooze out of the vascular bundles.

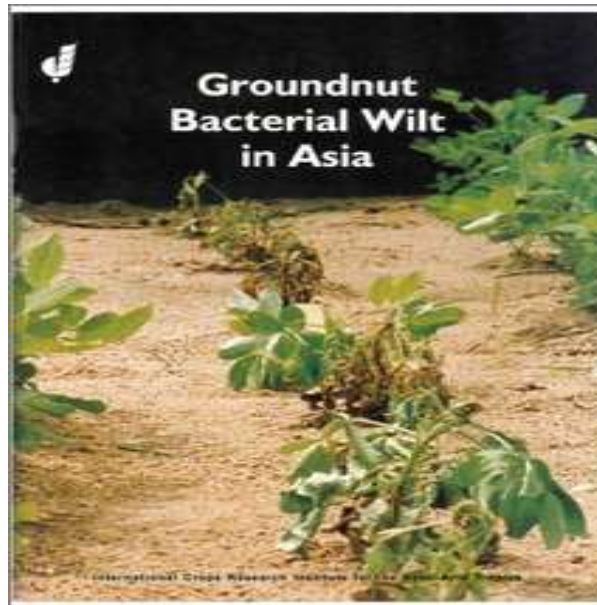


Fig 5.3: Wilt of groundnut

Disease cycle

Primary infection – Soil

Secondary infection – Oozes spread by water

Management

- Seed treatment with Streptocycline @ 0.01%.
- Spray Streptocycline @ 0.01% and copper oxychloride @ 0.3%.

LECTURE-6 DISEASES OF SOYBEAN

6.1 RHIZOCTONIA BLIGHT

Causal organism: *Rhizoctonia solani*

(Sub-division: *Deuteromycotina*)

Symptoms

The infection is common during the late vegetative stages. Initially circular to irregular green water soaked spots with reddish - brown margin appear on older leaves, sometimes on older leaflets. At the later stage of disease the spot turns tan or brown color and the spots start to appear on the petioles, stem and young pod. Brown protrusion grows on stems and petioles. Agglutinations of leaves with cottony fungal growth are also common. Severe infection cause pod blight and defoliation.



Fig 6.1: Rhizoctonia blight of Soybean

Disease Cycle

Primary infection – Sclerotia in soil

Secondary infection – Water

Favourable condition

Warm temperature and high humidity favours disease development.

Management

- Soil drenching with Validamycin @ 0.2%.

6. 2 BACTERIAL PUSTULES/SPOTS

Causal organism: *Xanthomonas axonopodis* pv. *glycines*

Symptoms

Symptoms are evident as tiny, light green spots with elevated centers that later on turn into raised lightly coloured pustules, typically without exudates. Infection is more frequent on the lower ones. Spots may vary from minute specks to large, irregular, mottled brown areas. Severely affected portions of leaves are torn away by wind imparting a ragged appearance to plants, and results in premature defoliation.



Fig 6.2: Bacterial leaf spot of soybean

Disease cycle

Primary infection – Seed and plant debris

Secondary infection – Ooze spread by water

Favourable condition

The disease appears in a severe form when warm temperatures and frequent showers prevail during growing season.

Management

- Remove and burn infected plant debris.
- Crop rotation with grain crop is recommended
- Two sprays at 45 and 55 DAS with a mixture of Streptocycline @ 0.01% + Copper oxychloride @ 0.3%.

6.3 MOSAIC

Causal organism: Soybean mosaic virus

Symptom

Infected plants can be recognized by their stunted growth, distorted and puckered leaves. The leaves are dwarfed, crinkled and narrow with their margins turned downwards. In severe cases, dark green blister like puckering along the veins takes place. Pod setting is drastically reduced. Infected plants produce distorted pods and fewer seeds. Seed discolouration can be seen under severe infection. The infected plants remain green even at the end of rowing season.



Fig 6.3: Mosaic disease of soybean

Disease cycle

Primary infection – Seed

Secondary infection – Aphids

Management

- Use virus free seed from healthy crop.
- Rogue out infected plants and burn them.
- Spray dimethoate @ 2ml/lit to control the vector.

6.4 SEED AND SEEDLING ROT

Causal organism: *Fusarium*, *Rhizoctonia*, *Phytophthora*, and *Pythium*

Symptoms

Phytophthora can attack and rot seeds prior to emergence, and can cause pre- and post-emergence damping off. It produces tan-brown, soft, rotted tissue. At the primary leaf stage (V1), infected stems appear bruised and soft, secondary roots are rotted, the leaves turn yellow, and plants frequently wilt and die.

Pythium can attack and rot seeds and seedlings prior to emergence and can cause post-emergence damping-off under wet conditions. The characteristic symptom of most *Pythium* infections is soft, brownish-colored, rotting tissue.

Rhizoctonia can damage seeds and plants prior to or after emergence. In seedlings and older plants, a firm, rusty-brown decay or sunken lesion on the root or on the lower stem is a characteristic symptom.

Fusarium is also a common pathogen that can damage seeds and seedlings. It causes light to dark brown lesions on roots that may spread over much of the root system and may appear shrunk. *Fusarium* may attack the tap root and promote adventitious root growth near the soil surface and may degrade lateral roots.



Fig 6.4: Seedling rot

Disease Cycle

Primary infection – Soil

Secondary infection – air and water

Management

- For *Pythium* and *Phytophthora* spray Metalaxyl @ 0.2%
- For *Fusarium* spray Carbendazim + Mancozeb @ 0.1%.
- For *Rhizoctonia* spray Validamycin @ 0.2%.

LECTURE-7 DISEASES OF FINGER MILLET

7.1 BLAST

Causal organism: *Pyricularia grisea*
(Sub-division: Deuteromycotina)

Symptoms

Infection may occur at all stages of plant growth. Young seedlings may be blasted or blighted in the nursery bed as well as developing young plants in the main field. There are three stages in disease development.

Leaf blast: It is more severe in tillering phase. The disease is characterized by spindle shaped spots on the leaves with gray centres surrounded by reddish brown margins.

Node blast: Infection on stem causes blackening of the nodal region and the nodes break at the point of infection. All the parts above the infected node die.

Neck blast: At flowering stage, the neck just below the ear head is affected and turns sooty black in colour and usually breaks at this point. In early neck infections, the entire ear head becomes chaffy and there is no grain set at all. If grain setting occurs, they are shrivelled and reduced in size.



Fig 7.1: Leaf blast

Fig 7.2: Neck blast

Disease cycle

Primary infection – Seed

Secondary infection – Conidia

Favourable condition

Application of high doses of nitrogenous fertilizers, low night (20⁰C) and day (30⁰C) temperatures with high relative humidity (92-95%) and rain or continuous drizzles favour the disease development. Presence of collateral hosts like bajra, wheat, barley and oats also favour disease development.

Management

- Destruction of collateral hosts and infected plant debris
- Treat the seeds with Carboxin + Thiram (Vitavax Power) @ 2g/kg of seeds.
- Grow resistant varieties like Ratnagiri, Padmavati, Gowtami and Godavari
- Spray with Tricyclazole @ 0.1%.

7.2 CERCOSPORA LEAF SPOT

Causal organism: *Cercospora penniseti*

(Sub-division: *Deuteromycotina*)

Symptoms

Small dark lesions on leaves which are usually oval in shape but may be oblong to rectangular; centres of lesions are gray to tan in color with visible black dots; lesions may be covered in spores during wet weather; lesions may also be present on the stems and are slightly longer than those on the leaves.



Fig 7.3: Cercospora leaf spot of Finger Millet

Disease cycle

Primary infection – Infected plant debris

Secondary infection - Conidia

Favourable condition

Low temperature and high humidity favours the disease development.

Management

- Spray Carbendazim + Mancozeb @ 0.2%.

LECTURE-8 DISEASES OF PIGEONPEA

8.1 STEM BLIGHT

Causal organism: *Phytophthora drechsleri* f. sp. *cajani*
(Sub-division: Mastigomycotina)

Symptoms

Phytophthora blight resembles damping off in that it causes seedlings to die suddenly. Infected plants have water soaked lesions on their leaves and brown to black, slightly sunken lesions on their stems and petioles. Infected leaves lose turgidity, and become desiccated. Lesions girdle the affected main stems or branches which break at this point and foliage above the lesion dries up.



Fig 8.1: Stem blight of Pigeon Pea

Disease Cycle

Primary infection – Oospore present in soil

Secondary infection – Zoospores

Favourable condition

Cloudy weather and drizzling rain with temperatures around 25⁰C favour infection that requires continuous leaf wetness for 8 hours to occur.

Management

- Avoid sowing redgram in fields with low-lying patches that are prone to water logging.
- Adjust the sowing time so that crop growth should not coincide with heavy rainfall.
- Grow resistant varieties like BDN 1, ICPL 150, ICPL 288, ICPL 304, KPBR 80-1-4.
- Seed treatment with 6g metalaxyl per kg of seed.
- Spray Metalaxyl + Mancozeb (Ridomyl Gold) at 0.2%.
-

8.2 WILT

Causal organism: *Fusarium udum*

(Sub-division: Deuteromycotina)

Symptoms

The disease may appear from early stages of plant growth (4-6 week old plant) up to flowering and podding. The disease appears as gradual withering and drying of plants. Yellowing of leaves and blackening of stem starting from collar to branches which gradually result in drooping and premature drying of leaves, stems, branches and finally death of plant. Vascular tissues exhibit brown discoloration. Often only one side of the stem and root system is affected resulting in partial wilting.



Fig 8.2: Wilt of Pigeon Pea

Disease Cycle

Primary infection – Chlamydospore in soil

Secondary infection – Conidia

Favourable condition

- Soil temperature of 17-25°C.
- Continuous cultivation of redgram in the same field.

Management

- Treat the seeds with *Trichoderma viride* at 4 g/kg (106cfu/g).
- Avoid successive cultivation of red gram in the same field.
- Crop rotation with tobacco.
- Mixed cropping with sorghum in the field.
- Grow resistant cultivars like Sharad, Jawahar, Maruthi, Malviya Arhar-2, C-11, Pusa-9, Narendra Arhar-1 and Birsa Arhar-1
- Soil drenching with carbendazim + Mancozeb @ 0.2% alternating with Thiophenate methyl @ 0.15%.

8.3 STERILITY MOSAIC DISEASE

Causal organism: *Sterility mosaic virus*

Symptoms

The disease attack can be seen in all stages of crop growth. In the field, the diseased plants appear as **bushy, pale green plants without flowers or pods**. Leaves of these plants are small and show typical light and dark green mosaic pattern. Symptoms initially appear as vein-clearing on young leaves. In severe cases, leaves become smaller and **cluster** near tip because of shortened internodes and stimulation of axillary buds. The plants are generally stunted and do not produce pod.



Fig 8.3: Sterility mosaic of Pigeon Pea

Disease Cycle

Primary infection – Self sown pigeon pea and perennial pigeon pea

Secondary infection – Eriophid mite (*Aceria cajani*)

Favourable conditions

Disease incidence is high when pigeonpeas are inter- or mixed cropped with sorghum or millets. Shade and humidity encourage mite multiplication, especially in hot summer weather.

Management

- Rogue out infected plants in early stages of disease development
- Grow tolerant genotypes like ICPL 87119 (Asha), ICPL 227, Jagruti and Bahar
- Spray Dicofol 3ml or Sulphur 3g in one liter of water to control mite vector in early stages of disease development

LECTURE-9 DISEASES OF BLACK GRAM AND GREEN GRAM

9.1 CERCOSPORA LEAF SPOT

Causal organism: *Cercospora canescens*

(Sub-division: *Deuteromycotina*)

Symptoms

Small, circular spots develop on the leaves with grey centre and reddish brown margin. The several spots coalesce to form brown irregular lesions. Under favourable environmental conditions, severe leaf spotting and defoliation occurs at the time of flowering and pod formation.



Fig 9.1: Cercospora leaf spot of Black gram and Green gram

Disease cycle

Primary infection – Infected plant debris

Secondary infection - Conidia

Favourable condition

Low temperature and high humidity favours the disease development.

Management

- Spray Carbendazim + Mancozeb @ 0.2%.

9.2 ANTHRACNOSE

Causal organism: *Colletotrichum lindemuthianum*

(Sub-division: Deuteromycotina)

(Sexual stage: *Glomerella lindemuthianum*)

Symptoms

The symptom can be observed in all aerial parts of the plants and at any stage of crop growth. The fungus produces dark brown to black sunken lesions on the hypocotyl area and cause death of the seedlings. Small angular brown lesions appear on leaves, mostly adjacent to veins, which later become greyish white centre with dark brown or reddish margin.

The lesions may be seen on the petioles and stem. The prominent symptom is seen on the pods. Minute water soaked lesion appears on the pods initially and becomes brown and enlarges to form circular, depressed spot with dark centre with bright red or yellow margin. Several spots join to cause necrotic areas with acervuli. The infected pods have discoloured seeds.



Fig 9.2 Anthracnose of Black gram and Green Gram

Disease Cycle

Primary infection – Seed

Secondary infection – Conidia

Favourable condition

- High relative humidity (Above 90 per cent),
- Low temperature (15-20° C)
- Cool rainy days.

Management

- Seed treatment with carboxin + Thiram @ 2g/kg of seeds.
- Foliar spray with Carbendazim + Mancozeb @ 0.2%.

9.3 RHIZOCTONIA ROOT ROT (WEB BLIGHT)

Causal organism: *Rhizoctonia bataticola*

(Sub-division: *Deuteromycotina*)

Symptoms

The disease symptom starts initially with yellowing and drooping of the leaves. The leaves later fall off and the plant dies within week. Dark brown lesions are seen on the stem at ground level and bark shows shredding symptom. The affected plants can be easily pulled out leaving dried, rotten root portions in the ground. The rotten tissues of stem and root contain a large number of black minute sclerotia.

Disease Cycle

Primary infection – Sclerotia remain in soil

Secondary infection – Water

Favourable condition

High temperature and high humidity favour the disease development.

Management

- Seed treatment with Carboxin + Thiram @ 2g/Kg of seed.
- Soil drenching with Validamycin @ 0.2%.

9.4 YELLOW MOSAIC

Causal organism: *Mungbean yellow mosaic virus* (MYMV)

Symptoms

Initially small yellow patches or spots appear on green lamina of young leaves. Soon it develops into a characteristic bright yellow mosaic or golden yellow mosaic symptom. Yellow discoloration slowly increases and leaves turn completely yellow. Infected plants mature later and bear few flowers and pods. The pods are small and distorted. Early infection causes death of the plant before seed set.



Fig 9.3: Yellow mosaic Disease of Black gram and Green gram

Disease cycle

Primary infection - weed hosts viz., *Croton sparsiflorus*, *Acalypha indica*, *Eclipta alba* and *Cosmos pinnatus* and legume hosts.

Secondary infection – White fly (*Bemisia tabaci*)

Management

- Rogue out the diseased plants upto 40 days after sowing.
- Remove the weed hosts periodically.
- Grow resistant black gram varieties like Teja, LBG 752, Pant-30 and Pant-90.
- Grow resistant green gram varieties like LGG 407 and ML 267..
- Treat seeds with Imidacloprid 70 WS @ 5ml/kg to control vector.
- Give one foliar spray with Dimethoate @ 0.2%.

LECTURE-10 DISEASES OF CASTOR

10.1 SEEDLING BLIGHT

Causal organism: *Phytophthora parasitica*
(Sub-division: Mastigomycotina)

Symptoms

The disease appears circular, dull green patch on both the surface of the cotyledon leaves. It later spreads and causes rotting. The infection moves to stem and causes withering and death of seedling. In mature plants, the infection initially appears on the young leaves and spreads to petiole and stem causing black discoloration and severe defoliation.



Fig 10.1: Seedling Blight of Castor

Disease cycle

Primary infection – Oospore present in soil

Secondary infection – Zoospores

Favourable Condition

- Continuous rainy weather.
- Low temperature (20-25°C).
- Low lying and ill drained soils.

Management

- Remove and destroy infected plant residues.
- Avoid low-lying and ill drained fields for sowing.
- Treat the seeds with Metalaxyl at 6g/kg.
- Soil drenching with Metalaxyl + Mancozeb (Ridomil gold) @ 0.2%.

LECTURE-11 DISEASES OF TOBACCO

11.1 BLACK SHANK

Causal organism: *Phytophthora parasitica* var. *nicotianae*
(Sub-division: Mastigomycotina)

Symptoms

The pathogen may affect the crop at any stage of its growth. Even though all parts are affected, the disease infects chiefly the roots and base of the stem. Seedlings in the nursery show black discolor of the stem near the soil level and blackening of roots, leading to wet rot in humid condition and seedling blight in dry weather with withering and drying of tips. The pathogen also spreads to the leaves and causes blighting and drying of the bottom leaves. In the transplanted crop, the disease appears as minute black spot on the stem, spreads along the stem to produce irregular black patches and often girdling occurs.



Fig 11.1: Black Shank of Tobacco

Disease cycle

Primary infection – Oospores present in soil

Secondary infection – Zoospores

Favourable condition

- Frequent rainfall and high soil moisture.
- High population of root knot nematodes *Meloidogyne incognita*.

Management

- Collect and burn plant residues and debris.
- Select disease free seedlings for transplanting.
- Remove and destroy the affected plants in the field.
- Spot application metalaxyl + Mancozeb (Ridomil Gold) @0.2% in planting points offer good protection.
- Burn the seed beds with paddy husk or groundnut shell at 15-20 cm thick layer.

11.2 MOSAIC

Causal organism: *Tobacco Mosaic Virus (TMV) or Nicotiana virus I*

Symptoms

The disease appears as light discoloration along the veins of the youngest leaves. Soon the leaves develop a characteristic light and dark green pattern, the dark green areas are usually associated with the veins. The dark green areas later develop into irregular **blisters** due to more rapid growth. The plants that become infected early in the season are usually very much stunted with small, chlorotic, mottled and curled leaves. In severe infections, the leaves are narrowed, puckered, thin and **malformed** beyond recognition. Later, **dark brown necrotic spots** develop under hot weather and this symptom is called “**Mosaic burn**” or “**Mosaic scorching**”.



Fig 11.2: Mosaic disease of Tobacco

Disease cycle

Primary infection – Alternate and collateral host

Secondary infection – Sap transmission (Mechanical transmission)

Management

- Remove and destroy infected plants.
- Keep the field free of weeds which harbour the virus.
- Wash hands with soap and running water before or after handling the plants or after weeding.
- Prohibit smoking, chewing and snuffing during field operations.

- Spray the nursery and main field with botanical leaf extracts of *Bougainvillea* or *Basella alba* at 1 litre of extract in 150 litres of water, two to three times at weekly intervals.
- Adopt crop rotation by growing non-host plants for two seasons.
- Grow resistant varieties like TMV RR2, TMV RR 2a and TMV RR3.

11.3 BLACK ROOT ROT

Causal organism: *Thielaviopsis basicola*

(Sub-division: Deuteromycotina)

Symptoms

Some early symptoms of black root rot include yellowing of foliage, marginal leaf scorch and overall plant decline. Black root rot may be mistaken for a nutrient deficiency. Infected herbaceous plants wilt rapidly during the hottest part of the day and recover during the evening hours. Branches may die back, and the entire plant may eventually die. Root systems are reduced to roots that are short, stubby, black and decayed.



Fig 11.3: Black Root rot of Tobacco

Disease cycle

Primary infection – Chlamydospores present in soil

Secondary infection – Irrigation water and insects

Favourable condition

High temperature favours the disease development.

Management

- Spray Carbendazim + Mancozeb @ 0.2%.

LECTURE- 12 DISEASES OF GUAVA

12.1 WILT

Causal organism: *Fusarium oxysporum* f. sp. *pisidi*
(Sub-division: *Deuteromycotina*)

Symptoms

Initially there is yellowing of leaves, drooping of fruits. Rotting of the base of the plant and also root occur. When the stem is split open there is discoloration of vascular bundles.



Fig 12.1: Wilt of Guava

Disease cycle

Primary infection – Chlamydospores in soil

Secondary infection – Conidia

Favourable conditions

- pH 6.0 is optimum for disease development. Both pH 4.0 and 8.0 reduces the disease.
- Disease is more in clay loam and sandy loam compared to heavy soil.
- Higher disease incidence in monsoon period.
- Disease appears from August and increases sharply during September-October.
- The presence of nematode, *Helicotylenchus dihystra* spread the disease.
- Trees of age 5 years are normally affected, 10-20 years old plant are highly susceptible to disease.
- **Management**
- Proper sanitation of orchard.
- Wilted plants should be uprooted, burnt and a trench of 1.0-1.5m should be dug around the tree trunk. Treat the pits with formalin and cover the pit for three days and then transplant the seedlings after two weeks. While transplanting seedlings avoid damage to the roots.

- Maintain proper tree vigour by timely and adequate manuring, interculture and irrigation.
- Intercropping with turmeric or marigold.
- Soil solarization with transparent polythene sheet during summer months.
- Application of oil cakes like neem cake, mahua cake, kusum cake supplemented with urea. Apply 6kg neem cake + 2kg gypsum per plant.
- Judicious application of N and Zn amendments.
- Grow resistant variety like **apple guava**
- Soil drenching and foliar spray with Carbendazim + Mancozeb @ 0.2% alternating with Thiophenate methyl @ 0.15%.

12.2 ANTHRACNOSE

Causal organism: *Colletotrichum gloeosporioides*
(Sub-division: *Deuteromycotina*)

Symptoms

Symptoms of this disease are observed on mature fruits on the tree. The characteristic symptoms consist of sunken, dark colored, necrotic lesions. Under humid conditions, the necrotic lesions become covered with pinkish spore masses. As the disease progresses, the small sunken lesions coalesce to form large necrotic patches affecting the flesh of the fruit.



Fig 12.2: Anthracnose of Guava

Disease cycle

Primary infection - Infected plant parts

Secondary infection – Conidia

Favourable condition

Low temperature and high humidity

Management

- Spray Carbendazim + Mancozeb @ 0.2%.

LECTURE-13 DISEASES OF BANANA

13.1 PANAMA WILT

Causal organism: *Fusarium oxysporum* f. sp *cubense*
(Sub-division: *Deuteromycotina*)

Symptoms

Yellowing of the lower most leaves start from margin to midrib of the leaves. Yellowing extends upwards and finally heart leaf alone remains green for some time and it is also affected. The leaves break near the base and hang down around pseudostem. There is discoloration of vascular bundles when the pseudostem is splitted open. The fungus spreads through use of infected rhizomes Continuous cultivation results in build up of inoculums.



Fig 13.1: Panama wilt of Banana

Disease cycle

Primary infection – Chlamydospore present in the soil

Secondary infection – Conidia

Favourable condition

High humidity, low temperature and attack of burrowing nematode (*Radopholus similis*) favour the disease development.

Management

- Avoid growing of susceptible cultivars viz., Rasthali, Monthan, Red banana and Virupakshi.
- Grow resistant cultivar Poovan.
- Since nematode predispose the disease pairing and prolinage with Carbofuran granules.

- Corm injection with Carbendazim @ 0.1%

13.2 BACTERIAL WILT / MOKO

Causal organism: *Pseudomonas solanacearum* / *Burkholderia solanacearum*

Symptoms

Leaves become yellow and progress upwards. The petiole breaks and leaves hang. When it is cut open discolouration in vascular region with pale yellow to dark brown colour. The discolouration is in the central portion of the corm. Internal rot of fruits with dark brown discoloration. When the pseudostem is cut transversely bacterial ooze can be seen.



Fig 13.2: Moko Disease of Banana

Disease cycle

Primary infection – Soil

Secondary infection – Ooze spread through water

Management

- Uproot the infected plants and destroy it.
- Spray Streptocycline @ 0.01% with Copper oxychloride @ 0.3%.

13.3 SIGATOKA LEAF SPOT

Causal organism: *Mycosphaerella musicola* (*Cercospora musae*)
(Sub-division: Ascomycotina)

Symptoms

On leaves small light yellow or brownish green narrow streaks appear. They enlarge in size becomes linear, oblong, brown to black spots with dark brown band and yellow halo. Black specks of fungal fruitification appear in the affected leaves. Rapid drying and defoliation of the leaves.



Fig 13.3: Sigatoka leaf spot of Banana

Disease cycle

Primary infection – Ascospores

Secondary infection – Conidia

Favourable condition

Low temperature and high humidity favours the disease development.

Management

- Spray Carbendazim + Mancozeb @ 0.2%.

13.4 BANANA BUNCHY TOP

Causal organism: Banana bunchy top virus

Symptoms

Subsequent leaving show the same symptoms and are dwarfed. Dark broken bands of green tissues on the veins, leaves and petioles. Plants are extremely stunted. Leaves are reduced in size marginal chlorosis and curling. Leaves upright and become brittle. Many leaves are crowded at the top. Branches size will very small. If infected earlier no bunch will be produced. The disease is transmitted primarily by infected suckers.



Fig 13.4: Bunchy top of Banana

Disease cycle

Primary infection – Infected suckers

Secondary infection – Aphid (*Pentalonia nigronervosa*)

Management

- Select suckers from disease free areas.
- Control vector by spraying Dimethoate @ 0.2%
- Infected plants are destroyed using 4ml of 2, 4, D (50g in 400 ml of water)

LECTURE-14

DISEASES OF PAPAYA

14.1 FOOT ROT

Causal organism: *Pythium aphanidermatum*, *Rhizoctonia solani*

Symptoms

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



Fig 14.1: Foot rot of Papaya

Disease cycle

Primary infection: Oospores (*Pythium*) or Sclerotia (*Rhizoctonia*) in soil

Secondary Infection: Water

Favourable conditions

- Appears from June to August
- Younger seedlings are more susceptible than older ones
- Severity increases with intensity of rainfall
- *R. solani* is severe in **dry and hot weather** (36⁰ C)

Management

- Seedlings should be raised in well drained nursery area
- Uproot the diseased seedlings and burn
- Seed treatment with Carboxin + Thiram (Vitavax power) @ 2g/kg of seeds.
- Soil drenching with Validamycin @ 0.2% for *Rhizoctonia* and Metalaxyl + Mancozeb (Ridomil Gold) @ 0.2 % for *Pythium*.

14.2 LEAF CURL

Causal organism: Tobacco leaf curl virus or Nicotiana virus 10

Symptoms

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



Fig 14.2: Leaf curl of papaya

Disease cycle

Primary Infection: Infected plant parts

Secondary Infection : Whitefly, *Bemesia tabaci* and grafting

Management

- Disease free seedlings.
- Rouging and destruction of diseased plants
- Vector control with Dimethoate@0.2%.

14.1 MOSAIC

Causal organism: *Papaya mosaic virus* or *Papaya ringspot virus* or *Carica virus1*

Symptoms

Mottling and puckering of leaves, especially in young leaves. The lamina is reduced and malformed and are often modified into tendril like structures (**shoestrings**). Decline & marked reduction in growth of diseased plants (within 30-40 days). Older leaves fall down and a small tuft of younger leaves is left at the top with upright position. The stem, petiole and fruits

elongated water soaked areas showing concentric or circular rings appear. Fruits develop innumerable circular, water soaked lesions with spots in the centre. Fruit size is severely reduced with deformed shape



Fig 14.3: Mosaic disease of Papaya

Disease Cycle

Primary infection: Affected plant parts (Mechanical)

Secondary infection: Aphids (*Myzus persicae*)

Management

- Disease free seedlings
- Rouging and destruction of diseased plants
- Vector control with Dimethoate @ 0.2%.
- *Carica cauliflora* is resistant
- Weekly sprays with 1% groundnut oil.

DISEASES OF POMEGRANATE

15.1. BACTERIAL LEAF SPOT

Causal organism: *Xanthomonas axonopodis* pv. *punicae*

Symptoms

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



Fig 14.4: Bacterial Leaf spot of Pomegranate

Disease cycle

Primary infection: Infected cuttings

Secondary infection: Wind splashed rains

Management

- Clean cultivation and strict sanitation in orchard
- Spray Streptocycline @ 0.01% + Copper oxychloride @ 0.3%.

LECTURE-15 DISEASES OF TOMATO

15.1 DAMPING OFF OF TOMATO

Causal organism: *Pythium spp.*
(Sub division – *Mastigomycotina*)

Symptom

In the nursery seed rot or radicle and plumule rot occur before germination resulting in poor germination (premergence damping off.). The seedling toppling over after emergence due to infection in roots or collar region. The infected tissue become soft and water soaked, constriction of the stem at base occur. (Post emergence damping off). Large patches of seedlings die in heavy infection.



Fig 15.1: Damping off of Tomato

Disease cycle:

Primary infection: Oospores

Secondary infection: By zoospore

Favourable condition:

Excess soil moisture due to stagnation, high humidity, overcrowding of seed rate and occurrence of too much organic matter.

Management:

- Treating the seed with suitable seed protectants like Metalaxyl @6g/kg of seeds.
- Seed treatment with *Trichoderma harzianum* or *Pseudomonas fluorescens*.
- Soil drenching with Metalaxyl + Mancozeb (Ridomil Gold) @ 0.2% gives good control.
- Use of light soil for nursery, raised seed bed, light but frequent irrigation better drainage control the disease.

15.2 WILT OF TOMATO

❖ Fungal wilt

Causal organism: *Fusarium oxysporum* f.sp. *lycopersici* (Sub-division: Deuteromycotina)

Symptom:

Clearing of the leaf veins and chlorosis are the initial symptoms of the disease. Petioles and leaves of affected plants droop and wilt. In severe cases black discoloration of vascular tissues can be seen if the roots and stem are split open.



Fig 15.2: Fungal wilt of Tomato

Disease cycle:

Primary infection: Chlamydospore and saprophytic mycelium occurring in soil cause primary infection present in soil.

Secondary infection: By conidia

Favourable condition:

- *Fusarium* wilt can survive for years in the soil and is spread by water, insects and garden equipment.
- The fungal disease develops during hot weather and is most destructive when soil temperatures 20-30°C.
- Dry weather and low soil moisture encourage this disease.

Management:

- Summer deep ploughing, destruction of left over plants, crop rotation, and removal of affected plants.
- Require of good drainage system.
- Seed treatment with Carboxin + thiram (Vitavax power) @ 2g / kg of seeds.
- Soil drenching with Carbendazim @ 0.1%.
- Grow resistant varieties such as Kanora and Roma.

❖ Bacterial wilt /Southern bacterial wilt

Causal organism: *Ralstonia solanacearum*

Symptom

Wilting, stunting and yellowing of foliage followed by collapse of entire plant. Browning of xylem in vascular bundles occurs. Stems, petioles of the lower leaves and roots become brown and on cutting of infected part slimy mass of bacteria ooze come out.



Fig 15.3: Bacterial wilt of Tomato

Disease cycle:

Primary infection: Infected plant parts

Secondary infection: Bacterial ooze spread through water.

Favourable condition:

- The disease more severe in soils infected by plant parasite nematode.
- Sandy loam soil having acidic and alkaline reaction help disease being more prevalent.

Management:

- Destruction of diseased plant, straw burning in field and deep summer ploughing.
- Go for crop rotation at least for 3 yr control the disease.
- Grow resistant variety.
- Seed treatment with Streptocycline @ 0.01 %.
- Spray Streptocycline @ 0.01 % and Copper oxychloride @ 0.3%.

15.3 EARLY BLIGHT OF TOMATO

Causal organism: *Alternaria solani*

(Sub-division: Deuteromycotina)

Symptom

Initially Small, isolated, scattered pale brown spots appear on the leaf. Fully developed spots are irregular, brown to dark brown in colour, and with concentric rings inside the spot. Spots coalesce to form large patches resulting in the leaf blight. Zonate lesions may also develop on stems and petioles, which break at the point of infection. Slightly dark, sunken, round to irregular lesions on fruit at the calyx end



Fig 15.4: Early leaf Blight of Tomato

Disease cycle:

Primary infection: Mycelium or conidia in infected plant debris.

Secondary infection: Conidia dispersed by wind, water or rain splashes.

Favourable condition

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

Management

- Maintain proper vigour of the plant.
- Use of disease free seed.
- Removal and burning of diseased crop debris
- Spray Mancozeb@0.25% at weekly intervals.

15.4 LATE BLIGHT OF TOMATO

Causal organism: *Phytophthora infestans*
(Sub-division: *Mastigomycotina*)

Symptom:

Late blight of tomato is identified by black/brown lesions on leaves and stems that may be small at first and appear water-soaked or have chlorotic borders, but soon expand rapidly and become necrotic. Late blight infections produce dark brown, firm lesions which may enlarge and destroy the entire tomato fruit. Late blight lesions on tomato fruit are often followed by soft rot.



Fig 15.5: Late leaf blight of tomato

Disease cycle:

Primary infection: Oospore present in infected plant debris and soil.

Secondary infection: Sporangia dispersed by wind or water.

Favourable conditions

- Cool moist conditions.
- RH: >90% and with suitable temperature (12-13⁰ C) and optimum soil moisture (15-20% saturation).

Management:

- Regulatory measures.
- Grow certified seed.
- Delayed harvesting.
- Treat the seeds with Metalaxyl @ 6 g/kg.
- Soil drenching with Metalaxyl + Mancozeb (Ridomil Gold) @ 0.2% gives good control.

15.5 BUCK EYE ROT OF TOMATO

Causal organism: *Phytophthora nicotianae* var. *parasitica*
(Sub-division: *Mastigomycotina*)

Symptom:

Pale brown spots with concentric rings appear on fruits. Entire fruit may be covered by spot but remain firm unless attacked by secondary organism. Immature fruits shrink and are mummified.



Fig 15.6: Buck eye rot of Tomato

Disease cycle:

Primary infection: Mycelium or oospore present in infected plant debris and soil.

Secondary infection: Sporangia dispersed by wind or water.

Favourable conditions

- Fruit come in contact with water-logged soil start the infection.
- High rainfall.

Management

- Crop rotation with non host crop.
- Good soil drainage.
- Treat the seeds with Metalaxyl @ 6 g/kg.
- Soil drenching with Metalaxyl + Mancozeb (Ridomil Gold) @ 0.2% gives good control.

15.6 VIRAL DISEASE OF TOMATO

❖ LEAF CURL OF TOMATO

Causal organism: *Tomato leaf curl virus* (ssDNA)

Symptom

Plants show stunted growth reduction in length of internode and downward curling, crinkling of leaves occur. In severe cases leaves reduced in size with puckering of leaves. On the lower side of leaves there will be thickening of veins with small leaf like outgrowths known as enations.



Fig 15.7: Leaf curl of Tomato

Disease cycle:

Primary infection: Through seed

Secondary infection: By vector - White flies (*Bemisia tabaci*)

Management:

- Use certified seed for growing nursery.
- For vector control apply dimethoate 0.2%.

❖ MOSAIC OF TOMATO

Causal organism: *Tomato mosaic virus (ssRNA)*

Symptom:

The leaves exhibit alternate green and light green patches with raised dark green area and distorted crinkled younger leaves. The plants are stunted and leaves may be distorted to a fan leaf or tendril like.



Fig 15.8: Mosaic of Tomato

Disease cycle

Primary infection: Seed

Secondary infection: Sap transmission

Management

- Rouge out and destroy diseased plants
- Virus free seed should be obtained and used for sowing
- Seed treatment with sodium hypochloride to remove external inoculum from seed.
- Cross protection of tomato seedlings by inoculating with mild strains.
- Field workers should avoid using tobacco products while working in the field.

LECTURE-16 DISEASES OF BRINJAL

16.1 PHOMOPSIS FRUIT ROT OR BLIGHT

Causal organism: *Phomopsis vexans* (P.S: *Diaporthe vexans*)
(Sub-division: *Deuteromycotina*)

Symptoms

It affects all above the ground plant parts. Spots generally appear first on seedling stems or leaves. Girdle seedling stems and kill the seedlings. Leaf spots are clearly defined, circular, up to about 1 inch in diameter, and brown to gray with a narrow dark brown margin. Fruit spots are much larger, affected fruit are first soft and watery but later may become black and mummified. Center of the spot becomes gray, and black pycnidia develop.



Fig 16.1: Phomopsis fruit rot and leaf blight of Brinjal

Disease cycle

Primary infection – Seeds

Secondary infection – Conidia

Favourable conditions

High relative humidity coupled with higher temperatures favour disease development. Maximum disease development takes place at about 26°C under wet weather conditions with 55% R.H

Management

- Removal and destruction of diseased crop debris
- Practicing crop rotation and summer ploughings helps in reducing initial inoculum.
- Use of disease free seed
- Hot water treatment of seed at 50⁰C for 30 minutes
- Seed treatment with Carboxin + Thiram @ 2g/kg of seeds.
- Spray twice with Carbendazim + Mancozeb @ 0.1% at 20 days interval.

16.2 COLLAR ROT

Causal organism: *Sclerotium rolfsii* (Sub-division: *Deuteromycotina*)

Symptoms

The disease occasionally occurs in serious form. The lower portion of the stem is affected from the soil borne inoculum (sclerotia). Decortication is the main symptom. Exposure and necrosis of underlying tissues may lead to collapse of the plant. Near the ground surface on the stem may be seen the mycelia and sclerotia.



Fig 16.2: Collar rot of Brinjal

Disease cycle

Primary infection – Sclerotia

Secondary infection - Water

Favourable Condition

Lack of plant vigour, accumulation of water around the stem, and mechanical injuries help in the development of this disease.

Management

- Seed treatment with 2 g of Carboxin + Thiram per kg seed will help in reducing the disease.
- Spraying with Carbendazim + Mancozeb @ 0.25%.
- Collection and destruction of diseased parts and portions of the plant.

LECTURE-17

DISEASES OF CRUCIFEROUS VEGETABLES

17.1 ALTERNARIA LEAF SPOT

Causal organism: *Alternaria brassicola*, *A.brassicae*, *A.raphani*
(Sub-division: *Deuteromycotina*)

Symptoms

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



Fig 17.1: Alternaria leaf spot of Cruciferous Vegetables

Disease cycle

Primary infection – Seeds and infected plant parts

Secondary infection – Conidia

Favourable condition

Low temperature and high humidity favours the disease development.

Management

- Hot water treatment at 50°C for 30min
- Seed treatment with Carboxin + Thiram @ 2g/kg of seeds.
- Foliar spray with Mancozeb@0.25%.

17.2 BLACK ROT

Causal organism: *Xanthomonas campestris* pv. *Campestris*

Symptoms

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



Fig 17.2: Black rot of Cruciferous Vegetables

Disease cycle

Primary infection – Seed, Soil and Collateral hosts (*Centella asiatica*)

Secondary infection – Oozes spread through irrigation water

Favourable condition

Low temperature and high humidity favours the disease development.

Management

- Seed treatment with Streptocycline @ 0.01%.
- Spray Streptocycline-0.01% + Cupper oxychloride @ 0.3% at transplanting, curd formation pod formation stage.
- Crop rotation for 2-3 yrs with non cruciferous crop
- Drenching seed bed with 5% formalin or Streptocycline @ 0.01% in nursery beds.
- Resistant Variety : **Cabbage:** Cabaret, Defender, Gladiator, Pusa Muktha
- **Cauliflower:** Pusa ice, Pusa snow ball-K-I-F, Sel-1

DISEASE OF OKRA/LADIES FINGER/BHENDI

17.3 YELLOW VEIN MOSAIC OF BHENDI

Causal organism: *Bhendi Yellow vein mosaic virus or bhendi vein clearing virus (ssRNA)*
Belonging to tymovirus group

Symptoms

Yellowing of the entire network of veins in the leaf blade (vein clearing) is the characteristic symptom of disease. In severe infections the younger leaves turn yellow, become reduced in size and the plant is highly stunted. In a field, most of the plants may be diseased and the infection may start at any stage of plant growth. Infection restricts flowering and fruits are not formed, if formed, turns smaller, harder and rough. Loss in fruit yield ranges from 50-100% based on disease incidence.



Fig 17.3: Yellow vein mosaic of Bhendi

Disease cycle

Primary infection: Infected plant parts

Secondary infection: The virus is transmitted by the **whitefly**, *Bemisia tabaci*.

Management

- Grow **tolerant varieties**: *Parbhani Kranti, Pusa savani, Janardhan, Haritha, Arka Anamika* and *Arka Abhay*.
- Spray Dimethoate @ 0.2% in the main field 15 and 30 days after transplanting to control white fly.

DISEASES OF BEANS

17. 4 ANTHRACNOSE OF BEAN

Causal organism: *Colletotrichum lindemuthianum*
(Sub-division: *Deuteromycotina*)

Symptom:

In leaves

Spots on leaves appear on lower side and are black. Later these may also appear on upper surface. When the infection is severe, the affected plants wither off.

In pods (characteristic symptoms)

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 appears raised.



Fig 17.4: Anthracnose of Beans

Disease cycle:

Primary infection: Through seed and collateral hosts

Secondary infection: Conidia by splashing rain water or air borne conidia.

Favourable conditions

Moderate temperature of 13-26°C along with high relative humidity favourable for disease development.

Management

- Use healthy seed for planting.
- Treat the seeds with Carboxin + Thiram (Vitavax Power) @ 2 g/kg.
- Protect the crop by spraying carbendazim+mancozeb @0.2% per 2Kg/ha at 7-10 days interval

17. 5. BACTERIAL BLIGHT OF BEAN

Causal organism: *Xanthomonas campestris* pv. *phaseoli*

Symptom:

Red irregular and sunken lesions are formed on the leaves. Yellow halo around the spots are common symptom. Lesions coalesce to form bigger spots and large area is affected. Leaf becomes distorted and finally defoliation occurs. Pods are also affected and show small brownish to reddish sunken spots. On green pods water soaked spots are seen and later it turn reddish.



Fig 17.5: Bacterial blight of Beans

Disease cycle:

Primary infection: Primarily through seeds and it survive in the seed for more than two years.

Secondary infection: The secondary spread through bacterial ooze that develops on the leaves and through rain splashes.

Favourable conditions

Optimum temperature 26 to 32°C.

Management

- Use healthy seeds.
- Seeds should be collected from healthy crops.
- Crop rotation.
- Rogueing of infected plants.
- Infected debris should be destroyed.
- Seed treatment with Streptocycline @ 0.01 %.
- Spray Streptocycline @ 0.01 % and Copper oxychloride @ 0.3%.

LECTURE-18

DISEASES OF COLOCASIA

18.1 PHYTOPHTHORA BLIGHT OF COLOCASIA

Causal organism: *Phytophthora colocasiae*

Sub-division: *Mastigomycotina*

Symptom:

The first symptoms on taro (*Colocasia esculenta*) are small, dark brown flecks or light brown spots on the upper leaf surface. These early spots often occur at the tips and margins of leaves where water accumulates. The spots enlarge rapidly, becoming circular, zonate, and purplish brown to brown in color. On the lower leaf surface, spots have a water-soaked or dry gray appearance and hard globules of plant exudate are sometimes present. As spots increase in size they coalesce and quickly destroy the leaf. In dry weather in resistant cultivars, the centers of lesions become papery and fall out, producing a “shot-hole” appearance. Dead leaves often hang on their long petioles like flags.



Fig 18.1: Phytophthora blight of Colocasia

Disease cycle

Primary infection: Oospores survive in soil and infected planting material.

Secondary infection: Spreads through irrigation water as zoospores.

Favourable conditions

Warm wet weather and water logging condition favourable for disease development.

Management

- Crop rotation for 3-5 years with non-host crops.
- Avoid water stagnation.
- Collect the seed from disease free plots.

DISEASE OF GINGER

18.2 RHIZOME ROT/SOFT ROT OF GINGER

Causal organism: *Pythium sp.*

Sub-division: *Mastigomycotina*

Symptom:

Yellowing is noticed on the top leaves, gradually spreading downwards of the leaf blade and leaf sheath along the margin. Later leaf become dry and withers and hangs down along the stem till shoot becomes dry. On stem, a translucent brown lesion develop at collar region and later becomes water soaked and soft, extends to whole shoots and can be easily pulled out from this point. Soft rot extends from the collar region to rhizomes which first become discoloured and gradually decompose; forming a watery mass of putrifying tissues enclosed by tough ring of rhizome. Roots arising from affected rhizome undergo rotting and softening. Rotting is also noticed in rhizomes collected from infected crop during storage.



Fig 18.2: Rhizome rots of Ginger

Disease cycle

Primary infection: Oospores survive in soil and infected rhizome.

Secondary infection: Spreads through irrigation water as zoospores.

Favourable conditions

Mimegralla flies play a role in the spread of the pathogen

Management

- Crop rotation for 3-5 years with non-host crops
- Avoid water stagnation
- Collect the seed from disease free plots.
- Treating the seed with suitable seed protectant like Metalaxyl @6g/kg of seeds.
- Soil drenching with Metalaxyl + Mancozeb (Ridomil Gold) @ 0.2% gives good control
- Control the *Mimegralla* insects by 0.05% methyl parathion

LECTURE-19 DISEASES OF COCONUT

19.1. BUD ROT

Causal organism: *Phytophthora palmivora*

Sub-division: Mastigomycotina

Symptoms

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



Fig 19.1: Bud rot of Coconut

Disease cycle

Primary infection: Through dormant mycelium and oospores present in host debris.

Secondary infection: Through sporangia with numerous zoospores which spread rapidly in the rain water.

Favourable conditions

High R.H., Temperatures of 18-20⁰ C presence of insect wounds and heavy rainfall aggravates the disease.

Management

- Cutting and burning of badly infected palms.
- If the disease is detected early remove the infected portions and protect with Bordeaux paste (Tree surgery).

- Spray copper fungicides (Bordeaux mixture @1% or Copper oxy chloride @0.3%) after onset of monsoon to prevent infection.

19.2 GANODERMA WILT/ BASAL STEMROT/THANJAVUR WILT

Causal organism: *Ganoderma lucidum*

Sub-division: Basidiomycotina

Symptoms

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



Fig 19.2: Basal stem rot of Coconut

Disease cycle

Primary infection: The fungus is soil borne (Basidiospores)

Secondary infection: Through irrigation water and by root contact (Mostly from March-August).

Management

- Dig isolation trenches of about 50cm wide and 1m deep, 2-3 m away from diseased palm to prevent spread of fungus
- Trenches dug for replanting should be filled with FYM, 5kg neem cake and *Trichoderma viride*
- Apply 40 liters of 1% Bordeaux mixture in basin of each tree, yearly once, during August – September.
- Root feeding with tridemorph (6ml in 25 ml of water), 3-4 times a year, in early stages of infection

LECTURE-20 DISEASE OF TEA

20.1 BLISTER BLIGHT

Causal Organism: *Exobasidium vexans*

Sub-division-Basidiomycotina

Symptom:

Small pale or pinkish circular spots appear on leaves and attain a size of 2.5 cm diameter. Later blister like swelling on leaf. When many spots coalesce, curling of leaves will occur and vigour of the tea bush is affected.



Fig 20.1: Blister blight of Tea

Disease cycle

Primary infection: By Basidiospore

Secondary infection: By Conidia

Favourable conditions:

- Relative humidity more than 83% for 7 to 10 days favours disease.
- Temperature below 30°C.
- Moist and shady localities suffer more.
- Pruned trees with new flush are 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.

DISEASE OF COFFEE

20.2 RUST

Causal Organism: *Hemileia vastatrix*

Sub-division-Basidiomycotina

Symptom

Small, pale yellow spots are seen on the upper surfaces of the leaves usually around the margins. Later masses of orange uredospores appear on the under surfaces of the leaf. The infected leaves drop prematurely, leaving long expanses of twigs devoid of leaves.



Fig 20.2: Rust of Coffee

Disease Cycle

Primary infection: Survive as mycelium or uredospores in infected leaves

Secondary infection: Uredospores dispersed by wind and water .**Pycnial and aecial stages are not known**

Favourable conditions

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

Management

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