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Centurion
UNIVERSITY

DISEASES OF FIELD AND HORTICULTURAL CROP AND THEIR MNAGEMENT-II,ASPP-3103



Session-1

DISEASES OF WHEAT

1.1 RUST OF WHEAT (BLACK OR STEM RUST, LEAF, BROWN OR ORANGE RUST, YELLOW OR STRIPE RUST)

❖ BLACK OR STEM RUST

Causal organism: *Puccinia graminis tritici*

Sub-division: Basidiomycotina

Symptoms

The symptom appear in the form of elongated ,narrow, elliptical reddish-brown pustules on stem,leaf sheath and leaves.The pustules (uredopustules-as it contain uredospore) running parallel with long axis of affected parts ,frequently coalesce with each other and burst easily exposing powdery mass of reddish uredospore. Later teliospustules produce from uredopustules,burst upon and expose black colour teliospore.Due to black teliospore the disease known as Black rust.



Fig 1.1: Black rust of wheat

Disease cycle

Primary infection: The uredospore carried to the plains of India work as the source of primary infection.

Secondary infection: By uredospore.

Favourable conditions

Hot days (25-30⁰C), mild nights (15-20⁰C), and wet leaves from rain or dew.

Management

- Eradication of self sown wheat plants and weed hosts.
- Grow resistant varieties like Kalyanasona, Sonalika, Choti Lerma, Lerma Rojo.
- Seed dressing with Plantavax @0.1%.
- Spray twice or thrice with Plantavax @0.1%, at 15 days interval

❖ LEAF, BROWN OR ORANGE RUST

Causal organism: *Puccinia recondita*

Sub-division: *Basidiomycotina*

Symptoms

The first symptom of the disease is the appearance of minute, round, orange sori, irregularly distributed on the leaves, rarely on the leaf sheath and stem. The sori turn brown with maturity. As the disease advances, the telial stage may be found in the same pustule. The telia are small, oval to linear, black and covered by the epidermis.



Fig 1.2: Orange or leaf rust of wheat

Disease cycle

Primary infection: The uredospore carried to the plains of India work as the source of primary infection.

Secondary infection: By windblown uredospore.

Favourable conditions

- Free moisture
- Temperature between 20-30°C.

Management

- Grow resistant varieties like Lerma Rojo, Safed Lerma, Sonalika and Choti Lerma.
- Spray plantavax@0.1%.
- Removal and destruction of weed hosts.

❖ YELLOW OR STRIPE RUST

Causal organism: *Puccinia striiformis*

Sub-division: *Basidiomycotina*

Symptoms

The uredosori appear as **bright yellow pustules mainly on the leaves. But in severe infections they may be seen on leaf sheaths, stem also.** The sori are elongated and are arranged in **linear rows between the veins of the leaf and hence it is referred as stripe rust. The sori** are mostly sub-epidermal and are remained covered by the epidermal layer and break only at the time of crop maturity. The teleutosori appear late in the season and are also arranged in linear rows, produce black crust.



Fig 1.3: Yellow rust of wheat

Disease cycle

Primary infection: The uredospore carried to the plains of India work as the source of primary infection.

Secondary infection: By windblown uredospore.

Favourable conditions

- Optimum temperature ideal for the disease development is 8 -13⁰C.
- No infection occurs above 23⁰C and below 20⁰C and Heavy Rainfall

Management

- Grow resistant varieties like Lerma Rojo, Safed Lerma, Sonalika and Choti Lerma.
- Spray plantavax @0.1%.
- Removal and destruction of weed hosts.

1.2 LOOSE SMUT OF WHEAT

Causal organism: *Ustilago nuda tritici*

Sub-division: *Basidiomycotina*

Symptoms

The symptoms are evident only at the time of emergence of the ears from boot leaf. All the spikelets in a ears transform into a mass of **black powdery spores**. The **infected ears** emerges earlier than healthy ones.



Fig 1.4: Yellow rust of wheat

Disease cycle

Primary infection: It is internally and externally seed borne and is systemic. The fungus is carried over in the seed as dormant mycelium act as the source of primary infection.

Secondary infection: Through wind borne smut spores.

Favourable conditions

- 20-21°C temperature and high RH (60-80%) during flowering stage favour the disease development.
- Flowers of cultivars with loose spikelets are more susceptible than those with compact spikelets.

Management

- Grow resistant varieties kalyanasona, PV 18, WG 307 and HD 450.
- *Solar seed treatment (Luthra and Sattar, 1934): Soak the seed in water for 4 hours (8 AM to 12 Noon) and expose the seed to the hot sun for 4 to 5 hours (from 12 Noon to 5 PM) on cement or rocky surface*
- Seed treatment with systemic chemicals like Carboxin + Thiram (Vitavax power) @0.2%.

1.3 KERNEL BUNT OF WHEAT

Causal organism: *Neovossia indica*

Sub-division: *Basidiomycotina*

Symptoms

The infection is usually confined to a **few grains in the spike with irregular arrangement**. In severe cases, the grain is reduced to black shiny sac of teliospores. As the grains mature the outer glumes spread and the inner glumes expand, exposing the bunted grains. The bunt balls are first enclosed by the pericarp but when it bursts the masses of bunt spores are exposed. The bunt affected plants emits a foul smell which is mainly due to the presence of **Trimethyl amine**.



Fig 1.5: Bunt of wheat

Disease cycle

Primary infection: The secondary sporidia produce from primary sporidia cause primary infection.

Secondary infection: Through wind borne and wind borne secondary sporidia.

Favourable conditions

Moderate temperatures (19-23⁰C), high humidity (>70%) and cloudiness or rainfall during anthesis favours disease development in susceptible host varieties.

Management

- Grow tolerant varieties, viz., WL 1562, HD 2281, etc.
- Follow strict quarantine measures. Use disease free seed for sowing.
- Judicious application of nitrogenous fertilizers.
- Adjust date of sowing..
- Intercropping with Gram or Lentil.

1.4 POWDERY MILDEW OF WHEAT

Causal organism: *Erysiphe graminis var. tritici*

Sub-division: *Ascomycotina*

Symptoms

Grayish white powdery growth appears on the leaf sheath, stem and floral part. Powdery growth later become black lesions and cause drying of leaves and other parts. The affected leaves die off prematurely.

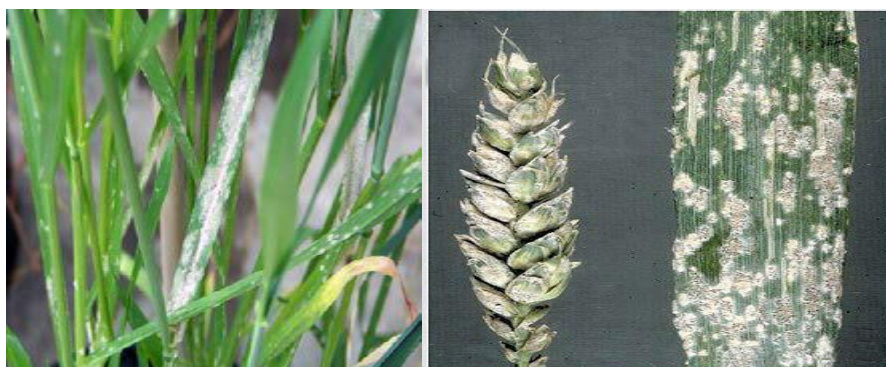


Fig 1.6: Powdery Mildew of wheat

Disease cycle

Primary infection: Primary spread is by the ascospores

Secondary infection: Through air borne conidia.

Favourable conditions

Temperature of 20-21 °C is ideal for the disease development.

Management

- Spray dust sulphur @ 40Kg/ha.
- Foliar spray with Callixin or Karathane @ 0.1%.
- Grow resistant varieties like C591, E750, UP1109 and VL421 etc.

1.5 ALTERNARIA LEAF BLIGHT OF WHEAT

Causal organism: *Alternaria triticina*

Sub-division: *Deuteromycotina*

Symptoms

Reddish brown oval spots appear on young seedlings with bright yellow margin. In severe cases, several spots coalesce to cause drying of leaves. The young leaves are not usually infected. Heavily infected fields display a burnt appearance even from a distance.



Fig 1.7: Alternaria leaf spot of wheat

Disease cycle

Primary infection: Primary spread is by **externally** and **internally** seed-borne conidia.

Secondary infection: Secondary infection is mainly through wind-borne conidia.

Favourable conditions

Temperature of 25 °C and high relative humidity favours the disease.

Management

- Soak the seeds in water for 4 hrs followed by 10 min. dip in hot water at 52°C.
- Grow resistant varieties like Co.25, Sonalika, Arnautka, E6160 and K7340.
- Spray the crop with Mancozeb@0.25% or Zineb@0.25%.

1.6 EAR COCKLE OF WHEAT

Causal organism: *Anguina tritici* (Nematode)

Symptoms

The nematode alone causes winking, twisting and various other distortion of the leaves, stem and produce small round galls on the leaves. The infected plants are shorter and thicker than healthy plants. In the distorted earheads dark galls are found in place of kernels. The earhead becomes chaffy and the kernels are replaced by dark nematode galls. Another interesting feature is the early emergence of ears in the nematode infected plants which is about 30 to 40 days earlier than the healthy ones.



Fig 1.8: Ear Cockle of wheat

Disease cycle

The disease starts from the seeds contaminated with the nematode galls. When such contaminated seeds are sown in the field, they absorb moisture from the soil and the larvae (juveniles) escape from the galls and climb upon the young wheat plants.

Management

- Sow gall free seeds.
- Separate the galls from the seed by floating in brine at 160 g of sodium chloride in litter of water
- Soil application with carbofuran or Carbosulfan @ 1kg a.i per ha.

session-2

DISEASES OF SUGARCANE

2.1 RED ROT OF SUGARCANE

Causal organism: *Colletotrichum falcatum*

Sub-division: *Deuteromycotina*

Symptoms

The pathogen also produces tiny reddish lesions on the upper surface of leaves with dark dots in the centre. Minute red spots also appear on the centre of the mid-rib and develop in both directions forming small or long lesions. The lesions are initially blood red with dark margins and later on with straw coloured centres. The reddening of the internal tissues occur in stalk, especially the vascular bundles, which are usually elongated at right angles to the long axis of the stalk. The presence of cross-wise white patches interrupting the reddened tissues are the important diagnostic character of the disease. Split open stems emit a characteristic acidic-sour odour.

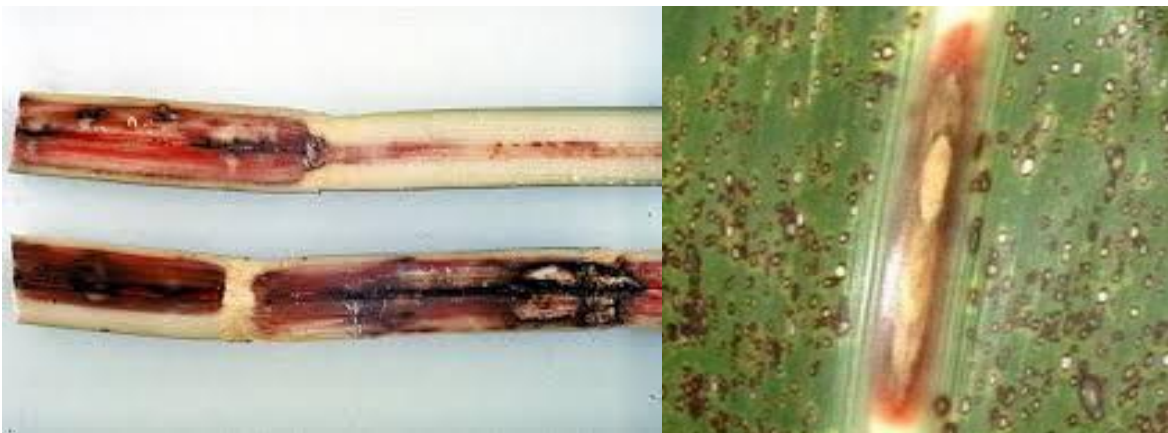


Fig 2.1: Red rot of Sugar cane

Disease cycle

Primary infection: The primary infection is mainly from infected setts.

Secondary infection: In the field by conidia through irrigation water and cultivation tools.

Favourable conditions

Mono-culturing of sugarcane, successive ratoon cropping, water logged conditions and injuries caused by insects favourable for disease development.

Management

- Removal and destruction of infected plant debris, stubbles and trash.
- Avoid ratooning of the diseased crop.
- Soak the setts in 0.1% Carbendazim solution for 20 minutes before planting.

2.2. SMUT OF SUGARCANE

Causal organism: *Ustilago scitaminea*

Sub-division: *Basidiomycotina*

Symptoms

The affected plants are stunted and the central shoot is converted into a long whip-like, dusty black structure. The length of the whip varies from few inches to several feet. On maturity it ruptures and millions of tiny black smut spores (teliospores) are liberated and disseminated by wind. The smutted clumps also produce mummified arrows in which lower portion consists of normal inflorescence with typical flowers and the upper portion of the rachis is converted into a typical smutted whip.



Fig 2.2: Smut of Sugar cane

Disease cycle

Primary infection: The primary infection is mainly from infected setts.

Secondary infection: The secondary spread in the field is mainly through the smut spores developed in the whips, aided by air currents.

Favourable conditions

Mono-culturing of sugarcane, continuous ratooning and dry weather during tillering stage favours the disease.

Management

- Plant healthy setts taken from disease free area.
- Remove and destroy the smutted clump (Collect the whips in a thick cloth bag/polythene bag and immerse in boiling water for 1 hr to kill the spores).
- Treat the setts in hot water at 50°C for 2 hours.

2.3 WILT OF SUGARCANE

Causal organism: *Cephalosporium sacchari*

Sub-division: *Deuteromycotina*

Symptoms

The first symptom of the disease is visible in the canes of **4-5 months age**. **The canes may wither in groups**. The affected plants are **stunted with yellowing and withering of crown leaves**. The midribs of all leaves in a crown generally turn yellow, while the leaf lamina may remain green. The leaves dry up. Stem develop **hollowness in the core or pith**. The pith shows **reddish discolouration with longitudinal red streaks passing from one internode to another**.



Fig 2.3: Wilt of Sugarcane

Disease cycle

Primary infection: The primary infection is mainly from infected setts.

Secondary infection: The secondary spread is aided by wind, rain and irrigation water.

Favourable conditions

High day temperature (30-35°C), low humidity (50-60 %), low soil moisture, alkaline soils and excess doses of nitrogenous fertilizers.

Management

- Select the seed material from the disease-free plots.
- Avoid the practice of ratooning in diseased fields.
- Burn the trash and stubbles in the field.
- Treat the setts in hot water at 50°C for 2 hours followed by dipping in 0.05% Carbendazim for 15 minutes.

2.4 POKKAH BOENG OF SUGARCANE

Causal organism: *Fusarium moniliformae*

Sub-division: *Deuteromycotina*

Symptoms

Chlorotic phage: The earliest symptom of pokkah boeng is a chlorotic condition towards the base of the young leaves lead to wrinkling, twisting, shorting and malformation of leaves. In the mature leaf, the irregular reddish stripes and specks are observed in chlorotic part.

Acute phage (top-rot phage): Red specks and stipe develop on young spindle and whole base of the young spindle rotton and dries up very fast and finally it formed a top rot of tender tissue of the apical part of the cane.

Knife cut phage: This phage associated with acute phage. It is characterized by one or two or even more transverse cuts in the rind the stalk/stem in such a uniform manner as, if tissue are removed in sarf knife.



Fig 2.4: Chlorotic phage Fig 2.5: Acute phage (top-rot phage) Fig 2.6: Knife cut phage

Disease cycle

Primary infection: This is an air-borne disease and primarily transmitted through the air-currents.

Secondary infection: secondary transmission is through the infected setts, irrigation water, splashed rains and soil

Favourable conditions

Cool and dry conditions favoured the survival of a fungus in plant debris.

Management

- Spraying of 0.1% Carbendazim (1 gm/ lit. of water) or 0.2% Blitox-50 (2gm/ lit. of water) or Copper oxychloride or 0.3% Dithane M-45 (3gm/ lit. of water) are the most effective fungicides for reducing the pokkah boeng disease.
- Canes showing 'top rot' or 'knife cut' should be rogued out.

2.5 RATTON STUNT OF SUGARCANE

Causal organism: *Clavibacter xyli pv. xyli* (*Xylem limited fastidious bacteria*)

Symptoms

Diseased clumps usually display **stunted** growth, reduced tillering, thin stalks with shortened internodes and yellowish foliage (**mild chlorosis**). When mature canes are split open, vascular bundles appear discoloured. In young canes, **pink colour** is seen in the form of minute pin head like areas near the nodes. The disease reduces the length, girth and the number of canes per clump.



Fig 2.7: Ratoon stunt of Sugar cane

Disease cycle

Primary infection: The disease spreads through use of **diseased setts**.

Secondary infection: Through cane harvesting implements contaminated with the juice of the diseased canes. **Maize, sorghum, Sudan grass** and *Cynodon* are some of the collateral hosts of the pathogen.

Favourable conditions

High day temperature (30-35⁰C), low humidity (50-60 per cent), low soil moisture, alkaline soils and excess doses of nitrogenous fertilizers.

Management

- Select the setts from disease free field.
- Remove and burn the clumps showing the disease.
- Sterilization of cutting knives with any antiseptic solution.
- Hot air treatment of setts at 54⁰C for 8 hours or hot water treatment at 50⁰C for 2 hrs or aerated steam treatment at 50⁰C for 1 hour.

2.6 GRASSY STUNT OF SUGARCANE

Causal organism: *Phytoplasma*

Symptoms

The disease symptoms are usually seen two months after planting. The disease is characterized by the production of numerous lanky tillers from the base of the affected shoots. Leaves become pale yellow to completely chlorotic, thin and narrow. The plants appear bushy and 'grass like' due to reduction in the length of internodes, premature and continuous tillering. In a diseased clump one or two thin, weak and small canes are produced. In plant crop, young leaves of diseased plants are white (Albino) and the buds on such canes are usually white, papery and abnormally elongated.



Fig 2.8: Grassy stunt of Sugar cane

Disease cycle

Primary infection: By collateral host. Sorghum serves as a natural collateral host.

Secondary infection: By vector aphid viz. *Aphis maidis*, *Rhopalosiphum maidis*, *Longiunguis sacchari*.

Management

- Plant disease free setts.
- Remove and burn the infected clumps periodically.

- Avoid ratooning in problem areas
- Hot Water Treatment (HWT) of setts at 52⁰C for 30min or Aerated Steam Therapy (AST) at 50⁰C for 1 hr followed by steeping in fungicidal solution of carbendazim@0.05% for 15 minutes.
- Control vector by spraying Malathion or Dimethoate@2ml/lt.

Session 3

DISEASES OF SUNFLOWER

3.1 SCLEROTINIA STEM ROT

Causal organism: *Sclerotium rolfsii*

Sub-division: *Deuteromycotina*

Symptoms

Initial symptoms are visible during pod development. Leaves will wilt and turn gray-green before turning brown, curling and dying. Infected plants can be spotted from a distance by their sickly appearance, later the entire plant withers and dies. White cottony mycelium and mustard seed sized sclerotial bodies are formed on the affected stem near soil level.



Fig 3.1: Sclerotinia stem rot of Sunflower

Disease cycle

Primary infection: The fungus survives as **sclerotia** in soil and plant debris.

Secondary infection: The secondary spread of the disease occurs through sclerotia by implements and irrigation water.

Favourable conditions

Alternate periods of high soil moisture and water stress conditions predispose the disease.

Management

- Collection and destruction of plant debris.
- Seed treatment with Carboxin + Thiram @0.3%.
- Use of antagonistic fungi such as *T. harzianum*.
- Spray **Validamycin@0.2%**.

3.2 ALTERNARIA LEAF SOPT

Causal organism: *Alternaria helianthi*

Sub-division: *Deuteromycotina*

Symptoms

The fungus produces brown spots on the leaves, but the spots can also be seen on the stem, sepals and petals. The lesions on the leaves are dark brown to black, circular to oval spots, ranging from 0.2 to 0.5mm in diameter. The spots are often surrounded by a chlorotic zone with necrotic centre. The spots later enlarge in size with concentric rings and become irregular in shape. Under high atmospheric humidity, several spots coalesce to show bigger irregular lesions leading to drying and defoliation. The disease sometimes cause rotting of flower heads and affects the quality of seeds by reducing the germination.

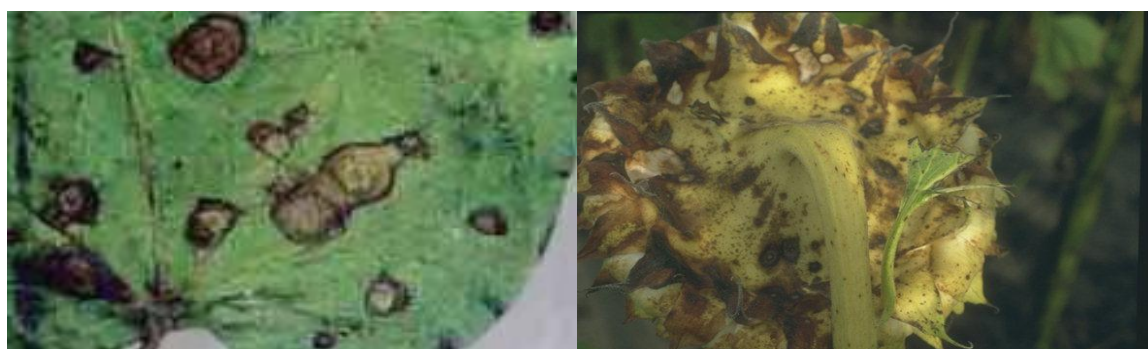


Fig 3.2: Alternaria leaf spot of Sunflower

Disease cycle

Primary infection: The fungus survives on seed, host debris and weed hosts.

Secondary infection: The secondary spread is mainly through windblown conidia.

Favourable condition

Rainy weather, cool winter climate and late sown crops are highly susceptible.

Management

- Remove and destroy infected plant debris.
- Spray twice or thrice with Mancozeb at 0.2% or carbendazim@0.1% at 10 days interval starting from first appearance of the disease or 35 DAS

session-4

DISEASES OF MUSTARD

4.1 ALTERNARIA LEAF SPOT

Causal organism: *Alternaria brassicae* and *A. brassicola*

Sub-division: *Deuteromycotina*

Symptoms

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



Fig 4.1: Alternaria leaf spot of Mustard

Disease cycle

Primary infection: The pathogen survives in the infected crop debris as dormant mycelium.

Secondary infection: The secondary spread is mainly by air-borne conidia.

Management

- Removal and destruction of infected plant debris
- Use disease free or treated seed with Carboxin + Thiram @ 2g/Kg.
- Spray with mancozeb @0.25% at 10 days interval.

4.2 DOWNY MILDEW

Causal organism: *Peronospora parasitica*

Sub-division: *Mastigomycotina*

Symptoms

Symptoms appear on all aerial parts but usually on leaves and inflorescence. Greyish white irregular necrotic patches develop on the lower surface of the leaves. The most conspicuous and pronounced symptom is the infection of inflorescence causing hypertrophy of the peduncle or inflorescence (**Stag head**). The affected inflorescence does not produce any siliqua or seed.



Fig 4.2: Downy Mildew of Mustard

Disease cycle

Primary infection: The fungus survives through oospores formed in affected host tissues and on weed hosts.

Secondary infection: The secondary spread is through wind borne sporangia.

Management

- Collect and destroy infected plant debris.
- Rotation with non-cruciferous crops.
- Seed dressing with Metalaxyl (Apron 35SD)@6g/kg seed
- Single spray with Metalaxyl + Mancozeb (Ridomil gold)@0.2%.

4.3 WHITE RUST

Causal organism: *Albugo candida* or *A. cruciferarum*

Sub-division: *Mastigomycotina*

Symptoms

Both local and systemic infection is observed. In case of local infection isolated white/creamy yellow raised pustules appear on under surface of leaves which later coalesce to form patches. Systemic infection causes hypertrophy and hyperplasia resulting in malformation and distortion of floral parts. Entire inflorescence is replaced by swollen sterile structure (**Stag head**). Maximum damage occurs when systemic infection of the stem is noticed.



Fig 4.3: White Rust of Mustard

Disease cycle

Primary infection: The fungus survives through oospores formed in affected host tissues.

Secondary infection: The secondary spread is through zoospores disseminated by rain or irrigation water.

Management

- Collect and destroy infected plant debris
- Rotation with non-cruciferous crops
- Seed dressing with Metalaxyl @6g/kg seed followed by a single spray with Metalaxyl + Mancozeb (Ridomil gold)@0.2%

4.4 SCLEROTINIA STEM ROT

Causal organism: *Sclerotinia sclerotiorum*

Sub-division: *Deuteromycotina*

Symptoms

The stems develop water-soaked spots which later may be covered with a cottony white growth. As the disease progresses, affected portions of the stem develop a bleached appearance, and eventually the tissues shred. Girdling of the stem results in premature ripening and in lodging of plants. Hard black bodies, the *sclerotia*, are formed inside the stem and occasionally on the stem surface. Basal stalk infections rarely occur.



Fig 4.4: Sclerotinia stem rot of Mustard

Disease cycle

Primary infection: sclerotinia survive in soil.

Secondary infection: By irrigation water.

Favourable conditions

High humidity (90-95%) and average temperature (18-25 °C) along with wind current favours the disease development.

Management

- Use crop rotation; do not plant highly susceptible crops more than once in four years, including dry edible beans, sunflowers, mustard and canola. Use at least a five year rotation for severely infested fields.
- Avoid planting next to a field that had severe *Sclerotinia* in the past four or five years. Control broad-leaved weeds.
- Plant thoroughly cleaned seed. Avoid dense stands of canola.

Session-5

DISEASES OF GRAM

5.1 WILT

Causal organism: *Fusarium oxysporum f.sp. ciceri*

Sub-division: *Deuteromycotina*

Symptoms

The field symptoms of wilt and death of seedlings or adult plants in patches. In field plants show typical symptoms of wilting, i.e., drooping of petioles, rachis and leaflets followed by sudden death of plant. All the leaves turn yellow and then light brown and droop prematurely. Vascular discoloration is observed on longitudinal splitting of stem. Sometimes only a few branches are affected, resulting in partial wilt.



Fig 5.1: Wilt of Gram

Disease cycle

Primary infection: The primary infection is through chlamydospores in soil, which remain viable upto next crop season.

Secondary infection: The secondary spread is through irrigation water, cultural operations and implements.

Favourable conditions

High soil temperature (Above 25⁰C), high soil moisture, monocropping and presence of weed hosts like *Cyperus rotundus*, *Tribulus terrestris* and *Convolvulus arvensis*.

Management

- Treat the seeds with Carboxin + Thiram (Vitavax power) at 2 g/kg or treat the seeds with *Trichoderma viride* at 4 g/kg or *Pseudonomas fluorescens* @ 10g/kg of seed.
- Apply heavy doses of organic manure or green manure.
- Follow 6-year crop rotation with non-host crops.

5.2 GREY MOULD

Causal organism: *Botrytis cinerea*

Sub-division: *Deuteromycotina*

Symptoms

Grey mould is most likely to first appear as a soft rot at the base of the stem in the collar region. The affected tissues become covered with a fluffy grey mould initially. As the disease progresses affected plants wither and die. Small black sclerotia may form on the surface of affected tissue when the plant dies. In older plants sometimes only a few branches on a plant are affected and the rest of the plant appears quite normal. Seedling infection can cause damping-off and considerable thinning of a crop.



Fig 5.2: Grey Mould of Gram

Disease cycle

Primary infection: The fungus survives on infected seed, as a saprophyte on decaying plant debris and as soil-borne sclerotia.

Secondary infection: These fungal spores can be carried from plant to plant by air currents and spread the disease rapidly.

Favourable conditions

High soil temperature (Above 25⁰C), high soil moisture, monocropping and presence of weed hosts like *Cyperus rotundus*, *Tribulus terrestris* and *Convolvulus arvensis*.

Management

- Treat the seeds with Carboxin + Thiram (Vitavax power) at 2 g/kg or treat the seeds with *Trichoderma viride* at 4 g/kg or *Pseudomonas fluorescens* @ 10g/kg of seed.
- Apply heavy doses of organic manure or green manure.
- Follow 6-year crop rotation with non-host crops.

5.3 ASCOCHYTA BLIGHT

Causal organism: *Ascochyta rabiei*

Sub-division: *Deuteromycotina*

Symptoms

The disease is usually seen in flowering and podding time as patches of blighted plants in the field. On leaves, small water-soaked necrotic spots appear that enlarge rapidly under favourable conditions leading to blighting of leaves. On leaflets, the lesions are round or elongated, with grey centres surrounded by brownish margin. Similar spots may appear on the stem and pods.



Fig 5.1: Ascochyta of Gram

Disease cycle

Primary infection: The primary spread is from seed-borne pycnidia and plant debris in the soil.

Secondary infection: The secondary spreads is mainly through air-borne conidia.

Favourable conditions

Night temperatures of 10⁰C and day temperature of 20⁰C, rains accompanied by cloudy weather and excessive canopy favour the disease spread.

Management

- Remove and destroy the infected plant debris in the field.
- Follow crop rotation with cereals.
- Treat the seeds with Carboxin + Thiram (Vitavax power).
- Spray with Carbendazim@0.1% or Chlorothalonil@0.3%.

Session-6

DISEASES OF LENTIL

6.1 RUST

Causal organism: *Uromyces viciae fabae*

Sub-division: *Basidiomycotina*

Symptoms

Small, oval to round in shape and light brown in colour urediosori appear on both the surface of leaf. In severe case the sori cover all the part of maximum area of leaf. Later stage the infected leaf become wither and fall prematurely.



Fig 6.1: Wilt of Gram

Disease cycle

Primary infection: Primary infection occurs through the pathogen i.e. urediospore and teliospore present in alternate host like bean, pea, sweet pea etc.

Secondary infection: Secondary source infection is aeciospores.

Favourable conditions

Low temperature and moist condition for few weeks favourable for disease development.

Management

- Remove the infected plant from the field.
- Application of Oxycarboxin (Plantavax) @ 0.2%
- Grow resistance variety.

6.2 WILT OF LENTIL

Causal organism: *Fusarium oxysporum f.sp. lentis*

Sub-division: *Deuteromycotina*

Symptoms

Seedling wilt is characterized by sudden drooping, followed by drying of leaves and seedling death. Vascular discolouration occurs. Adult wilt symptoms appear from flowering to late pod-filling stage and are characterized by sudden drooping of top leaflets of the affected plant, leaflet closure without premature shedding, dull green foliage followed by wilting of the whole plant or of individual branches.



Fig 6.2: Wilt of Lentil

Disease cycle

Primary infection: The primary infection is mainly from dormant hyphae and chlamydospores in the soil.

Secondary infection: The secondary spread is through conidia and chlamydospores which are disseminated by irrigation water.

Favourable conditions

A soil temperature of (23° to 27°C) is most favorable for *Fusarium* or true wilt.

Management

- Treat the acid-delinted seeds with Carboxin + Thiram (Vitavax power) 2g/kg of seeds.
- Remove and burn the infected plant debris in the soil after deep summer ploughing.

Session-7

DISEASES OF COTTON

7.1 VASCULAR WILT OF COTTON

Causal organism: *Fusarium oxysporum f.sp. vasinfectum*

Sub-division: *Deuteromycotina*

Symptoms

The earliest symptoms appear on the seedlings in the **cotyledons which turn yellow and then brown. The base of petiole shows brown ring**, followed by wilting and drying of the seedlings. In plants, the first symptom is **yellowing of edges of leaves and area around the veins, i.e. discolouration/Marginal chlorosis** starts from the margin and spreads towards the midrib. The leaves lose their turgidity, gradually turn brown, droop and finally drop off. **Browning or blackening of vascular tissues is the other important symptom**, black streaks or stripes may be seen extending upwards to the branches and downwards to lateral roots. The plants affected later in the season are stunted with **fewer bolls which are very small and open prematurely**.



Fig 7.1: Vascular Wilt of Cotton

Disease cycle

Primary infection: The primary infection is mainly from dormant hyphae and chlamydospores in the soil.

Secondary infection: The secondary spread is through conidia and chlamydospores which are disseminated by irrigation water.

Favourable conditions

- Soil temperature of 20-30⁰C. Hot and dry periods followed by rains. Heavy black soils with an alkaline reaction

Management

- Treat the acid-delinted seeds with Carboxin + Thiram @2g/kg of seeds.
- Remove and burn the infected plant debris in the soil after deep summer ploughing.

7. 2 ANTHRACNOSE OF COTTON

Causal organism: *Colletotrichum capsici*

Sub-division: *Deuteromycotina*

Symptoms

In seedling the lesions develop on the collar region, stem may be girdled, causing seedling to wilt and die. In boll Small water soaked, circular, reddish brown depressed spots appear on the bolls. The lint is stained to yellow or brown, becomes a solid brittle mass of fiber. The infected bolls cease to grow and burst and dry up prematurely.



Fig 7.2: Anthracnose of Cotton

Disease cycle

Primary infection: The primary infection is mainly by dormant mycelium in the seed or as conidia on the surface of seed. The pathogen also perpetuates on the rotten bolls and other plant debris in the soil.

Secondary infection: By air-borne conidia.

Favourable conditions

Prolonged rainfall at the time of boll formation and close planting predispose the disease.

Management

- Treat the delinted seeds with Carboxin + Thiram @ 2g/kg of seeds
- Spray the crop at boll formation stage with Carbendazim + Mancozeb @0.2% .
- Remove and burn the infected plant debris and bolls in the soil.
- Rogue out the reservoir weed hosts.

7.3 BLACK ARM OF COTTON/ BACTERIAL BLIGHT / ANGULAR LEAF SPOT

Causal organism: *Xanthomonas campestris pv. malvacearum*

Symptoms

ANGULAR LEAF SPOT:

Small, dark green, water soaked areas develop on lower surface of leaves, enlarge gradually and become angular when restricted by veins and veinlets and spots are visible on both the surface of leaves.

BLACK ARM:

On the stem and fruiting branches, dark brown to black lesions are formed, which may girdle the stem and branches to cause premature drooping off of the leaves, cracking of stem and gummosis, resulting in breaking of the stem which hang typically as dry black twig to give a characteristic “black arm” symptom.



Fig 7.3: Black arm of Cotton

Disease cycle

Primary infection: The bacterium is also seed-borne and remains in the form of slimy mass on the fuzz of seed coat. It multiplies soon after the seed is sown and infects the seedling through the micropyle.

Secondary infection: The secondary spread of the **bacteria** may be through wind, windblown rain splash, irrigation water, insects and other implements.

Favourable conditions

Optimum soil temperature of 28⁰C, high atmospheric temperature of 30-40⁰C, relative humidity of 85 per cent, early sowing, delayed thinning, poor tillage, late irrigation and potassium deficiency in soil.

Management

- Remove and destroy the infected plant debris.
- Spray with Streptomycin sulphate (Agrimycin 100), 500 ppm along with Copper oxychloride at 0.3%.

Session8

DISEASES OF PEA

8.1 DOWNY MILDEW

Causal organism: *Peronospora pisi*

Sub-division: *Mastigomycotina*

Symptoms

Early infection causes systemic infection in plants that are a sickly yellowish-green and severely stunted and distorted. Infected plants may turn chlorotic. Secondary infection is localised in upper leaves, stems, tendrils and pods and results in the appearance of isolated greenish-yellow to brown blotches on the upper leaf surface. In the lower surface downy growth of fungus appear.



Fig 8.1: Downy Mildew of Pea

Disease cycle

Primary infection: Infected seed can act as a primary source for systemic and local infections.

Secondary infection: Secondary source of infection through zoospore.

Favourable conditions

The disease can develop quickly when conditions are cold (5 - 15°C) and humid over 90 per cent for 4 - 5 days, often when seedlings are in the early vegetative stage.

Management

- Remove the infected plant from the field.
- Seed treatment with metalaxyl @6g/kg of seeds.
- Foliar spray with Metalaxyl + Mancozeb (Ridomil gold) @0.2%.

8.2 POWDERY MILDEW

Causal organism: *Erysiphe polygoni*

Sub-division: *Ascomycotina*

Symptoms

White floury patches appear on both side of leaves as well as tendrils, stem, pods etc. As the plants become older, the symptoms almost cover the entire plant, become more or less greyish-brown and infected parts impart dirty appearance. Premature defoliation of leaves occur.



Fig 8.2: Powdery Mildew of Pea

Disease cycle

Primary infection: Ascospores

Secondary infection: By windblown conidia.

Favourable conditions

Dry weather low humidity favourable for disease development.

Management

- Clean cultivation of vines or removal and destruction of all diseased parts.
- Spray wettable sulphur @0.3% or karathane or calixin @0.2%

8.3 RUST OF PEA

Causal organism: *Uromyces fabae*

Sub-division: *Basidiomycotina*

Symptoms

small, oval to round in shape and light brown in colour urediosori appear on both the surface of leaf. In severe case the sori cover all the part of maximum area of leaf. Later stage the infected leaf become wither and fall prematurely.



Fig 8.3: Rust of Gram

Disease cycle

Primary infection: Primary infection occurs through the pathogen i.e. urediospore and teliospore present in alternate host like bean, lentil, sweet pea etc.

Secondary infection: Secondary source infection is aeciospores.

Favourable conditions

Low temperature and moist condition for few week favourable for disease development.

Management

- Remove the infected plant from the field.
- Application of plantavax @0.1%.
- Grow resistance variety.

Session-9

DISEASES OF MANGO

9.1 ANTHRACNOSE

Causal organism: *Colletotrichum gloeosporioides*

Sub-division: *Deuteromycotina*

Symptoms

On leaves initially circular, light yellow brown spots are produced which soon enlarge with dark brown to black margins. If infection is severe individual spots coalesce leading to twisting of foliage and premature defoliation. On fruits Spots appear near the stem end as small brown areas that enlarge rapidly and become black. Fruit pulp beneath the spots become hard followed by cracking and decay at ripening.



Fig 9.1: Anthracnose of Mango

Disease cycle

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

Secondary infection: Mainly due to rain splash or wind driven rain water.

Favourable conditions:

Temperature of 25°C and R.H 95-97% along with Moist and humid condition favourable for the disease.

Management

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

- Before storage, treat the fruits with hot water (50-55°C), for 15 minutes or dip in Carbendazim solution 0.1%.

9.2 MANGO MALFORMATION

Causal organism: *Fusarium moniliformae sub sp. subglutinans*

Sub-division: *Deuteromycotina*

Symptoms

Vegetative malformation:

The affected plants develop excessive vegetative branches which are of limited growth, swollen and have short internodes. Sometimes the branches show a bunchy top appearance, compact leaves are formed in a bunch at the apex of shoot or in the leaf axil.

Floral malformation:

The flowering panicles instead of coming out as a normal one into just compact bunch of hard flowers. Individual flower is greatly enlarged and has a large disc. The inflorescence gets hypertrophied. The percentage of bisexual flowers in malformed panicles is very low. The malformed heads dry up in black masses and persist on the trees for a long time.



Fig 9.2: Mango Malformation

Disease cycle

Primary infection: Through malformed inflorescence.

Secondary infection: Either by air borne conidia or by conidia carried by eriophid mite *Aceria mangiferae*.

Favourable conditions:

Younger plants are more susceptible, vegetative malformation reduces with growing age. Mild temp. (8-27 °C) and high RH more than 85% are conducive.

Management

- It is advisable to avoid scion-stick from trees bearing malformed inflorescence for proportion.
- Only certified saplings should be used for propagation.
- Healthy orchards located in disease prone pockets should be sprayed with fungicides like carbendazim (0.1%).
- Spray 200ppm NAA before blossoming.

9.3 POWDERY MILDEWS

Causal organism: *Oidium mangiferae*

Sub-division: *Deuteromycotina*

Symptoms

The disease can easily recognized by whitish or grayish powdery growth on the inflorescence and tender leaves. Leaves become twisted, curled and defoliate. Infected floral parts are severely damaged and drop off. If the fruits are set, they do not grow in size and may drop before attaining pea size.



Fig 9.3: Powdery Mildew of Mango

Disease cycle

Primary infection: Through infected plant debris by conidia.

Secondary infection: Wind borne conidia of *Oidium mangiferae*.

Favourable conditions:

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

Management

- Can be controlled with two preventive sprays with wettable sulphur 0.3% once before the flowers open and 2nd after the fruit set.
- Spraying with Karathane 0.1% before flowering and after fruit set (peanut stage).

9. 4 MANGO BACTERIAL CANCKER

Causal organism: *Xanthomonas campestris pv. mangiferae indica*

Symptoms

Groups of minute, water-soaked lesions, delimited by veins, appear towards the tip of the leaf. They increase in size about 1-4mm, become raised and turn brown to black in colour. Some time the spots surrounded by chlorotic halo .Cankrous lesions also appear on petioles, twigs and young fruits.



Fig 9.4: Bacterial Canker of Mango

Mode of spread and survival:

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

Management

- Three sprays of Streptocycline (0.01%) + Copper oxychloride 0.3% after first visual symptom at 10 day intervals.
- Monthly sprays of Copper Oxychloride (0.3%) are effective in controlling the disease.

Session-10

DISEASES OF CITRUS

10.1 CITRUS GUMMOSIS

Causal organism: *Phytophthora nicotianae* var. *parasitica*, *P. palmivora*, *P. citrophthora*,

Sub-division: Mastigomycotina

Symptoms

Disease starts as water soaked large patches on the basal portions of the stem near the ground level. First symptoms are dark staining of bark which progresses into the wood. Bark in such parts dries, shrinks and cracks and shreds in lengthwise vertical strips. Bark at the base is destroyed and finally death of the tree. Profuse exudation of gum from the bark of the trunk occurs. Prior to death, the plant usually blossoms heavily and dies before the fruits mature.



Fig 10.1: Citrus Gummosis

Disease cycle

Primary infection: Oospore

Secondary infection: Zoospore spread by water.

Favourable conditions

Prolonged contact of trunk with water as in flood irrigation; water logged areas and heavy soils favourable for the disease development.

Management

- Selection of proper site with adequate drainage and high budding (30 to 46 cm or above).
- Provision of an inner ring about 45 cm around the tree trunk to prevent moist soil. (Double ring method of irrigation)

- Soil drenching with 0.2% metalaxyl and 0.5% *Trichoderma viride* commercial formulation is also effective.

10.2 CITRUS CANKER

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

Symptoms:

The lesions appear as minute water soaked round, yellow spots which enlarge slightly and turn brown, eruptive and corky. The spots are about 2 to 3 mm in diameter. These pustules are surrounded by a characteristic yellow halo in leaves. Canker lesions on the fruit do not possess the yellow halo as on leaves. Several lesions on fruit may coalesce to form a patch.



Fig 10.2: Citrus Canker

Disease cycle

Primary infection: From infected plant parts.

Secondary infection: Ooze spread by splashing rain water ,irrigation water and Citrus leaf miners (*Phyllocnistis citrella*).

Favourable conditions:

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

Management

- Prune out and burn all canker infected twigs before monsoon.
- Spray Streptocycline @ 0.01% and Copper oxychloride @ 0.3%.

Session-11

DISEASES OF GRAPEVINE

11.1 DOWNY MILDEW

Causal organism: *Plasmopara viticola*

Sub-division: *Mastigomycotina*

Symptoms

Irregular, yellowish, translucent spots on the upper surface of the leaves. Correspondingly on the lower surface, dirty white, powdery growth of fungus appears. Affected leaves become, yellow and brown and gets dried due to necrosis. 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 and show soft rot symptom. No cracking of the skin of the berries.



Fig 11.1: Downy Mildew of Grapevine

Disease cycle

Primary infection: Sporangia or zoospores by wind, rain etc.

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

Favourable conditions

- Optimum temperature: 20-22°C. Relative humidity: 80-100 %.

Management

- Collect and burn fallen leaves and twigs.
- Sanitation of the orchard..

- Vine should be kept high above ground to allow circulation of air by proper spacing.
- Sprays with 1% Bordeaux mixture or Copper oxychloride.

11.2 POWDERY MILDEW

Causal organism: *Uncinula necator* (I.S: *Oidium tuckeri*)

Sub-division: Ascomycotina

Symptoms

Small whitish patches appear on both the surface of the young leaves. These patches enlarge covering the leaf surface with a characteristic, whitish powdery coating. In advanced stage affected leaf turn greyish white and become dwarf ,twisted and malformed. Floral infection results in shedding of flowers, discolouration of flower and poor fruit set. Powdery growth is visible on older berries and the infection results in the cracking of skin of the berries.



Fig 11.2: Powdery Mildew of Grapevine

Disease cycle

Primary infection: Through dormant mycelium and conidia present in the infected shoots and buds.

Secondary infection: Through air-borne conidia.

Favourable conditions

- Cool dry weather.
- Maximum temperature in the range of 27-31⁰C with R.H. upto 91% favourable disease. (November and December).

Management

- Clean cultivation of vines or removal and destruction of all diseased parts.
- Spray wettable sulphur @0.3% or karathane or calixin @0.1%.

11.3 ANTHRACNOSE / BIRDS EYE DISEASE OF GRAPEVINE

Causal organism: *Elsinoe ampelina* (I.S: *Gloeosporium ampelophagum*)

Sub-division: Ascomycotina

Symptoms

Circular, greyish black spots with yellow halo appear on leaves. Later the centre of the spot becomes grey, sunken and fall off resulting in a symptom called 'shot hole'. Sunken spots with ashy grey centre and dark margin on fruits (**Birds eye symptom**). In warm and wet weather pinkish spore mass develop in the centre of the spots. Mummification and shedding of berries



Fig 11.3: Birds eye disease of Grapevine

Disease cycle

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

Secondary infection: Through conidia by air or water.

Favourable conditions

- Warm wet weather
- Low lying and badly drained soils.

Management

- Removal of infected twigs.
- Selection of cuttings from disease free areas .Spraying Bordeaux mixture 1% four times in a month from the time of pruning and ending prior to fruit maturity.
- Spray Carbendazim + Mancozeb @ 0.2%.

Session12

DISEASES OF APPLE

12.1 SCAB

Causal Organism: *Venturia inaequalis*
Sub-division: *Ascomycotina*

Symptoms:

Scab infections usually noticed on leaves and fruits. On leaf: Affected leaves become twisted or puckered and have black, circular spots on their upper surface. Severely affected leaves may turn yellow and drop. On flower: Scab can also infect flower stems and cause flowers to drop. On fruit: Infected fruit become distorted and may crack, allowing entry of secondary organisms, severely affected young fruit may drop.



Fig 12.1: Scab of Apple

Disease Cycle:

Primary infection: Ascospores formed from Pseudothecia

Secondary infection: Wind borne conidia.

Favourable condition:

Wet and cool weather favours disease development.

Management

- Clean cultivation
- **Resistant varieties:** Emira, red free, Ambstraking, Ambroyal, Ambrich and Ambred
- Spray captan@0.2% or dodine@0.25% at short intervals after petal fall
- Single application of difolaton@0.3% at green bud stage followed by captan@0.2% at petal fall
- **Spray schedule**
 - 1st spray - Silver tip stage - 0.2% captofol (or) 0.3% captan
 - 2nd spray pink bud - 0.2% captan (or) 0.3% mancozeb
 - 3rd spray at petal fall - 0.5% carbendazim
 - 4th spray - after 10 days - 0.2% captan
 - 5th spray - 15 days after - mancozeb 0.3%
 - Fruit set - 0.15% captafol

12.2 POWDERY MILDEW

Causal organism: *Podosphaera leucotricha*

Sub-division: Ascomycotina

Symptom:

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.



Fig 12.2: Powdery Mildew of Apple

Disease cycle:

Primary infection: Mycelium in diseased vegetative buds and fruits

Secondary infection: Wind borne conidia

Management:

- Sanitation of orchard
- Pre-bloom spray of lime sulphur (1:60)
- Spray dinocap@0.05% or Wettable Sulphure.
- Resistant varieties: Maharaja chunth and Golden Chinese (apple cultivars),
- YantarkaAltaskya, Dolgoe (Crab apple cultivars)

12.3 FIRE BLIGHT OF APPLE

Causal Organism: *Erwinia amylovora*

Symptom:

All above ground tissues including blossoms, fruits, shoots, branches, and in the root stock near the graft union on the lower trunk are affected. **Blossom clusters and young shoots:** The floral receptacle, ovary, and peduncles become water soaked and dull, grayish green in appearance. Later shrivel and turn brown to black. **Shoot symptoms:** Tips of shoots may wilt rapidly to form a "shepherd's crook". Leaves on diseased shoots often show blackening along the midrib and veins, before becoming fully necrotic. Numerous diseased shoots give a tree burnt and blighted appearance. Droplets of milky coloured, sticky ooze may appear on infected parts which usually turns brown on exposure to air.



Fig 12.3: Fair Blight of Apple

Disease cycle:

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

Secondary Infection: Insects such as bees, flies and ants spread the bacteria.

Favourable condition: Warm and Humid climate favours the disease development

Management:

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

12.4 CROWN GALL

Causal organism: *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.



Fig 12.4: Crown Gall of Apple

Management:

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

Session13

DISEASE OF PEACH

13.1 PEACH LEAF CURL

Causal organism: *Taphrina deformans*

Sub-division: *Ascomycotina*

Symptom

The peach leaf curl pathogen infects leaf, green twigs, shoots and fruits.

On leaf: Leaf become thick, puckered severely distort. The thickened areas turn yellowish and then grayish white. The loss of leaves decreased tree growth and fruit production

On shoot: Affected shoots become thickened, stunted, distorted, and often die.

On fruit: Distorted areas develop on fruit surfaces. Later in the season these infected areas of fruit become corky and tend to crack.



Fig 13.1: Peach leaf curl

Disease cycle

Primary infection – Ascospores

Secondary infection - Conidia

Favourable condition

Low temperature and high humidity favours disease development.

Management

- Spray copper oxychloride @ 0.3%.

Session14

DISEASES OF STRAWBERRY

14.1 LEAF SPOT

Causal organism: *Mycosphaella fragariae*
Sub-division: *Ascomycotina*

Symptom: The spot can occur on leaves, fruits, berry caps, petioles, and runners. The most noticeable symptoms of the disease are small, round, necrotic (i.e., dead) spots on strawberry leaves looks like bird's-eye spot. The spots eventually develop white centre with distinct reddish-purple to brown borders.



Fig 14.1: Leaf Spot of Straw berry

Disease Cycle:

Primary Infection: Ascospore

Secondary Infection: Windblown conidia.

Favourable Condition:

Warm and humid weather favours disease development.

Management:

- Use disease-free plants.
- Plant resistant cultivars.
- Spray copper Oxychloride @ 0.3%.
- Soil fumigation also very effective measure for management of inoculum.

Session 15

DISEASES OF POTATO

15.1 LATE BLIGHT

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

Symptoms

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



Fig 15.1: Late leaf spot of Potato

Disease cycle

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

Favourable conditions

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

Dutch rules

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

Management

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

Prophylactic measures

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

15.2 EARLY BLIGHT

Causal organism: *Alternaria solani*

Sub-division: *Deuteromycotina*

Symptoms

It is present in both hills & plains. Brown-black necrotic spot-angular, oval shape characterized by concentric rings. Several spots coalesce & spread all over the leaf. Shot holes on fruits are seen.



Fig 15.2: Alternaria leaf spot of Potato

Disease cycle

Primary infection – Infected tubers

Secondary infection – Conidia

Favourable condition

Low temperature and high humidity favours disease development..

Management

- Spray mancozeb @ 0.25%.

15.3 VIRAL DISEASES

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

Symptoms

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



Fig 15.3: Mosaic of Potato

Spread

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

Management

- Disease free seed tubers for planting
- Rouging of diseased plant.

❖ Severe mosaic – Potato virus Y (PV Y)

Also called potato leaf drop streak.

Symptoms

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

Survival and spread

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

Management

- Disease free seed tubers for planting
- Rouging of diseased plants
- Aphid control by application of dimethoate @ 0.2%

❖ .LEAF ROLL – *Potato leaf roll virus*

Symptoms

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



Fig 15.4: Potato Leaf Roll

Spread

- Infected seed tubers or by **aphids**

Management

- Disease free seed tubers for planting
- Aphid control by application of dimethoate @0.2%.

15.4 BLACK SCRUF

Causal Organism - *Rhizoctonia solani*

Sub-division: Deuteromycotina

Symptom

Black speck, black speck scab, russet scab on tubers. At the time of sprouting dark brown colour appear on the eyes. Affected Xylem tissue causes to wilting of plants. Infected tuber contains russetting of the skin. Hard dry rot with browning on internal tissue. Spongy mass appear on the infected tuber. Seed tubers are source of spread. Moderately cool, wet weather and temp 23 °C are the favourable for the development of disease.

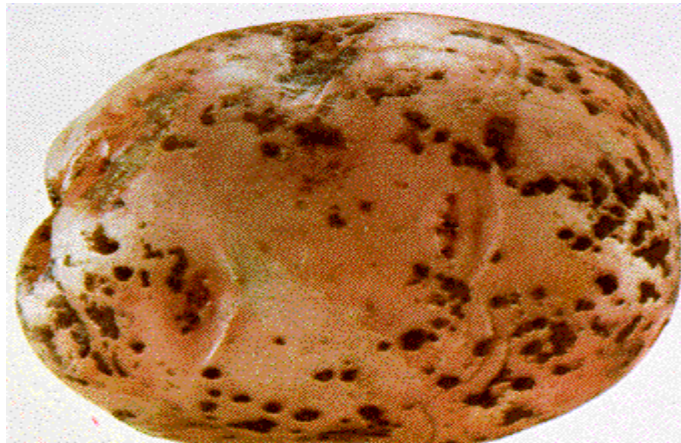


Fig 15.5: Black Scurf of Potato

Disease cycle

Primary infection – Sclerotia present in soil

Secondary infection - Water

Management

- Disease free seed tubers alone should be planted.
- If there is a slight infection of black scurf that can be controlled by treating seed tubers with mercuric chloride solution for 1.5 hr with acidulated mercuric chloride solution for 5 min.
- Treating the soil with pentachloroni trobenzene at the rate of 70 kg/ ha lowers the incidence of the disease, but it is too expensive and cumbersome.
- Well sporulated tubers may be planted shallow to control disease. The disease severity is reduced in the land is left fallow for 2 years.

Session16

DISEASES OF CUCURBITS

16.1 DOWNY MILDEW

Causal organism: *Pseudoperonospora cubensis*

Sub-division: Mastigomycotina

Symptoms:

Yellow, angular spots appear on upper surface of leaves. Lower surface of the leaf shows a purplish downy growth under moist weather. The diseased leaves become yellow and fall down. Diseased plants get stunted and die. Fruits produced may not mature and have a poor taste.



Fig 16.1: Downy Mildew of Cucurbits

Disease cycle

Primary Infection: Collateral hosts or fungus surviving in plant debris.

Secondary Infection: Wind borne sporangia or splashing rain water.

Favourable condition:

Cool and moist weather favours the disease development.

Management

- Destruction of cucurbitaceous weeds around field.
- Spray metalaxyl + Mancozeb @0.2%

16.2 POWDERY MILDEW

Causal Organism: *Erysiphe cichoracearum*

Sphaerotheca fuliginea

Sub-division: *Ascomycotina*

Symptom: Whitish or dirty grey, tiny powdery growth on foliage, stems and young growing parts. The diseased areas turn brown and dry. Premature defoliation of leaf and death of plant occur in sever condition.



Fig 16.2: Powdery Mildew of Cucurbits

Disease Cycle:

Primary infection: Ascospore

Secondary infection: Wind borne conidia

Favourable conditions

Cool dry weather favours conidial germination

High RH favours disease development

Management:

- Spray Calixin 0.1% or Karathane @0.2%

16.3 VASCULAR WILT

Causal Organism: *Erwinia tracheiphila*

Symptoms:

Symptoms of the disease first appear on a single leaf which suddenly wilts and becomes dull green. The wilting symptoms spread up and down further the entire plant shrivels and dies. Creamy white bacterial ooze consisting of thousands of microscopic, rod-shaped bacteria may sometimes be seen in the xylem vascular bundles of an affected stem if it is cut crosswise near the ground and squeezed.



Fig 16.3: Vascular wilt of Cucurbits

Disease cycle:

Primary Infection: Bacteria survive on striped cucumber beetle.

Secondary Infection: Spread by striped cucumber beetle.

Favourable condition:

- Mon cropping of cucurbits plantation.
- Stripped cucumber beetle population large.

Management

- Resistant variety
- Spraying of insecticides against beetle carbaryl (Sevin), malathion, or rotenone.
- Early control, beginning as soon as the plants emerge.

Session 17

DISEASES OF GARLIC AND ONION

17.1 PURPLE BLOTCH

Causal organism: *Alternaria porri*
Sub-division: Deuteromycotina

Symptoms:

Circular to oblong, **concentric velvety rings** appear on the leaves. Sometimes yellow halo is seen around lesions. Diseased leaves break at point of infection & hang down, severely infected crop dries up



Fig 17.1: Purple Blotch of Onion

Disease cycle:

Primary infection: Plant debris and seed bulb

Secondary infection: Air-borne conidia

Favourable condition:

Warm humid weather with rains or heavy dew

Management

- Select disease free bulbs for planting
- Seed treatment with Carboxin + thiram @ 2g/kg seed
- Spray Mancozeb@0.25%.

17.2 STEMPHYLIUM LEAF BLIGHT

Causal organism: *Stemphylium vesicarium*
(Teleomorph: *Pleospora allii*)
Sub-division: Deuteromycotina

Symptom

Initial infections on the leaves and leaf sheaths are small, light yellow to brown, and water-soaked. As the lesions expand, they coalesce, causing extensive blighting of the leaves. Typically, lesions are found in higher numbers on the side of leaves facing the prevailing

wind. The centers of lesions turn brown to tan, then dark olive brown, and finally black as the fungus sporulates. Sometimes fruiting bodies called perithecia may appear in infected tissue as small, black, pinhead-like raised bodies.



Fig 17.2: Stemphylium leaf blight of Onion

Disease cycle:

Primary infection: Plant debris and seed bulb

Secondary infection: Air-borne conidia

Favourable condition: Warm humid weather with rains or heavy dew

Management

- Spray with Carbendazim + Mancozeb @ 0.25%.

Session18

DISEASES OF CHILLI

18.1 ANTHRACNOSE OR DIE-BACK AND FRUIT ROT

Causal Organism: *Colletotrichum capsici*

Perfect stage: (Glomerella cingulata)

Sub-division: Deuteromycotina

Symptoms:

On leaves: Small, circular to irregular, brownish black scattered spots appears on leaves. Severely infected leaves defoliated. **On branches:** 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.

On Fruit: Ripe fruits are more liable for attack than the green ones. Small, circular, yellowish to **pinkish sunken spots** appear on fruits. Severe infection result in the shrivelling and drying of fruits. On the surface of the lesions minute black dot like fruiting bodies called ‘**acervuli**’ develop in **concentric rings**. The affected fruits may fall off subsequently.



Fig 18.1: Fruit rot of Chilli

Disease cycle:

Primary Infection: Acospore

Secondary Infection: Conidia

Favourable conditions

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

Management

- Collect and destroy all infected plant parts.
- Collect seeds only from fruits without infection
- Removal and destruction of Solanaceous weed hosts and infected plant debris.
- Seed treatment with Carboxin + Thiram @ 2g/kg of seeds.
- Spray thrice with Carbendazim + Mancozeb @ 0.2% just before flowering, at fruit formation stage and 15 days after second spray.
- Resistant varieties: **G3, G4, B61, Lorai, etc.**

18.2 FUSARIUM WILT

Causal Organism: *Fusarium oxysporum* f.sp.*capsici*

Sub-division: *Deuteromycotina*

Symptom: Disease symptoms are characterised by an initial slight yellowing of the foliage and wilting of the upper leaves that progress in a few days into a permanent wilt with the leaves still attached.



Fig 18.2: Wilt of chilli

Disease cycle:

Primary Infection: Chlamydo spores

Secondary Infection: Conidia

Favourable condition:

Acidic or light textured soils with poor drainage facility increase disease incidence.

Management:

- Use of wilt resistant varieties.
- Drenching the soil with 1% Bordeaux mixture.
- Seed treatment with 4g *Trichoderma viride* formulation or 2g Carbendazim per kg seed is effective.
- Mix 2kg *T. viride* formulation mixed with 50kg FYM, sprinkle water and cover with a thin polythene sheet. When mycelia growth is visible on the heap after 15 days, apply the mixture in rows of chilli in an area of one acre.

18.3 CHILLI LEAF CURL

Causal Organism: *Chilli leaf curl virus*

Symptom: Leaves curl towards midrib and become deformed. Stunted plant growth due to shortened internodes and leaves greatly reduced in size. Flower buds abscise before attaining full size and anthers do not contain pollen grains.



Fig 18.3: Leaf curl of chilli

Disease cycle:

Primary Infection: Diseased wild and chilli plant

Secondary Infection: Insect vector white fly

Favourable condition: High humidity, mild temperature, low wind speed

Management:

- Spray dimethoate @0.2% to control the vector.
- Grow resistant varieties.
- Uproot the disease plant.

DISEASES OF TURMERIC

19.1 LEAF SPOT OF TURMERIC

Causal organism: *Colletotrichum capsici*
Sub-division: *Deuteromycotina*

Symptom:

On leaves, **elliptic to oblong spots** appear on both the surfaces, but more on upper surface. 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.



Fig 19.1: Leaf Spot of Turmeric

Disease cycle

Primary Infection: Infected plant debris

Secondary Infection: Air borne conidia

Favourable condition:

Cool and humid weather favours the disease development

Management

- Remove and destroy infected plant debris
- Treat rhizomes with Copper oxychloride@0.25% solution
- Spray Carbendazim + Mancozeb@0.2% during Aug-Dec .
- Avoid excess shading
- Tolerant varieties: **TS-2, TS-4, TS-9, TS-8.**

DISEASES OF CORIANDER

20.1 STEM GALL OF CORIANDER

Causal organism: *Protomyces macrospores*
Sub-division: *Ascomycotina*

Symptoms

Galls appear on the leaves and stems of the plants affected by this disease. Shape of coriander seeds change due to effect of the disease.



Fig 20.1: Stem gall of Coriander

Disease cycle:

Primary Infection: Chlamydospores.

Secondary Infection: Conidia

Favourable condition:

- Minimum/maximum atmospheric temperature and relative humidity plays an important role in the initiation and development of this disease.
- Potassium and nitrogen fertilizers reduced stem gall incidence while phosphorus fertilizers increased it. pH of 7.5 was most suitable for infection while minimum infection occurred at pH .

Management:

- The disease affects less in the early and late sown crops.
- Sowing crop around 16 October and 16 November gave minimum yield losses.
- Use of clean and healthy seed and follow suitable crop rotation. Use resistant cvs./ lines like JD 1, G-5365-91, Pant Haritma, UD 20, Rcr41,Pant-1,CIMAP-2053.
- Seed treatment with Carboxin + Thiram 2g/kg of seeds followed by their foliar sprays were found effective in managing this disease.

DISEASES OF MARIGOLD

21.1 BOTRYTIS BLIGHT

Causal organism:*Botrytis cinerea*

Sub-division: *Deuteromycotina*

Symptom:

Flower parts become necrotic and die. A gray mass of spores develops on necrotic tissue during wet conditions.



Fig 21.1: Botrytis Blight of Marigold

Disease cycle:

Primary Infection: By infected flower

Secondary Infection: Conidia

Favourable condition: High humidity and rainy condition favour the disease development

Management:

- Remove all dead and dying plant parts (particularly blossoms) on and around plants.
- Avoid overhead irrigation or apply such that plants are not wet for extended periods of time.
- Space plants for good air circulation.
- Spray Copper Oxychloride @ 0.3%

DISEASES OF ROSE

22.1 DIE-BACK

Causal organism: *Diplodia rosarum*
Sub-division: *Deuteromycotina*

Symptom: Infection starts from the pruned surface of the twigs. The infected portion become brown to dark brown or black. Infected twig dries from tip downwards. Older plants and neglected bushes are more frequently attacked.

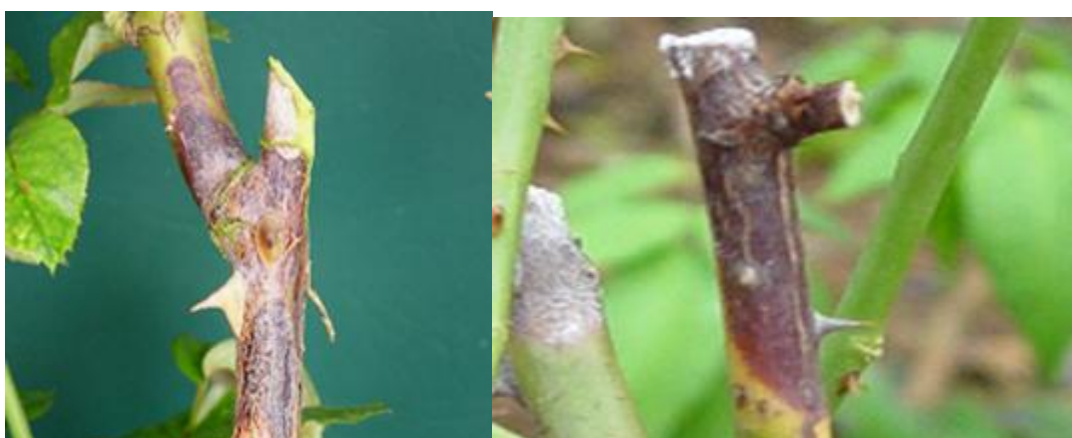


Fig 22.1: Die-back of Rose

Disease cycle

Primary Infection: Pycnidia present in dead twigs

Secondary Infection: Conidia through irrigation water

Favourable condition: **Cool moist weather, old and neglected plant.**

Management:

- Diseased twigs should be carefully removed and destroyed.
- After pruning the cut end should be protected with chaubattia paste.
- Spray Copper oxychloride @ 0.3% in early September and late October.
- Resistant varieties: **Blue moon, Red gold, Summer queen**, etc.

22.2 POWDERY MILDEW

Causal organisms: *Sphaerotheca pannosa* var. *Rosae*
Sub-division: *Ascomycotina*

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. Infected floral parts become discoloured, dwarfed and dried



Fig 22.2: Powdery mildew of Rose

Disease cycle:

Primary Infection: Ascospore

Secondary Infection: Wind borne conidia

Favourable condition: Cool and dry climate favours the disease development.

Management

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

22.3 BLACK SPOT

Causal Organism: *Diplocarpan rosae*
(Perfect stage: Marssonina rosae)
Sub-division: *Ascomycotina*

Symptoms:

Dark brown tar coloured spots with fringed borders on the leaf. Infected leaves turn brown and defoliate. Fungus may also attack stems and flowers of rose bushes.



Fig 22.3: Black spot of rose

Disease Cycle

Primary Infection: Pycnidia or ascospores in infected plant debris

Secondary Infection: Wind borne conidia

Management

- Affected parts should be collected and destroyed.
- Spray Carbendazim @ 0.2% 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.