

TAMIL NADU AGRICULTURAL UNIVERSITY
Agricultural college and Research Institute, Eachangkottai
PAT 401 Diseases of Horticultural crops and their management (2+1)

LECTURE -1 MANGO

Powdery mildew - *Oidium mangiferae*

Symptoms

- White powdery growth appears on the **leaves, tender stems, inflorescences and young fruits**
- Normally infection spreads from tip of inflorescence and covers the floral axis, young leaves and stem.
- Whitish powdery growth is seen on upper surface of leaf. Leaves lose green colour and dry up.
- Whitish patches formed on the stalks of inflorescence which later turn brown or black.
- Shedding of infected leaves may also occur.
- Affected fruits do not develop in size and may drop before attaining pea size or show malformation and discolouration

Fungus

Mycelium is ectophytic, conidiophores non-septate short and hyaline; conidia hyaline, single celled, barrel-shaped and are produced in chains.

Management

Dust twice with sulphur powder at 15 days interval

Sulfex (0.2%) or Thiovit or Bavistin (0.1%) or Calixin (0.1%) at fortnightly interval are effective.

Sooty mould - *Capnodium ramosum*, *C.mangiferae* and *Meliola mangiferae*

Symptoms

- The disease is associated with scale insects and aphids.
- The honey secreted by the insects on the leaves and twigs of host plants attracts the fungus, which multiplies rapidly, spreading on the plant surface.
- Because of the production of masses of black spores, which stick to the leaf surface due to the sticky honey dew, the foliage appears black and ugly and hence the name **sooty mould**.
- Photosynthetic activity and yield are reduced.

Management

- Insecticidal sprays with Dimethoate or Imidachlopid (0.1 per cent) should be applied to kill the insects.
- The fungal growth can be checked by spraying with 0.2 per cent wettable sulphur or Bordeaux mixture 1.0 % or copper oxychloride 0.25 %

Anthraxnose - *Colletotrichum gloeosporioides*

Symptoms

- The disease appears on young leaves, stem, inflorescence and fruits.

- Brown or **dark circular or irregular spots** on leaves & crinkled Leaves. The affected portions dry up and fall off and leave ragged margins. - **shot-hole symptom**.
- Leaves also shed and leaving the twigs bare.
- On young stem, grey-brown spots develop. These enlarge and cause girdling and drying of the affected area.
- Often, black necrotic areas develop on the twigs from the **tip downwards causing a die-back**.
- On the lesions and dead portions black fructification is seen
- Flowers stalks are also attacked- **withering and shedding of flowers** occur. Fruit formation is not there.
- Tender fruits turn black and fall off. **Shriveling, blackening and shedding of fruits noticed**.
- Mature fruits black, sunken spots are formed.
- As ripening lesion extends and rotting.
- **Latent infections of fruit** are established before harvest. The ripening fruits show typical anthracnose.
- Black spots appearing on skin of the affected fruits gradually become sunken and coalesce.

Pathogen

- Acervuli develops on diseases parts and appear as black dots.
- When acervuli mature exude masses of conidia under moist condition.
- Conidia borne on conidiophores are hyaline, cylindrical or oval with two oil drops, non septate with round ends.

Management

Diseased twigs, leaves and fruits should be collected and destroyed

Infected twigs should be pruned and burnt

Spray carbendazim 0.1 % or thiophanate methyl 0.1 % or chlorothalonil 0.2 % before flowers open and during fruit formation

Before storage, the fruits should be dipped in thiabendazole 1000 ppm for 5 min or benlate 500 ppm or carbendazim 500 ppm.

The hot water treatment (55^o C for 5 min) is alone controlled the anthracnose for three weeks and benomyl or TBZ added to hot water gave control for four weeks.

Grey blight - *Pestalotiopsis mangiferae* (Syn. *Pestalotia mangiferae*).

Symptoms

- Brown spots develop at the margin and tip of leaf lamina
- Spots distribute irregularly on the entire leaf.
- Leaf tip dries and the infection spreads down towards petioles
- On matured fruits small brown spots with greyish centre appears.
- Acervuli are seen as minute black dots on affected portions.

Fungus:

Mycelium is coloured and septate. Conidia are five celled. Middle three cells are coloured and the end cells are hyaline. Appendages are slender, 3-5 in number and are seen at the apex of the conidia.

Diplodia stem-end rot - *Diplodia natalensis*

Symptoms

- An important **post harvest disease of** ripe mango fruits.
- In the initial stage, the epicarp darkens around the base of the pedicel.
- The affected area enlarges to form a circular, black patch and turns the whole fruit completely black within two to three days.
- The pulp of the diseased fruit becomes brown.
- The infected fruits lose ascorbic acid rapidly and they have low content of non-reducing sugars in the pulp.

Fungus:

Conidia are produced in pycnidia

The fungus persists in infected plant parts

RH- 80 %

Management

Spray Bordeaux mixture or copper oxychloride or mancozeb

Bacterial leaf spot (Black spot) and canker - *Xanthomonas campestris* pv. *mangiferae-indicae*.

Symptoms

- It attacks leaves, petioles, fruits and tender stems.
- Small water soaked lesions appear in groups towards the tip of the leaf.
- They increase in size, turn brown to black and are surrounded by a distinct halo.
- Cankorous lesions appear on petioles and branches.
- On young fruits, lesions are water soaked and they turn black.
- Infected fruits exhibit cracks on the skin.
- Badly affected fruits drop prematurely.

Bacterium:

The bacterium is Gram negative, rod-shaped, motile by means of a polar flagellum and is without endospores.

Management

- Orchard should be kept free from disease by pruning.
- Shoots selected for grafting should be free from infection.
- Diseased plants parts should be collected and burnt.
- Spray Copper Oxychloride (0.3%) or Agrimycin (0.01%) at monthly intervals.

Phanerogamic parasite

Symptoms

- The parasitic stem creeps along the stem of mango and it attacks by peg-like growth at several places.
- It forms a bushy growth.
- At the point of attachment haustoria penetrate and absorb food material and cause cessation of growth of affected branches.
- Affected branches lose the foliage and dry up.
- Trees gradually deteriorate and die.
- The parasite also attacks *Citrus* spp., jack, neem, etc.

Parasite: Giant mistletoes- *Dendrophthoe longiflorus*, *D. ampullaceus*, *D. capillatus* and *D. elasticus*. Leaves of the parasites are narrow, thick, leathery and green. Fruits are fleshy with sticky mucilaginous contents.

Mode of survival and spread: Seed

Management

- Infected branches should be cut to eradicate the haustoria.
- Spray 30-40% diesel oil emulsion in soap water to eradicate the parasite

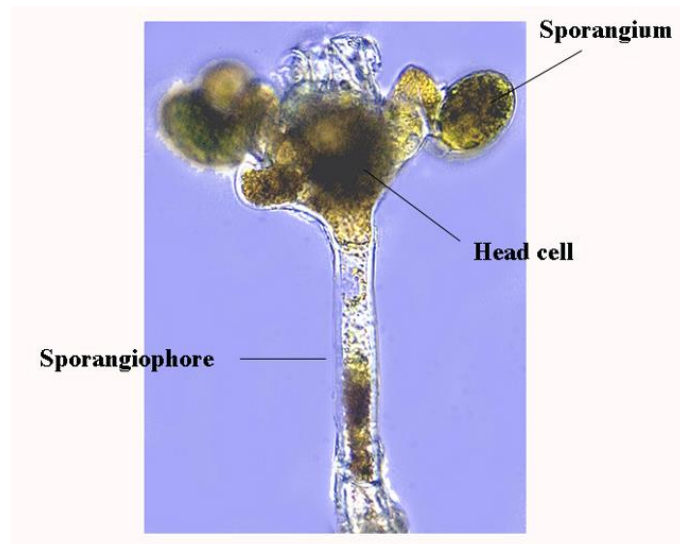
Red rust - *Cephaleuros virescens*

Symptoms

- Rusty-red elevated spots occur on leaves, petioles and young twigs.
- The upper surface of the spot consists of numerous, unbranched filaments which project through the cuticle. Some of the filaments represent sterile hairs while others the fertile ones, which bear cluster of spores at the apex.
- After shedding of spores and hairs, a creamy white mark of the algae remains at the original rust spot.
- The disease is more common on closely planted mother plants.
- Fruiting bodies of the algae form in moist atmosphere.

Algae :

Sporangia – zoospores



Management

- Avoidance of close planting may be helpful in keeping the disease away.
- The disease can be checked by spraying with Bordeaux mixture (6:6:100), copper oxychloride or lime sulphur.
- The affected trees with severe lichen intensity generally show poor growth.
- The lichens can be controlled by spraying with one per cent commercial caustic soda.

Malformation

Also known as bunchy top, very serious in northern India.

Three distinct types are produced

- Bunchy top of seedlings

- Vegetative malformation
- Floral malformation

Bunchy top : appears young plants of 3-4 months old. Formation of bunch of thickened small shootlets bearing small rudimentary leaves. Shortened and stunted shoot. Plant growth stopped and bunchy top appears.

1. Vegetative malformation – excessive vegetative branches in young seedlings. Witches broom like growth of shoot. These infected branches do not bear fruits.
2. Floral malformation - Abnormal development of inflorescence is known as floral malformation. Flowers appear in clusters

Vegetative Malformation

- The numerous small shootlets, arising from apex of shoot or leaf axil, thickened and clustered together, giving the twig a broom like appearance commonly known as 'Bunchy Top'.
- Trees between 4 to 8 years age suffer the most (90.9 %) from vegetative malformation.
- The infected seedlings bearing bunchy outgrowth at apex remain stunted and die ultimately.
- In the older seedling plants, usually normal growth appears above the infected region.
- This structure is called as witches broom.
- They severely restrict the growth and appearance of inflorescence.

Floral Malformation

- This is an abnormal development of inflorescence and the peduncle bearing the flower is also much thickened.
- The affected panicles continue to bear flower buds even after the fruit setting in the normal panicles is over.
- The malformed flowers remain green for longer period and hang on the trees even after the fruiting season.
- The malformed panicles may be loose or compact.

Pathogen

- Microconidia are one or two celled, oval to fusiform.
- Macroconidia are rarely produced.
- Chlamydospores are not produced.

Management

- Spray naphthelene acetic acid (NAA) 200 ppm during first week of October followed by deblossoming spray in January-February
- Pruning of diseased parts along with basal 15-20 cm apparently healthy portions followed by spraying carbendazim 0.1 % or captafol 0.2 %

Black-tip

(Physiological disorder)

Symptoms

- Occur in orchards located in close proximity to a brick kiln.
- Small etiolated areas appear at the distal end of the fruit, gradually spread, turn nearly black and cover the tip completely.

- Isolated greyish spots appear which becomes dark brown enlarge and coalesce into a continuous necrotic area.
- In severe cases the necrosis extends to the endocarp.

Questions

1. Excessive vegetative branches & Swollen with short internodes is the symptom of
 A) **Mango malformation** B) Mango Anthracnose
 C) Mango Powdery mildew D) Mango Sooty mould
2. Latent infection on unripe fruit is carried from field and develops further in storage
 A) Powdery mildew B) **Anthracnose**
 C) Grey Blight D) Sooty mould
3. How will you manage anthracnose in mango ?
4. List out the major disease of mango and explain in detail about powdery mildew ?

LECTURE -2 BANANA

Panama disease / *Fusarium* wilt - : *Fusarium oxysporum* f.sp. *cubense*

Symptoms

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

Fungus

Mycelium is septate, hyaline and branched. Fungus produces microconidia, macroconidia and chlamydospores. Microconidia are single celled or rarely one-septate, hyaline and elliptical or oval. Macroconidia are sickle-shaped, hyaline, 3-septate and they are tapering at both the ends. Chlamydospores are thick walled, spherical to oval and hyaline to slightly yellow in colour.

Management

Crop rotation including paddy / sugarcane once or twice followed by banana for 2-3 cycles or flooding the field for 6 months

Field fallowing or long rotation

Selection of resistant varieties such as Poovan, Robusta and Nendran for planting in endemic areas.
Avoid susceptible varieties such as Rasthali, Monthan, Karpuravalli, Kadali, Rasakadali, Pachanadan etc.
Planting of healthy suckers extracted from healthy plantations.
Restricting the movement of infected suckers to non infected areas
Providing good drainage especially during rainy season.

Anthracnose / Fruit rot - *Gloeosporium musarum* (*Colletotrichum musae*)

Symptoms

- Immature fruits are affected and they turn black and are covered with pink mass of fungal spores.
- This causes discoloration and rotting of the pulp.
- Entire fruit, stalk and buds are affected and the fruits are shrivelled.

Fungus:

Mycelium is septate and coloured. Acervuli are round or elongated and erumpent. Conidiophores are cylindrical, tapered towards the apex, hyaline and septate. Conidia are single celled, hyaline, small and elongated.

Management

- Spraying of bunches/plants with carbendazim or thiophanate methyl (0.1%) or Prochloraz (0.15%) at 20 days intervals in quite effective. The last spray should be given 15-20 days before harvesting.

SIGATOKA LEAF SPOT/YELLOW SIGATOKA - *Cercospora musae* (Syn. *Mycosphaerella musicola*)

Symptoms

- Elongated dark brown spots appear on leaves.
- The spots increase in size and show grey centre and brown margin and are surrounded by yellow halos.
- More spots on leaves causes drying.
- Fructification of the fungus is seen as black dots in the grey centre.
- Rapid drying and defoliation of leaves are the characteristic feature of the disease.

Fungus:

Mycelium is septate and coloured. Conidia are hyaline, cylindrical, long and 3-5 septate.

Management

- Removal and destruction of infected leaves
- Intercultural operation such as timely removal of suckers, weed free cultivation, improving the drainage condition and adopting correct spacing decreases the disease severity.
- Spraying 0.1 % carbendazim or 0.1 % thiophanate methyl or 0.1 % prochloraz or chlorothalonil 0.2 % or mancozeb 0.2 % or mineral oil 0.3 % along with wetting agent.
- Spraying with systemic fungicides such as Propiconazole (1ml /litre) or Carbendazim (0.1%) + Calixin (0.1%) along with few drops of stickers like Sandovit or Teepol or Triton AE 1ml/litre of water was effective in containing the disease

Freckle disease / Black spot - *Phyllostictina musarum* (Syn. *Macrophoma musae*)

Symptoms

- Numerous, minute, black, raised spots are seen on the leaves and the infected leaves become yellow.
- Spots are more on the upper surface.

- Spots on fruits are superficial (skin deep) and are produced either singly or in groups.

Fungus:

The fungus produces pycnidia and pycnidiospores. Pycnidiospores are needle-shaped, hyaline and multiseptate.

Bacterial wilt / Moko disease - *Burkholderia solanacearum* (*Pseudomonas solanacearum*)
Ralstonia solanacearum

Symptoms

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

Bacterium:

The bacterium is Gram negative and rod-shaped.

Management

- Strict quarantine and phytosanitary measures
- Pruning wounds are the common entry points hence disinfect the tools used (formalin diluted with water at 1:3 can be used as disinfectant)
- Provision of drainage facilities
- Removal of male buds when the hands begin to turn upwards
- Removal of weed hosts like *Heliconia* spp. (Alternative host)
- Fallowing or rotation with sorghum
- Fumigation with methyl bromide – but it is expensive.

Tip over / Head rot / Top rot - *Erwinia carotovora* subsp. *carotovora*

Symptoms

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

BUNCHY TOP/CURLY TOP /CABBAGE TOP/STRANGLE DISEASE - *Banana Bunchy top virus (BBTV)* or *Musa virus-1*

Symptoms

- Appearance of irregular, dark green streaks about 0.75 mm wide along the secondary veins on the underside of the leaf.
- Green streaks range from a series of dark green dots to a continuous dark green line (**Morse code**)
- In badly attacked plants, leaves are small, erect and bunched together at the apex or crowded at the top (Bunchy top)
- The petiole, mid rib and lamina become more brittle and can easily be snapped when bent or crushed
- Plants show marked stunting

Banana mosaic / Infectious chlorosis

Symptoms

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

Management

- Selection of healthy suckers
- Removal of affected trees and suckers
- Injecting Fernoxone 80 WP (2,4-D) 4 ml (prepared with water in the ratio of 1:8 i.e., 125 mg/lit of water) into the pseudostem using TNAU pseudostem injector
- Capsule application of 2,4-D @ 200 mg of Fernoxone/corn.
- Injected plant collapses and topples in 3 to 5 days of application

Banana Bract mosaic/kokkan disease - *Banana Bract Mosaic Virus (BBMV)*

Symptoms

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

Management

Growing of cucurbitaceous crop as an intercrop should be avoided
Spray systemic insecticide, methyl demeton 0.03 %

Banana Streak - *Banana Streak Virus (BSV)*

Symptoms

- The disease is characterized by the presence of discontinuous yellow streaks along the blade or midrib which turn into discoloured patches.
- Necrosis appears on the lower side of the sheath, which leads to drying of leaves.

Causal agent:

Virus particles are bacilliform. The disease is neither transmitted mechanically nor by aphid vector.

Cigar end rot - *Verticillium theobromae*, *Trachysphaera fructigena* and *Gloeosporium musarum*

Symptoms

- A black necrosis spread from the perianth into the tip of immature fingers.
- The rotted portion of the banana finger is dry and tends to adhere to fruits (appears similar to the ash of a cigar).

Questions

1. Leaves hang around pseudostem – yellow skirt symptom is caused by
A) ***Fusarium oxysporum f. sp. cubense*** B) *Fusarium oxysporum f. sp. psidii*
C) *Fusarium guttiforme* D) *Fusarium oxysporum f. sp. lycopersici*
2. Moko wilt of banana is caused by
A) ***Ralstonia solanacearum*** B) *Xanthomonas solanacearum*
C) *Erwinia carotovora* D) *Clavibacter michiganense*
3. The vector of Strangles disease is
A) ***Pentalonia nigronervosa*** B) *Aphis gossypii*
C) *Bemisia tabaci* D) *Aceria cajani*
4. Write the symptoms and management of strangle disease ?
5. List out the major disease of Banana and explain in detail about sigatoka leaf spot ?
6. Differentiate Moko wilt and panama wilt

LECTURE - 3 CITRUS and GRAPES

CITRUS

Gummosis - : *Phytophthora palmivora*, *P. citrophthora* and *P. parasitica*

Symptoms

- Profuse oozing of the gummy substances on the affected bark forming an encrustation on the bark is the characteristic symptom.
- Droplets of gum trickles down the stem.
- The bark is destroyed all round the trunk, girdling the tree and eventually the tree dies.
- The bark, wood and cambium show discolouration.
- The bark cracks and shreds longitudinally.
- Leaves turn yellow and pale.
- Affected tree dies in few months.
- Prior to death, the tree produces more flowers but dies before the fruits mature.
- Shedding of leaves from lower branches, fruit drop and rotting of fruits.
- Fallen fruits are covered by whitish cottony fungal growth.

Fungi:

Mycelium is coenocytic and hyaline. Sporangium is round or pear-shaped and contains zoospores which are biflagellate.

Management

- Provision of proper drainage and avoid excess irrigation
- Avoid injuries to plants
- Drenching or pasting the trunk with Bordeaux mixture 1.0 %
- Two sprays with drenching either by Fosetyl-AI (2.5g/L) or Metalaxyl MZ-72 (2.75g/l water) covering the whole plant canopy and basin of affected plant at 40 days interval after onset of monsoon.
- Scrap the affected parts and apply of Metalaxyl MZ-72 paste

Diplodia gummosis - Diplodia natalensis**Symptoms**

- Infection starts at cracks.
- Gum oozes from few **spots near fork/limbs**, dries and become black.
- Discolouration of wood into brown.
- Large limbs are killed and breaks at the infected portion.

Mode of spread

- Through wind borne pycnidiospores
- Reduced tree vigour, insect damage, poor nutrition and old age
- favours the incidence

Management

- Trees should be kept in vigorous growing condition.
- Gummed portions of affected bark should be removed and protect the cut surface.
- Wounds should be scraped and protected with Bordeaux paste.
- Cut and burn the broken limbs.
- Spray carbendazim 0.1% on the affected limbs and forks

Ganoderma root rot - Ganoderma lucidum**Symptoms**

- Infection starts at one or more of the lateral roots of the tree.
- Later it spreads to crown roots and to the main trunk. Affected tissues of the wood die, discoloured, soft and decomposed. Aerial parts start drying.
- In advanced stages, woody bract-like fructification (sporophores) appear at the base of the trunk. Ultimately the whole tree dies up.

Mode of spread

- Through contacting roots of adjacent trees or through spores falling from sporophore

Management

- Growing and incorporation of green manure in the soil
- The debris should not be allowed to contact with root system
- Soil incorporation of sulphur @ 0.5 to 1.0 kg / tree
- Dead and decayed stumps should be removed

- Digging a trench around infected tree
- Tree basin should be drenched with Aureofungin – Sol 0.03 % or Carbendazim 0.05 % or Bordeaux mixture 1.0 %

Dry root rot - *Macrophomina phaseoli*, *Fusarium spp.* and *Diplodia natalensis*

Symptoms

- Moist decay of the bark in the early stages and a dry shredded condition of the bark in later stages.
- The affected roots emit bad odour. Affected tree defoliates, and produces heavy crop of small-sized fruits.

Favourable condition

- Frequent injuries to roots, heavy soils, insufficient supply of nitrogen and closer planting

Management

- Growing and incorporation of green manure in the soil
- Proper manuring
- Dead and decayed stumps should be removed
- Tree basin should be drenched with Carbendazim 0.1 %

Anthraxnose and die-back / Wither tip - *Colletotrichum gloeosporioides* (Sexual stage: *Glomerella cingulata*)

Symptoms

- Affected branches begin to wither from the tip downward (die-back).
- The leaves wither and drop off. Black dots of acervuli appear on dead twigs.

Fungus:

Mycelium is septate, branched and dark coloured. Acervuli contain single celled, hyaline and ellipsoid conidia.

Mode of spread

Dead twigs and branches

Management

- Pruning of dead twigs
- Paste the cut ends with Bordeaux paste
- Spray carbendazim 0.1 % or captafol 0.2 % after pruning
- Adequately manure with urea to improve vigour
- Improve drainage facilities
- Proper irrigation

Powdery mildew - *Oidium tingitaninum*

Symptoms

- Whitish powdery growth appears on leaves and young twigs.
- Leaves become yellow and distorted and shed.
- Tender leaves are highly susceptible.
- Young fruits are covered by mildew growth.

Fungus:

Mycelium is hyaline, septate and external. Conidia are produced in chain. They are single celled, hyaline and barrel-shaped.

Sooty mould - *Capnodium citri***Symptoms**

- The disease is common in the orchards where mealy bug and scale insects are not controlled efficiently.
- Black velvety coating on the leaves, twigs and fruits is the characteristic of disease.
- Under dry conditions the affected leaves curl and shrivel up.
- The photosynthetic activity of the leaves is reduced.
- The trees look sickly and fruit yield is reduced.

Scab / Verucosis - *Elsinoe fawcetti* (Conidial stage: *Sphaceloma citri*)**Symptoms**

- Attacks leaves, twigs and fruits of mandarin.
- Leaves show irregular corky raised reddish or yellowish lesions mostly on the lower surface leading to severe distortion wrinkling and stunting.
- The lesions are flat or depressed at the centre.
- On twigs dark corky outgrowths are seen.
- Lesions on fruit are corky and the affected fruits are mis-shapened show prominent warty projections and they drop prematurely.

Fungus:

Conidia formed in pink acervuli are hyaline, oblong and one celled. Pseudothecia are produced. Ascospores are hyaline and 1 to 3 septate

Mode of spread and survival

Survives as ascospores and the sec. spread through conidia

Management

Diseased leaves, twigs and fruits should be collected and destroyed
Spraying Bordeaux mixture 1.0 % or COC 0.3 % or Difolatan or Chlorothalonil 0.2 %

Pink disease - *Pellicularia salmonicolour***Symptoms**

- Usually the disease appears during or just after monsoon rains.
- The affected branches are covered with a fine silvery-white film of mycelium.
- From the characteristic pink colour produced by the fungus on the branches, the disease is aptly called the pink disease.
- When the bark is severely infected it gets shredded, and the wood is exposed.
- Longitudinal cracking and gumming of the branches may also take place.

Canker - *Xanthomonas axonopodis* pv. *citri* (Syn. *Xanthomonas campestris* pv. *citri*.)

Symptoms

- Acid lime, lemon and grape fruits are attacked.
- The disease attacks all the plant parts viz., leaves, twigs, thorns, older branches and fruits.

Leaves

- Raised yellowish brown, watery, translucent spots appear on lower and then on both sides of leaves
- The surface of the spots become white / greyish and ruptures in the centre giving corky, rough corky like appearance
- Spots appear with yellow halo
- Spots on petiole and midrib cause premature defoliation
- Spots also appear on twigs, branches and thorns

Fruit Symptoms

On the fruit surface round to irregular, raised cankerous spots without yellow halos are seen and they reduce market value of fruits

- Gumming is also noticed in fruits
- Reducing market value
- It provide entry of other organisms
- Fruit drop

Twig Symptoms

- Twig lesions are similar
- The canker often encircles the twigs causing death of portions above the infected area –die back

Bacterium:

The bacterium is a Gram negative, rod, forms chains and capsules, motile by polar flagellum and non-spore former.

Management

- Collection and destruction of diseased plant parts
- Disease free seedlings for planting
- The vigour should be maintained by proper fertilization & manuring
- Care should be taken to minimize the attack by leaf miner
- Pruning and destruction of infected twigs followed by three to four sprays with streptomycin sulphate + tetracycline combination 100 ppm + copper oxychloride 0.3 %
- Spraying neem cake solution 5 % is effective in minimizing leaf miner damage as well as bacterial canker.

Citrus greening - Fastidious vascular bacteria (phloem inhabiting bacteria)

Symptoms

- Leaves may be completely yellow or yellow with green veins and small green dots.
- Leaf blade may be dwarfed, thickened, upright become leathery.
- Twigs show short internodes, multiple bud formation and are upright and produce smaller leaves.
- Fruits show orange colour on the sides exposed to sunlight whereas the other side remains dull green.

- Fruits are small, lopsided with aborted seeds and drop prematurely.
- Fruits are low in soluble solids but high in acid.

Causal agent:

It is an obligate, Gram-negative bacterium.

Transmission

Bud wood and Citrus psyllid, *Diaphorina citri*

Management

- Removal of affected and unproductive trees
- Planting disease free budded plants raised on improved rootstock
- Strengthen regulatory (quarantine) measures to limit its movement
- Spray tetracycline 500 ppm to inhibit multiplication of pathogen.
- Spray phosphamidon (1ml/lit) or apply dimethoate 10% granules to soil around the plant basin to control nymphs and adults of insect vector.

Tristeza / Quick decline / Stem pitting disease - Citrus Tristeza Virus

Symptoms

- Lime is highly susceptible.
- Leaves of acid lime exhibit large number of vein flecks (elongated translucent areas).
- Die-back symptom is commonly associated.
- Characteristic pits or depressions on wood (stem pitting) can be clearly seen on the stem after removal of bark.
- Roots decay, twigs die-back, fruits are small, trees are stunted and die.
- Yield is much reduced.

Causal agent:

Flexuous rod having ds RNA as its genome – mild, severe and seedling yellow strains have been reported.

Transmission

Infected bud wood, Black citrus aphid (*Toxoptera citricidus*) and dodder (*Cuscuta reflexa*)

Management

- Removal of infected trees
- Use of virus free materials on tolerant root stock
- For acid lime, pre-immunization (cross protection) with mild strain is more useful
- Periodical spraying of monocrotophos 0.05 % is effective

Red rust (algal disease) - *Cephaleuros virescens*

Symptoms

- Reddish brown circular to irregular spots develop on the leaves.
- When the twigs are attacked the bark is thickened and develops cracks leading to the chlorosis of foliage, defoliation and death of the affected twigs.
- Reddish spots are seen on fruits.

Algae:

It is an algal parasite. It produces thallus, sporangiophore and sporangia. Sporangia are single celled, oval and releases zoospores.

Dodder - *Cuscutta* sp.

(Total stem parasite)

Symptoms

- Small masses of branched, thread-like, cream yellow or orange coloured, leafless stems, devoid of green pigments twine around the stem or leaves of the host.
- It penetrates the host through haustoria, by which it draws nutrients from the host.

Causal agent:

- It perpetuates through seeds which fall on the ground and remain viable until favourable season return. It produces tiny, white, pink or yellowish flowers in clusters.

GRAPEVINE

Powdery mildew - *Uncinula necator*

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

Symptoms

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

Fungus:

Mycelium is external, septate and hyaline. Conidiophores are short and arise from external mycelium. Conidia are single celled, hyaline, barrel-shaped and in chain (*Oidium* type). Sexual fruiting body, cleistothecium produces asci and ascospores.

Management

- Overcrowding and dense growth of vines should be avoided by proper pruning
- Spray wettable sulphur 0.2 % or dinocap 0.2 % or carbendazim 0.1 % or sulphur dusting

Downy mildew - *Plasmopara viticola***Symptoms**

- Symptoms appear on all aerial and tender parts of the vine.
- Symptoms are more pronounced on leaves, young shoots and immature berries.

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

Fungus:

Mycelium is coenocytic and intercellular. Sporangiophores branch monopodially and dichotomously at right angles and tips of branches are blunt. Sporangia are thin walled, lemon-shaped, single celled and hyaline. Sporangia produce zoospores. Oospores are thick walled.

Management

- Removal and burning of all diseased leaves, shoots, flowers and berries
- Planting of vines with proper spacing and training (pruning)
- Spraying with Bordeaux mixture 1.0 % or difolatan 0.2 % or chlorothalonil 0.2 % or metalaxyl 0.2 % and repeated at weekly intervals and every two or three days for non-systemic fungicides

Bird's eye spot / Anthracnose - *Gloeosporium ampelophagum* (*Elsinoe ampelina*)

Symptoms

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

Fungus:

The fungus produces acervuli. Conidiophores are 1 to 2 septate, cylindrical, unbranched and pale brown. Conidia are single celled, oval, hyaline and smooth. Ascocarps are produced. Asci are globular. Ascospores are hyaline and three-septate.

Management:

Pruning of diseased leaves and twigs Spray Bordeaux mixture 1.0 % or copper oxychloride 0.25 % or carbendazim 0.1 % or mancozeb 0.2 % or difolatan 0.2 % or chlorothalonil 0.2 % or bitertenol 0.1 % effectively controls

Rust: *Phakopsora vitis*

Symptoms

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

Alternaria leaf spot: *Alternaria vitis*

Symptoms

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

Black rot - *Guignardia bidwellii*

Symptoms

- Circular red spots with black margin appear on the leaves.
- Fruiting bodies are seen as minute black dots in concentric rings on the spots.
- Light brown circular spots on the berries.
- Spots increase in size and entire berry is discoloured and decay.
- They are transformed into hard, black and shriveled mummies.

Fungus:

Matured mycelium is brown and septate. Pycnidia are globose and conidia are ellipsoid and hyaline. Perithecia are globose and asci are clavate with 8-ascospores which are hyaline. 2-celled and sub-ovoid.

Disease cycle

- Perithecia present on mummified fruits – primary
- Pycnidiospores – secondary

Management

- Collect and destroy the diseased berries and leaves
- Spray Bordeaux mixture 1.0 % or captan or chlorothalonil 0.2 %

Pierce's disease of grapevine – Fastidious Vascular Bacteria – *Xylella fastidiosa*

Symptoms

PD is first apparent as leaf scorch. Scorching typically begins at the margins of leaves, or in the lobes of some varieties and moves inwards. Typically a distinct banding pattern of red and orange colors is apparent, especially in red grape varieties. Leaf blades will eventually drop off leaving “match stick” petioles, canes may begin to show alternating patterns of green and brown sections, and fruit clusters will shrivel. PD is

notable for its patchiness within a vine – often one cordon or even cane can be showing strong symptoms while the rest of the vine looks healthy

Grapevine Fan leaf – Grapevine fan leaf virus

Infected plants often show a slow decline and difficulty setting fruit, but nearly always bear a distinctive leaf deformity. Affected leaves exhibit a **fanlike shape due to abnormalities in vein formation**, and yellow coloration either in a mosaic pattern or in bands along major veins. This yellow coloration generally appears in summer. Infected plants do not produce flowers and fruits

Questions

- 1 Scab or Verucosis disease of Citrus is caused by
A) *Phytophthora palmivora* B) ***Elsinoe fawcettii***
C) *Gloeosporium gloeosporioides* D) *Capnodium citri*
- 2 Special method for the management of Tristeza or Quick decline
A) Root feeding B) Trunk injection
C) **Preimmunization** D) Grafting
- 3 Corky cankerous out growth seen on the citrus fruits without yellow halo and reduces market value is due to
A) **Canker** B) Scab
C) Rust D) Verucosis
4. Birds eye spot in Grapes is caused by
A) *Phakopsora euvtis* B) ***Elsinoe Ampelina***
C) *Uncinula necator* D) *Elsinoe fawcettii*
5. Grapevine fan leaf NEPO virus is transmitted by
A) *Radopholus similis* B) *Meloidogyne* sp
C) *Pratylenchus* sp D) ***Xiphinema index***

LECTURE -4 GUAVA, SAPOTA, POMEGRANATE, ANNONA AND JACK

GUAVA

Fusarium wilt - *Fusarium oxysporum* f.sp. *psidii*

Symptoms

- Leaves of affected branches show yellowing, curling and drying but they do not shed for sometime.
- Affected branches bearing infected leaves begin to die and the twig barks turn light brown and show severe splitting.
- It is severe at the time of fruit bearing stage.
- Trees do not produce any new flush or flowers.
- Trees die within a year.

Fungus:

Mycelium is hyaline, branched and septate. Microconidia are unicellular, oval and hyaline. Macroconidia are multiseptate, hyaline and sickle-shaped. Chlamydospores are intercalary /terminal.

Favourable condition:

Monsoon period (Sep-Oct), alkaline soil with moderate soil moisture

Management

- Removal of affected branches / trees
- Apply gypsum or lime to make the soil pH 6.0 to 6.5
- Treat the pit soil with formalin 37-40 % (45 ml + 270 ml of water for treating 35 kg of soil)
- Cover the soil with polythene mulch

Anthracoze / Fruit rot - *Gloeosporium psidii* (*Glomerella psidii*)

Symptoms

- Dark brown to black, sunken, circular spots appear on the unripe fully grown fruits and bear numerous, minute, black stromata in the centre of the lesion.
- Several spots coalesce to form bigger lesions.
- Diseased portions are comparatively harder and develop cracks.
- Ripe fruits become soft.
- Unopened flowers and buds are attacked and shed.
- Necrotic ashy grey lesions occur on leaf tips and margins.
- Main branches show die-back symptoms.

Fungus:

Mycelium is septate and dark coloured. Acervuli are dark brown to black. Conidia are single celled, hyaline and oblong.

Mode of spread: Dormant propagules in unripe fruits and mummified fruits

Management:

Spraying of Bordeaux mixture 1.0 % or COC 0.2 %

Grey blight and fruit canker /Scab - *Pestalotiopsis psidii*

Symptoms

- On the leaves grey spots with brown margin appear.
- Acervuli are seen on the centre.
- Infection on fruits is generally on green fruits.
- Numerous circular, raised dark coloured corky cankerous growth occurs on the unripe fruits.
- Infected fruits give a chicken pox appearance.
- They do not ripe properly, become hard and are not palatable.
- Scab disfigures the fruit and reduces market value.

Fungus:

Acervuli are brown to black. Conidia, which are oblong and 5-celled. Three median cells are dark brown and gradually bulged and the end cells are hyaline. Three apical hyaline setulae are present. Apical cell is conical or cylindrical. Basal cells are obtuse and erect with a small pedicel.

Mode of spread

Infected leaves and fruits and secondary spread by conidia

Management

Spraying of Bordeaux mixture 1.0 % or Copper oxychloride 0.2 %

Sooty mould - *Meliola* sp. and *Capnodium* sp**Symptoms**

Black sooty growth is found on the surface of leaves, branches and fruits. Sooty growth (mycelium, conidiophores and conidia) is associated with the infestation of scales and mealy bugs.

Red rust (Algae) - *Cephaleuros virescens***Symptoms**

- Dark green, brown or red, rough spots appear on the upper leaf surface.
- The spots become faded after release of sporangia.
- Fruit lesions are small and dark green to black in colour.

Giant mistletoe (Partial stem parasite) - *Dendrophthoe falcata* and *D.longiflora***Symptoms**

The flowering parasite attacks young branches of trees in neglected gardens. Branches above the point of attack appear sickly or dry.

Causal agent:

This is a phanerogamic parasite with dull green leaves with profuse flowering.

SAPOTA**Leaf spot - *Phavophleospora indica*****Symptoms**

- Small, round and pinkish to dark brown spots with grey centre are seen on leaves.
- They are either distributed or grouped on the leaf.
- The spots coalesce and cause premature leaf fall and reduction fruit yield.

Management

Spraying of zineb or ziram 0.2 % or Copper oxychloride 0.25 %

Sooty mould - *Capnodium* sp.**Symptoms**

Black sooty growth develops on the upper surface of the leaves which reduces the photosynthetic ability of the trees.

Fungus:

The mycelium is septate, dark coloured and superficial.
(for further details refer sooty mould disease of mango / guava)

Flat limb - *Botryodiplodia theobromae*

Symptoms

- Branches are typically flat, twisted with thin, yellow, hollow leaves in bunches.
- Fruits formed are small hard and dry.

POMEGRANATE

Leaf spot and fruit spot - *Colletotrichum gloeosporioides*

Symptoms

- The disease is characterized by small, dull violet spots on the leaves and are surrounded by yellow halo.
- The infected leaves turn yellow and drop off.
- On the fruits dark brown, depressed spots are observed.
- In severe cases, the infected fruits crack and become unmarketable.
- Diseased portions appear with minute, black dots (acervuli).

Management

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

Cercospora* leaf spot - *Cercospora punicae

Symptoms

- Light brown spots appear on leaves and fruits.
- Black and elliptic spots appear on the twigs.
- Such infected twigs are flattened, depressed with raised edge and dry up.
- In severe cases the whole plant dies.

Fungus:

Conidiophores are olive brown, short and septate. Conidia are pale olive, cylindrical and septate.

Management:

- Pruning of affected twigs
- Spray thiophanate methyl 0.1 % or mancozeb or chlorothalonil 0.2 %

Bacterial blight - *Xanthomonas axonopodis* pv. *punicae*

Symptoms

- Spots on leaves are dark brown and are surrounded by prominent water-soaked margins and these spots coalesce to form large patches.
- Severely infected leaves are often distorted and malformed and fall off prematurely.
- On the stem brown to black spots appear around the nodes, girdle the stem and causes the branches to break.
- The spots on the fruits are raised, oily and brown to black.
- Finally it results in cracking of fruits.

Bacterium:

It is a Gram negative, rod-shaped, motile with single polar flagellum. The bacteria infect through wounds and stomatal openings.

Annona**FRUIT ROT & ANTHRACNOSE:** *Glomerella cingulata***Symptoms**

Blackish brown spots occur at blossom end, spread and cover entire fruit. Fruits become shrivel, dry and fall down later.

ALTERNARIA LEAF SPOT: *Alternaria alternata***Symptoms**

- ❖ Small yellowish spots first appear along the leaf margins, which gradually enlarge and turn into brownish patches with concentric rings.
- ❖ Severe infection leads to drying and defoliation.
- ❖ Dark brown-purplish patches appear on the infected fruits and rachis just below its attachment with the shoots.

Management:

Spraying of thiophanate methyl 0.2% or pyraclostrobin+metiram 0.1%

Cylindrocladium leaf spot: *Cylindrocladium colhounii***Symptoms**

- dark purple spots about develop first on the shoulders of the fruit and then spread down the sides.
- Spots enlarge and then later dry out and crack.

Management:

- Collect and burn the infected plant parts to minimize the spread of the disease.
- Increase air circulation by proper training and pruning
- Spraying of Carbendazim 0.1%
- Spraying of tebuconazole+mancozeb 0.1%

Diplodia rot: *Lasiodiplodia theobromae*.**Symptoms**

- Diseased fruits show symptoms of purplish to black spots or blotches confined to the surface of the fruit and eventually covered with white mycelia and black pycnidia.
- Diplodia rot is distinguished by its dark internal discoloration and the extensive corky rotting produces.
- The penetrated flesh eventually softens or hardens and cracks, depending on the presence of secondary microbes.

Management:

- Remove dead twigs and mummified fruits.
- Spraying of Carbendazim 0.1%
- Spraying of tebuconazole 0.1%

Black canker: *Phomopsis annonacearum***Symptoms**

- Purple to black, irregularly shaped spots ranging from small specks to large blotches.
- Spots have an indistinct 'feathered' edge.

- Tissue damage under the spots is not more than 10 mm deep.

Management:

- Regularly monitor the diseases and remove dead twigs and mummified fruits.
- Follow proper plant canopy by appropriate pruning and training
- Spraying of tricyclazole 0.1%
- Spraying of pyraclostrobin 0.1%

JACK

Pink Disease- *Erythricium salmonicolor*

Symptom:

- serious in high-density planted areas or under shade during high rainfall.
- Silky-white mycelial threads on the bark of branches and trunk.
- Under wet conditions, they turn slightly pink in colour and rough pink encrustations are formed.
- bark later cracks and the branches dry up and wilt.

Management

- Avoid close planting or intense shading. Prune off infected parts of the plant, and
- practice good field hygiene by removing all plant debris.
- Monitor the disease in the field closely for recurrence of the disease.

Jack fruit rot- *Rhizopus atrocarpii*

Symptom

- Young fruits and male inflorescences are badly attacked by the fungus and only a small percentage of the fruits reach maturity.
- Female inflorescence and matured fruits are not usually attacked.
- The disease is a soft rot. A large number of the affected fruits fall off early. In the first stage of attack the fungus appears as greyish growth with abundant mycelia which gradually becomes denser forming a black growth.
- The fungus gradually advances until the whole fruit or the entire inflorescence rots and falls off.

Management

- Spray young fruits with Mancozeb 0.25% or Copper oxychloride 0.25 per cent at an interval of three weeks during the months of January, February and March.

Questions

1. Yellowing, curling and premature shedding of leaves in the terminal branches of guava is caused by
 A) *Fusarium oxysporum* f sp. *cubense* B) *Fusarium guttiforme*
 C) *Fusarium oxysporum* f sp. *lycopersici* D) ***Fusarium oxysporum* f.sp. *psidii***
2. Branches of the affected trees become flat and twisted with severe bunching of leaves in sapota is caused by
 A) ***Lasioidiplodia theobromae*** B) *Phaeophleospora indica*
 C) *Pestalotiopsis versicolor* D) *Gloeosporium gloeosporioides*

3. Bacterial leaf spot of Pomegranate is caused by
- A) *Xanthomonas campestris* pv. *campestris* B) ***Xanthomonas campestris* pv. *punicae***
 C) *Xanthomonas vesicatoria* D) *Xanthomonas axonopodis* pv. *mangiferae*
4. Young fruits of jack rots and mummified due to the infection of
- A) *Pellicularia salmonicolor* B) ***Rhizopus atrocarpi***
 C) *Phytophthora parasitica* D) *Pythium aphanidermatum*

LECTURE -5 PAPAYA, PINEAPPLE,BER, AMLA

PAPAYA

Damping off - *Pythium aphanidermatum*

Symptoms

Young seedlings are killed before they come out of soil. Germinated seedlings topple over at any time after emergence.

Fungus:

Mycelium is coenocytic and hyaline. Sporangia are lobulate. Zoospores are kidney-shaped and biflagellate(with whip lash and tinsel).

Foot rot / Stem rot - *Pythium aphanidermatum* and *Rhizoctonia solani*

Symptoms

- Water soaked lesions appear on the bark near the ground level and enlarge.
- Affected tissues turn dark brown or black and the infection girdle the stem at the base.
- Terminal leaves become yellow, droop and wilt.
- Fruits shrivel and drop.
- Roots disintegrate and decay.

Powdery mildew - *Oidium caricae*

Symptoms

- It attacks seedlings and matured trees.
- White powdery growth appears on leaves and fruits.
- Young infected leaves dry up prematurely and drop down.

Fungi:

Mycelium is hyaline and septate. Conidia are hyaline, single celled, barrel-shaped and are produced in chain.

Anthracnose - *Colletotrichum papayae* (*Colletotrichum gloeosporioides*)

Symptoms

- The spots on fruits are brown, circular slightly sunken and 1-3 cm in diameter and they coalesce later.
- Sparse mycelial growth appears on the margins of spots on fruits.
- Severely diseased fruits turned brown and rot.
- Infection on very young fruits results in mummification and deformation.
- It attacks leaves, petioles and stems also, where acervuli are seen in concentric rings.

Dry root rot - *Macrophomina phaseolina*

Symptoms

- Leaves exhibit yellowing, drooping and later drying.
- Basal portion of the stem and roots exhibit decay.
- Bark of the trees at the basal region splits into shreds and a large number of sclerotial bodies are seen on affected root tissues.

Fungus:

Mycelium is septate, brown and much branched. The sclerotia are black, spherical or irregular in shape.

Mosaic - *Papaya mosaic virus* / *Carica virus*

Vector: *Myzus persicae*, *Aphis malvae*, *A. medicaginis*, *A. gossypii* and *Macrosiphum sonchi*.
(Aphids).

Symptoms

- Typical mosaic symptoms showing chlorosis with dark green blisters are seen on leaves.
- Puckering and malformation of young leaves happen.
- Leaf lobes are thin and are increased in number and show **shoestring** symptoms.
- Old leaves get defoliated. New leaves formed after infection show yellow mosaic symptom.
- Fruits show circular, water soaked lesions with white spots in the centre.

Casual organism:

The virus is a flexuous rod.

Leaf curl - *Tobacco leaf curl virus*.

Vector: *Bemisia tabaci* (White fly)

Symptoms

- Leaves show severe curling, crinkling and distortion accompanied by vein clearing and reduction of leaf size.
- Inverted cups are formed due to inward and downward curling of leaves.
- Leaves become leathery and brittle and veins are thick and dark green.
- Petioles are twisted into zig-zag manner.
- Defoliation and stunting are common.
- Affected plants do not flower or bear few fruits in advanced stages.

Ringspot - Papaya ringspot virus

Vector: *Aphis gossypii* & *Myzus persicae*

Symptoms

- Vein clearing and puckering between secondary veins and veinlets
- Margins roll downwards and inwards
- Virus induces shoe-string symptom and stunting of plants
- Fruits are smaller, deeply lobed
- Diseased fruits contain 40 % lower sugar content and poor latex content

PINEAPPLE

Leaf and fruit rot - *Ceratocystis paradoxa*

Symptoms

- The spots are produced on leaves and fruits.
- The spots vary in size and are grey with dark margins.
- Later the infected tissues dry and the leaves are distorted.
- Diseased suckers rarely put forth roots and their leaves are small and chlorotic.

Root rot - *Phytophthora parasitica*

Symptom

- Yellowing of leaves which later turns to brown.
- Fruit development is arrested and entire plant wilts from the tip downward
- The fruits exhibit spongy texture.
- When the plant is pulled out, the roots appear dark and decayed.

Management

- Provide good drainage & proper sanitation.
- Cultural practices include crop rotation, planting in raised beds, soil solarisation
- Soil drenching with 1% Bordeaux mixture after removal of the affected plant.
- Spraying with 1% Bordeaux mixture (or) COC 0.25% .
- Soil application of neem cake and Trichoderma viride .

BASAL ROT

Pathogen : *Chalara paradoxa*

Symptoms : Seen on crowns, slips and suckers before or immediately after planting.

- A grey to black rot of the soft butt tissue develops, leaving stringy fibres and a cavity at the base of the stem.
- If affected material is planted, partial decay of the butt severely reduces plant growth.

Management

- Improve soil drainage.
- Destroy diseased plants.
- Avoid suckers from the infected areas for planting .
- Avoid planting during wet weather.
- Dip the fruits after harvest in thiabendazole 0.1%.

BER

1. POWDERY MILDEW

Pathogen : *Oidium erysiphoides f.sp.zizyphi*

Symptoms :

- The symptoms of the disease are noticed on flowers and newly set fruits.
- The developing young leaves shows a whitish powdery mass , which causes them to shrink and defoliate.
- White powdery spots appears at the surface of the fruits and later it covers the whole fruit surface.
- Affected fruits drop off prematurely or become cracked, misshapen and remain underdeveloped

Management

- Collect and destroy infected fallen leaves and fruits.
- Spraying of dinocap 0.05% or wettable sulphur 0.25% should be done during 1st and 3rd weeks of november or when the fruit attains pea size.
- Teepol or sandovit may be added for adhesion.
- Resistant varieties : Sonora 2, sonora 6, Chauhara

2. ANTHRACNOSE

Pathogen : *Colletotrichum gleosporoides*

Symptoms :

- Appearance of irregular, rough , corky reddish brown spots with yellow margins.
- The spots appears on the upper surface of the leaves and not restricted by veins.
- Initially these spots were isolated but at later stage they may coalesced to form large patches on the infected leaves.
- On fruits symptoms were small, circular , black coloured spots with depressed sporulating zone at the centre.

AONLA

RUST

Pathogen : *Ravenelia emblicae*.

Symptoms :

- Reddish brown , circular, 2-5 mm dia, uredopustules appears on both surfaces of the leaflets.
- On fruits, pustules are black at first , later they develop into rings.
- The pustules join together and cover a big area of the fruit.
- The black spores get exposed by rupturing a paper covering and the fruit gives a dirty appearance.

MANAGEMENT :

- Spray mancozeb or zineb 0.2% or wettable sulphur 0.3% or thiophanate methyl or propiconazole 0.1%.
- Resistant variety : NA-6

ANTHRACNOSE

Pathogen : *Colletotrichum gleosporoides*

Symptoms :

- Circular, brown to grey spots with yellow margin studded with dot-like fruiting bodies seen on the leaflets.
- On the fruits, lesions are depressed and dark at the centre.
- Acervulli arranged in rings are found on the fruit spots.
- The fruits become shriveled and rot.

MANAGEMENT

- Keep the orchard clean.
- Collect and destroy the affected fruits from the orchards.
- Spray carbendazim 0.1% before harvesting fruits.

SOOTY MOULD

Pathogen : *Capnodium spp*

Symptoms :

- Velvety covering of black fungal growth on the surface of leaves, twigs and flowers.
- Infection is restricted only to the surface and do not penetrate into leaves.

MANAGEMENT

- Avoid shade trees around orchards
- Proper pruning and training
- Use of protective fungicides like Mancozeb
- Spray starch 2% + methyl demeton 0.05% + wettable sulphur.

BLUE MOULD

Pathogen : *Penicillium citrinum*

Symptoms :

- It causes brown patches and water soaked areas on the fruit surface.
- As the disease progresses three different types of colours develop in succession i.e first bright yellow, purple brown and finally bluish green.
- Exudation of drops of yellow liquid on fruit surface.
- The entire fruit finally gives a bluish green postulated or beaded appearance.

MANAGEMENT

- Careful handling reduces damage to rind.
- Good hygiene and sorting reduces spore load and infection rates.
- Postharvest fungicides should be applied within 24 hrs of harvest.
- Lower storage temperatures slow down fungal development.
- Resistant varieties : Desi, Kanchan

Questions

1. Leaf distortion leads to shoe string symptom and stunting of plants ininfected papaya plant
 A) Carica Virus B) Papaya Leaf curl virus
 C) **Papaya Ring Spot Virus** D) Tobacco Leaf Curl Virus

2. In Papaya the internal tissues of the bark give a honey comb appearance indisease
 A) Root rot B) **Foot rot**
 C) Fruit rot D) Leaf rot
3. Rust disease of Aonla caused by
 A) ***Ravenelia emblicae*** B) *Uromyces emblicae*
 C) *Puccinia emblicae* D) *Pakospora emblicae*

LECTURE -6 APPLE, PEAR, PLUM, PEACH

APPLE

Scab - *Venturia inaequalis*

Symptoms

Leaves

- Large brown olivaceous spot on lower surface of leaves.
- Spots exhibit wavy margin.
- Later lesion appear on upper surface of leaves.
- Lesions become velvety with slight depression on upper surface. Lower surface is convex and finally leaves become curled and fall off.

Fruits

- Brown lesion which then turn black and corky with white halo.
- Cracks develop in the lesion and fruits shrinks.
- In cracks secondary saprophytic infection is seen. Market value and keeping quality gets reduced

Pathogen

- Mycelium is hyaline ,septate first later brown in host tissues
- It produces short conidiophore that give rise to 1-2 celled conidia that are oval and smoke brown
- Pseudothecia , Asci are formed
- Ascospores are two celled, ovoid, greenish grey or yellow with the upper cell shorter than the lower cell

MANAGEMENT

- Clean cultivation, collection and destruction of fallen leaves and pruned materials in winter to prevent the sexual cycle.
- Spray Tridemorph 0.1% before flowering.
- Spray Mancozeb 0.25% at bearing stage.
- Spray 5% urea prior to leaf fall in autumn and 2% before bud break to hasten the decomposition of leaves.
- Resistant varieties- Shreen, Firdous, Akbar, Freedom, Belmac, Redfree, Prima

Powdery mildew - *Podosphaera leucotricha*

Symptoms

- All parts of the tree are affected.
- Small white greyish patches of fungal growth appear on both the surfaces and the affected leaves are hard brittle, crinkled and curled.
- Powdery growth is also seen on the twigs and fruit buds.
- Affected fruits remain small or deformed, harden and develop crack.

Fungus:

The mycelium is ectophytic and produce conidiophore and conidia. Each conidiophore bears a chain of conidia. The conidia are hyaline, single celled and barrel-shaped. Sexual fruiting body is globose cleistothecium containing only one ascus. The ascus contains 8 ascospores.

MANAGEMENT

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

Fire blight - *Erwinia amylovora*

Symptoms

- It affects flowers, twigs, fruits, branches and trunk and it is characterized by sudden browning of leaves as if they had passed through hot flame and exudation from pores of bark.
- Diseased flowers become water soaked, shrivel rapidly, turn brownish to black and may fall or remain hanging in the tree.
- Droplets of bacterial ooze from infected inflorescence.
- Brown, black blotches are seen along the mid rib and main vein of leaves.
- The leaves curl and shrivel, hang downward and usually cling to the curled or blighted twigs.
- Terminal twigs wilt from the tip downward and the tip of the twig hooked and the leaves cling to the twig.
- Formation of cankerous lesions on the trunk which girdles the stem.
- Immature fruits are water soaked become brown, shrivels, mummifies and finally turn black.
- Dead fruits may also cling to the tree for several months.
- Under humid condition, droplets of milky coloured sticky ooze may appear on the surface of any recently infected part.

Bacterium:

Rod shaped, motile by peritrichous flagella.

Management

- Removal and destruction of affected parts.
- Removal of blighted twigs.
- Spray with Streptomycin 500ppm

Crown gall - *Agrobacterium tumefaciens*

Symptoms

- Small outgrowth appears on stem and roots.
- At young stage, the galls are soft, spherical, white or flesh coloured.
- The galls vary in size from 7-100 mm in dia.
- The galls are hard and corky on woody stems and are generally knobby and knotty and become more cleft as they grow older.
- The affected plants are stunted with chlorotic leaves.

Bacterium:

Gram-negative, rod shaped. Survives in soil.

Mosaic - *Apple mosaic virus*

Symptoms

- Leaves exhibit irregular creamy white or yellow spots, which may coalesce.
- Presence of yellow band along larger veins on both the sides is common.
- Affected leaves show withering.

PEAR

Scab - *Venturia pirina*

Symptom:

- Olive green circular spots appear which later become grey and necrotic.
- Spots on fruits are black and the affected fruits are deformed and small in size
- Fruits develop cracks and become corky

Fungus:

Fungus produces perithecia. Paraphyses absent. Ascospores are unequally two celled, ovoid and olive. Fungus overwinters in fallen leaves and infected twigs.

Management:

- Clean cultivation, collection and destruction of fallen leaves and pruned materials in winter to prevent the sexual cycle.
- Spray Tridemorph 0.1% before flowering.
- Spray Mancozeb 0.25% at bearing stage.
- Spray 5% urea prior to leaf fall in autumn and 2% before bud break to hasten the decomposition of leaves.
- Resistant varieties- Shreen, Firdous, Akbar, Freedom, Belmac, Redfree, Prima

PLUM

Leaf curl: *Taphrina deformans*

(Symptoms and management measures are as in peach leaf curl)

Pocket plum or Bladder plum gall : *Taphrina pruni*

Symptoms:

Gall appears on the developing fruit form elongated, flattened, hollow, stone less the surface of the gall becomes corrugate & coated with the fungus, showing as a white bloom of ascospore. The fruits become inedible, shrivel and in most cases fall prematurely.

Management:

- Remove infected branches, twigs & fruits to avoid the propagation of the disease (burn or bury them) Control of *T. pruni* is achieved by treatment with an organic copper based fungicide during the main flowering period.

PEACH

Leaf curl - *Taphrina deformans*

Symptoms:

- The disease first appears in the early spring when the leaves begin to unfold.
- Leaf blade thickens and puckers along the midrib and curls and veins do not develop properly.
- Then the leaf tissues gradually change to yellow and finally to a reddish purple tint and the reddish velvety surface of the lamina is soon covered with a whitish grey bloom of the fungus on the upper surface.
- Both the leaves and petioles may curl and the affected leaves die and drop prematurely.
- Twigs become pale green to yellow, swollen, stunted and exude gummy material.
- Fruit set is poor. Affected flowers and fruits drop prematurely.

Fungus:

Mycelium is intercellular and it does not produce ascocarp. Asci are naked and are individually. Each ascus bears eight uninucleate ascospores, which are globose.

Management:

Removal and burning of infected twigs

Spraying of Bordeaux mixture 1.0 % or chlorothalonil 0.2%, COC 0.25%

Rust - *Puccinia pruni-spinosae* (Syn. *Tranzschelia pruni-spinosae*)

Symptoms

- Pale yellow spots appear on both on both the leaf surfaces.
- On the under surface brown rusty pustules are seen.
- When the leaves are severely infected defoliation occurs.

Management

Spraying of Mancozeb 0.2 % or sulphur dusting or Carbendazim 0.1%

Powdery mildew - *Sphaerotheca pannosa* var. *persicae*

Symptoms

- The young leaves are coated on the upper surface with a thick layer of mycelium.
- Terminal portion of the growing shoot may get covered with a white powdery layer.
- White, round spots develop on fruits and turn them to pink to dark brown.

Fungus:

The fungus is similar to *Erysiphe* but *Sphaerotheca* has only one ascus in each cleistothecium. Cleistothecia are dark brown, globose with myceloid appendages.

Management

Spraying of Mancozeb 0.2 % or sulphur dusting or Carbendazim 0.1%

Questions

1. Boat shaped bicelled ascospores which is unequal in size is produced by
A) *Podosphaera leucotricha* B) *Penicillium expansum*
C) ***Venturia inaequalis*** D) *Glomerella cingulata*
2. Terminal twigs of apple wilt from tip to downward and forming a very typical "shepherd's crook" symptom in
A) **Fire Blight** B) Scab
C) Powdery Mildew D) Soft Rot
3. Naked asci are produced individually and Ascospores undergo budding division before released from Ascus in
A) *Erwinia amylovora* B) *Glomerella cingulata*
C) ***Taphrina deformans*** D) *Sphaerotheca pannosa*
4. ***Glomerella cingulata* causesdisease in Apple**
A) **Bitter Rot** B) Soft Rot
C) Scab D) Blight
5. Bladder plum gall is caused by
A) *Taphrina deformans* B) ***Taphrina pruni***
C) *Glomerella cingulata* D) *Sphaerotheca pannosa*

LECTURE 7 POST HARVEST DISEASES OF APPLE, MANGO, BANANA, CITRUS, GRAPES, PAPAYA

APPLE

1. Soft Rot Or Blue Mould: *Penicillium expansum*

- Rotted area is light in colour with soft and watery texture. Rotten areas are not sunken.
- Grey-blue cushions of fruiting bodies are seen on the diseased skin.

2. Bitter Rot: *Glomerella cingulata*

- Faint, light brown discolouration appears beneath the skin.

- Discolouration extends in a cone shaped manner.
- Rough, circular lesion becomes depressed.
- Tiny, raised black dots appear beneath the cuticle and they give rise to acervuli which break through the cuticle.
- Entire fruit rots. Rotten fruits mummify and drop.

3. Grey Mould: *Botrytis cinerea*

- Translucent watery light brown to dark brown spots seen on fruits.

4. Phytophthora Rot: *Phytophthora cactorum*

- Irregularly outlined rotten surface is seen on fruits. Flesh turns pale to brown.
- Affected portion becomes spongy and water soaked.

MANAGEMENT

- Provide orchard sanitation.
- Follow precautionary measures while picking, grading and packing.
- Discard injured fruits. Adopt proper cold storage 0°C – 1.6°C.
- Wrap the fruits in wrapper treated with double boiled linseed oil.
- Follow post-harvest dipping in 500 ppm Aureofungin for 20 mins.

Post Harvest Diseases :: Mango

1. Anthracnos – *Colletotrichum gloeosporioides*
2. Stem end rot - *Lasiodiplodia theobromae*
3. Diplodia stem end rot - *Diplodia natalensis*
4. Black mould rot - *Aspergillus niger*
5. Brown spot - *Pestalotia mangiferae*
6. Black spot rot - *Phomopsis mangiferae*
7. Bacterial rot - *Pseudomonas mangiferae-indicae*

1. Anthracnose – *Colletotrichum gloeosporioides*

Symptoms:

- Infection occurs – leaves, stems, young flowers and fruit
- Sunken black spots appear on the surface of the fruit during ripening.
- Infection – fruit is usually latent and manifests itself only as the mango begins to ripen
- The disease is most severe – wet weather.

Mode of spread and survival:

- Inoculum remains on dried leaves, defoliated branches, mummified flowers and flower brackets.
- Spread through air-borne conidia
- The fungus can enter the pores of green fruits.
- The latent infection of mature fruits may take place through lenticles.
- The fungus apparently infects the fruits - green and develops in flesh during ripening.
- The latent infection is carried from the field to storage.

Epidemiology:

The optimum temperature - 25°C and relative humidity from 95 to 97 per cent.

Management

Pre-harvest control

Spray with mancozeb (800 g/kg at 2 g/L) weekly during flowering and then monthly until harvest. Stop spraying 14 days before harvest. During dry weather, flower sprays may be reduced to fortnightly intervals. Should rain occur during flowering, apply prochloraz (462 g/kg) (Octave, registered trade mark), using 1 g product/L in a tank mix with mancozeb. Prochloraz only needs to be applied every 3-4 weeks. Copper oxychloride sprays (4 g/L) used for bacterial black spot control also control anthracnose, however copper oxychloride should not be used during flowering. Where bacterial black spot is serious, copper oxychloride can be substituted for mancozeb sprays after flowering.

Postharvest control

Hot carbendazim

Hot carbendazim (registered trade mark Spin Flo, manufactured by Aventis) is registered for postharvest treatment of mango in Queensland, Northern Territory, Western Australia and New South Wales. Spin Flo is a liquid formulation containing the active ingredient carbendazim.

Dip fruit within 24 hours of harvest by totally submerging them for 5 minutes in **hot water (52°C)** to which has been added 100 mL product /100 L water. Lowering the temperature of the dip below 52°C will reduce the effectiveness of the treatment.

Temperature must be carefully controlled to within 0.5° to prevent fruit damage. Use an accurate thermometer to monitor temperatures in various parts of the dip during use, especially near the heat source. Many growers use specially designed tanks heated by gas or electricity with manual or thermostatic temperature control. With an approximate ratio of 3 litres of dip to 1 kg of fruit, no appreciable temperature drop occurs when fruit is added to the tank. This dip also partially controls stem end rot.

Notes on dipping

- Vigorous agitation before and during dipping by means of a powerful recirculating pump is recommended to keep the fungicide suspended. This is preferable to stirring or paddling. Agitation also helps distribute heat from the heating element.
- Bleed sap from fruit before dipping. Mango sap affects the stability of the fungicide suspension.
- Replace the dip once it becomes contaminated by sap and dirt or after 3 days continuous use or after 4000 trays have been treated. Prewashing fruit helps to prolong dip life.
- Dipping temperatures should not exceed 52° as this may result in skin damage. Allow fruit to cool before brushing. During wet weather, reduce the dipping temperature to 50° as susceptibility to skin damage increases. Disease control will be reduced at these lower temperatures.

Unheated prochloraz

- Unheated prochloraz (Sportak, registered trade mark) spray to control anthracnose can be used as an alternative to dipping in hot carbendazim (Spin Flo).
- Prochloraz is not effective against stem end rot.
- Apply prochloraz 45% at 55 mL/100 L of water at ambient temperature. Prochloraz has been approved for use only as a non-recirculated spray over fruit. Complete coverage of the fruit is essential for effective control.
- Fenthion may be mixed with prochloraz for fruit fly treatment for Victoria, provided fruit remain wet for one minute.
- Postharvest treatments will not provide complete disease control.

1. Stem End Rot: *Lasiodiplodia theobromae*

Symptoms

- In fruits, the pericarp darkens near the base of the pedicel.
- The affected area enlarges to form a circular, black patch which under humid atmosphere extends rapidly and turns the whole fruit completely black within two or three days.
- The pulp becomes brown and softer.

Management

Postharvest control

- Avoid harvesting immature fruit. Postharvest treatment with hot water and carbendazim (Spin Flo) is partially effective against stem end rot.
- For control of stem end rot during controlled atmosphere storage, a dual treatment of hot carbendazim (Spin Flo) followed by prochloraz is necessary.
- Fruit from orchards with a history of stem end rot losses should be rejected for long term storage. The severity of stem end rot can be assessed as follows.
- Harvest 100 mature fruit at random from throughout the orchard.
- Leave them untreated and store at 25° until they are fully ripe. Ideally, less than one-tenth and certainly no more than one-third of the fruit should develop symptoms of stem end rot by the time they are fully ripe.

3. Diplodia stem –end rot: *Diplodia natalensis*

Symptom:

- Epicarp darkens around the base - pedicel.
- Circular, black patch which under humid atmosphere.
- Soft rot –aid of pectinolytic & cellulolytic enzymes.
- More portions of fruit turns black and soften.
- Lose ascorbic acid & non- reducing sugars rapidly

Mode of spread and survival:

- The fungus persists in infected plant parts which serve as source of inoculum

Epidemiology:

- RH – 80%, max.& min.temp. of 31.5 and 25.90C.

2. Black mould rot: *Aspergillus niger*

Symptom

- Yellowing of base – development of irregular, hazy, greyish spots.
- Mesocarp of the rotted area becomes depressed – soft.
- The fruit surface – covered – blackish fungal growth.
- Decrease in ascorbic acid.

5. Brown spot: *Pestalotia mangiferae*

Symptoms:

- The affected area of fruits becomes olivaceous-black and shrinks.
- Black dots appear at the centre of the spots represent the acervuli.
- On matured green fruits, small brown spots appear with greyish white centre which later turn to bigger lesions with large number of acervuli seen as black dots.

Epidemiology:

- Temp. between 20 and 25°C.
- Mycelial growth with sporulation takes place at pH 5.5 to 6.0.
- Wounding leads to more disease incidence.

Black soft rot: *Phomopsis mangiferae*

Symptom:

- Discrete and discoloured areas all over.
- Turn dark brown – black at maturity.
- Black fruit in bunches appear on the spots.

Spread

- Soil-borne

Conidia transmitted by wind & rain water.

8. Bacterial rot : *Pseudomonas mangiferae-indicae*

Symptom:

- Water-soaked lesions develop – turn dark brown to black.
- The spots become black as the disease advances, which are usually haloes.
- In severe cases these spots form in groups and become necrotic.
- Cracks in the skin – badly affected ones drop prematurely.

Mode of spread & survival:

- Bacterium enters the leaf through stomata and lenticels in fruit.
- When fruits are found in bunches disease spreads when they contact each other.

Management of other post-harvest diseases

A few other fungi (*Aspergillus niger*, *Mucor* spp. etc) occasionally cause losses in fruit during storage. They cause rots on the sides or at the stem end of fruit. Rough harvesting and handling can encourage these diseases. Hot carbendazim (Spin Flo) used for anthracnose control, careful handling and observance of hygiene measures will help control these problems.

Export requirements

Choose fruit from orchards with low disease levels. Fruit from orchards with a history of stem end rot or other diseases should not be exported.

Where carbendazim and prochloraz are not acceptable to the importing country, export is not recommended unless fruit are treated with a combination of hot water and vapour heat. Vapour heat treatment was developed for export markets which require quarantine security against fruit fly but do not accept chemical disinfestation treatments such as ethylene dibromide. Vapour heat treatment will control anthracnose during short term storage, but will not give adequate control of stem end rot. Dipping fruit in hot water at 48-52°C for 5 minutes, 24 hours prior to vapour heat treatment will improve stem end rot control.

Sanitation of packing equipment

Sanitisers should be used after equipment has been cleaned. Steam cleaners or high-pressure hot water applicators are very effective. Otherwise, use a hose and household detergent. If possible, use chlorinated town water.

Spray packing equipment with a sanitising agent such as:

(a) Chlorine solution

Use a solution containing 200 ppm (0.02%) available chlorine.

Notes

1. Sodium hypochlorite (liquid)

- Most preparations contain from 5% to 12.5% available chlorine.
- For a 5% commercial solution, add 4 mL/L.
- For a 12.5% commercial solution add 1.6 mL/L.

2. Calcium hypochlorite (powder)

- Contains approximately 30% active chlorine
- First make a stock solution by adding 330 g of powder/L, then store in a cool, dark place.
- Add 2 mL stock solution/L

3. Monitoring the chlorine level

- Add 5 mL of wash solution to one litre of water, which should give a solution of 1 ppm available chlorine.
- Use a swimming pool test kit to check the concentration.

Banana

Anthracnose: *Colletotrichum musae*

Symptoms

- Small, black, circular specks on the skin- sunken & coalesce to form large spots.
- Bright salmon-coloured conidial mass appears on the spots.
- Severely infected fruits become dark due to blemishes.
- Acervuli also develop on the skin and the pulp becomes partially soft.
- Non-latent infection usually starts during or after the harvest of bunches in small peel wounds and it continues to develop without a dormant period.

- Many latent infections at the time of harvest show large number of appressoria on the surface of the peel.
- The spread of the disease is by air-borne conidia and numerous insects which frequently visit banana flowers also spread the disease.
- Temp.30 to 35°C and RH- 85.7 -100 %

Management

- Post harvest dipping of fruits in Carbendazim 400 ppm, or Benomyl 1000 ppm, or Aureofunginsol 100 ppm.

Cigar-end rot: *Verticillium theobromae*

Symptoms

- Tip of immature fruit and spreads upward.
- Ashy conidia and conidiophores cover the rotted portion.
- Imparting burnt ashy cigar-end appearance with a dark border.
- Decay may extend up to one-third of the fruit but internal tissues develop a dry rot.
- Conidia are hyaline, oblong to cylindrical, borne at the ends of tapering phialides, aggregated into rounded, mucilaginous translucent heads.
- The fungus – plant debris – microsclerotia.
- Infected plant parts – irrigation water – implements.

Management

- The principal method of control is frequent manual removal and burning of dead flower parts and infected fruits.
- Use of fungicide to control the disease is also recommended.
- In the packhouse, care should be taken to cull infected fruits to avoid contaminating the washing water with spores.
- Cigar-end rot is effectively controlled by covering the flower (immediately after emergence) with a polyethylene bag before the hands emerge.

Crown rot: *Fusarium roseum*, *Lasidiplodia theobromae*, *Deightonialla torulosa*

Symptoms

- Darkening of the hand and the adjacent peduncle. The discoloured area covers almost one fourth of the fruit if the conditions are favourable. Loss of ability of hand to support fruit.
- The conidia are usually 3 to 5 septate. The conidia are spread by air.
- Occurrence of black tip – fruit piercing moth. Infection – direct penetration – fungus. Temp.23.90 oC
- Wind blown bunches – develop severe spotting on the fingers- rainy weather.

Management

- Control of crown rot starts in the field with the regular removal of leaf trash.
- Proper field sanitation can greatly reduce the number of crown rot fungi spores present.
- Do not keep rotting fruits or plant waste materials near the packing station.

- Maintain clean washing water in the delatexing baths and change the water frequently to stop it becoming heavily contaminated with spores.
- Dehanding should be done carefully with a sharp knife so as to avoid leaving a ragged cut. Finally, post-harvest treatment of fruits with an effective fungicide is essential.

CITRUS

Anthracnose: *Colletotrichium gloeosporioides*.

Symptoms

- Superficial leathery appearance
- Silver/grey to dark lesions.
- Tear-staining pattern common.
- Pink tinge (spores) under humid conditions.

Occurrence

- Infection occurs by rain-splash during autumn.
- Ethylene degreening increases sensitivity to anthracnose.

Management

- Dead wood should be pruned as the fungus harbours in dead branches.
- Field sprays of copper-based fungicides should be applied prior to autumn rains.
- Postharvest treatment with Benzimidazole fungicides may reduce fruit losses.

Septoria spot: *Septoria depressa*.

Symptoms

- Dark brown collapsed lesions, with a purple tinge.
- Black specks develop in decayed area.

Occurrence

Mainly inland citrus regions.

- Infection occurs in autumn but remains dormant until cool conditions.
- Fruit more susceptible after frosts.

Management

- Field application of copper-based fungicides.

Blue & Green Mould: *Penicillium digitatum* (green mould) and *P. italicum* (blue mould).

Symptoms

- Softening of damaged tissue.
- White fungal growth, which progressively turns blue or green as spores develop.
- Postharvest fungicides (Imazalil) can arrest spore development resulting in white only fungal growth.

Occurrence

- Infections develop from damaged areas.
- The growth of mould increases with storage temperatures (up to an optimum of 27 °C).
- Late season fruit more susceptible.
- Damaged rind is more susceptible.

Management

- Careful handling reduces damage to rind.
- Good hygiene and sorting reduces spore load and infection rates.
- Sanitation destroys spores in recirculating water and packingline equipment.
- Postharvest fungicides should be applied within 24h of harvest.
- Lower storage temperatures slow down fungal development.

Sour Rot: *Galactomyces citri-aurantii* (formally, *Geotrichum candidum*).

Symptoms

- Very soft, watery decay.
- Distinct margin between decayed and healthy tissue.
- Sour odour detectable.

Occurrence

- Infection occurs in damaged fruit.
- Fungicide used to control blue & green moulds may not control Sour rot. (eg., USA accepted fungicides).
- Sour rot spores in soil can accumulate in recirculating water in dips and drenches.
- Spreads by contact after packing creating nests of infected fruit in boxes.

Management

- Careful handling reduces rind damage.
- Apply Guazatine fungicide within 24hrs of harvest.
- Strong emphasis of sanitisers when Guazatine fungicide not approved for use.

GRAPES

1. Anthracnose/ Bird eye spot: *Elsinoe ampelina*
2. Botrytis Bunch Rot or Gray Mold of Grape: *Botrytis cinerea*
3. Blue mould rot: *Penicillium digitatum*
4. Stalk end rot: *Aspergillus niger*
5. Rhizopus rot : *Rhizopus nigricans*

Anthraco nose/ Bird eye spot: *Elsinoe ampelina*

- On berries, small, reddish circular spots initially develop.
- The centers of the spots turn whitish grey and are surrounded by narrow reddish-brown to black margins.
- Acervuli (fungal fruiting structures) eventually develop in the lesions.
- A pinkish mass of fungal spores (conidia) exudes from these structures during prolonged wet weather condition.
- Wetness for 24 hours or more and the temperature is above 36°F.
- splashing rain are spread the disease

Management:

- The diseased leaves and twigs should be pruned and burnt.
- Spraying -Ferrous sulphate 2.5 kg + 0.5 pint sulphuric acid in 4.5 l of water.
- Spraying -BM 1.0 % or Copper oxychloride 0.25% or Carbendazim 0.1% or Mancozeb 0.2% or Difolatan 0.2% or Chlorothalonil 0.2% or Bitertanol 0.1%.
- Resistant varieties – Bangalore Blue, Beauty Seedless, Bharat Early, Golden queen, Large white.

Botrytis Bunch Rot or Gray Mold of Grape: *Botrytis cinerea*

- Infected berries first appear soft and watery.
- Infected berries of white cultivars become brown and shriveled,
- Purple cultivars develop a reddish color
- Healthy berries touching infected berries will become infected.
- Rotted berries generally shrivel and drop to the ground as hard mummies

Management

- Preharvest infection can be controlled by three application of captan 0.2 % at monthly intervals before rainfall.

3. Blue mould rot: *Penicillium digitatum*

- Scanty growth - white and turn bluish green are seen.
- Decay the berries
- Infected tissues become soft and watery
- Infected berries emits a mouldy flavour

Management

- Avoiding injuries to the ripe berries helps to reduce soft rot.
- Clean planting stock; (ii) Disease wood removal and immediate burning; (iii) fungicide application at shoot extension and later if temperatures are cool. Sulphur is said to reduce new infections in the early Spring

3. Stalk end rot: *Aspergillus niger*

- Brown rot at stalk end is start point of attack the pathogen.
- Rotting begins as a small, circular to oval, water soaked spots are brown in colour.

- Infected berries are soft and emit bad odour

5. Rhizopus rot : *Rhizopus nigricans*

- Round irregular, light brown and water soaked lesion appear on fruits.
- Decaying fruits emits fermented, mouldy smell.
- Conidia aseptate, small and globose

Management:

Diphenyl sprayed on cushions is effective at 1 g and 2 g per pack in protecting the fruits upto 15 days in storage as protectant and eradicant.

Questions

- 1.. Post harvest diseases of vegetables can be controlled by
 - A) **Low Temperature**
 - B) High humidity
 - C) High moisture
 - D) High Sugar content
2. List out the post harvest disease of apple
3. Explain the physical methods for post harvest disease management

LECTURE -8 BRINJAL AND BHENDHI

Damping off - *Pythium aphanidermatum*

Symptoms

Seedling infection is seen as brown discolouration at the lower portion of the stem where the tissues later become soft. Such diseased seedlings collapse at soil level.

Fungus:

Mycelium is coenocytic and hyaline. Zoospores are lobed. Zoospores are reniform in shape and biflagellate. Oospores are spherical, aplerotic, single, smooth and thick walled.

Fusarium wilt - Fusarium solani

Symptoms It attacks seedlings as well as matured plants. Leaves become flaccid and hang down. Leaves turn chlorotic. If the bark of the stem is peeled, brown streaks can be seen. Roots exhibit rotting. Whitish fungal growth is seen on base of stem and roots.

Fungus:

Mycelium is septate and hyaline. It produces microconidia, macroconidia and chlamydospores. Microconidia are hyaline, wedge shaped, 2-celled and are formed in chain. Macroconidia are falcate and septate. Chlamydospores are globose, intercalary or terminal.

Bacterial wilt - *Pseudomonas solanacearum*

Symptoms

- Bacterial wilt disease causes severe problem in brinjal cultivation. The characteristic symptoms of the disease are wilting of the foliage followed by collapse of the entire plant.

- The wilting is characterized by gradual, sometimes sudden, yellowing, withering and drying of the entire plant or some of its branches.

Phomopsis blight and fruit rot - Phomopsis vexans

Symptoms

- The pathogen infects the crop from seedling to harvest.
- In the seed bed, it causes damping off.
- The leaves coming in contact with soil is affected.
- Circular or irregular, grey to brown spots with light coloured centre appear on leaves and the affected leaves turn yellow and die.
- The stem base is affected, girdled and the plant topples down.
- The fruit is attacked while in the plant.
- Pale sunken spots appear on fruits and later it covers the entire fruit.
- The internal portion of fruits rots and the whole fruit is mummified.

Fungus:

Mycelium is septate. Pycnidia developed on the spots produce two types of conidia. viz., Alfa conidia and beta conidia. Alfa conidia are hyaline, one-celled and fusoid. Beta conidia (stylospores) are filiform, hyaline and one-celled. Perithecia are in clusters containing clavate, sessile, 8-spored asci. Ascospores are bluntly fusoid and 2-celled.

Little leaf - Phytoplasma

Symptoms

- The infected plants exhibit general chlorosis and reduction in plant height.
- Leaf size is abnormally reduced.
- Axillary buds are induced to grow with small narrow and thin leaves.
- Internode length is reduced leading to clustering and overcrowding of leaves.
- Flowers are phylloid and fruits are rare.

Transmission: Leaf hopper, *Hishimonas phycitis*

Mosaic - Potato Virus Y

Symptoms

- Mosaic mottling of the leaves
- Stunting of plants.
- The leaves of infected plants are deformed, small and leathery.
- Plants show a stunted growth when infected in the early stages.

Transmission: Aphids (*Aphis gossypi* and *Myzus persicae*)

BHENDI

Powdery mildew - *Erysiphe cichoracearum*

Symptoms

- White or greyish white patches appear on the upper surface of leaf.
- Later it covers the entire leaf surface.

- The fungal growth changes brown and the affected leaves dry and fall.

Fungus:

Mycelium is ectophytic and haustoria are button-shaped. Conidia are hyaline, barrel-shaped, single celled and are produced in chain. Cleistothecia are globose and dark. Each ascus has two ascospores, which are hyaline, unicellular and oval.

Yellow vein mosaic / Vein clearing - Bhendi yellow vein mosaic virus (BYVMV)

Symptoms

- The green colour of main and lateral veins is bleached and the veins and veinlets exhibit yellow net work.
- Veins are thickened.
- The interveinal portions first exhibit small portions of green colour.
- As the disease develops, these green portions turn chlorotic and finally the leaves become yellow, papery and wither.
- The affected plant is severely stunted.
- The leaf size is reduced. Fruits are smaller, malformed, thick, fibrous and yellow.

Transmission: *Bemisia tabaci* (Whitefly).

Questions

1. Little leaf of Brinjal is transmitted by
 A) *Hishimonas phycitis* B) Grafting
 C) *Aphis gossypii* D) **Both A & B**
2. Bhendi Yellow vein mosaic virus is made up of
 A) **DNA** B) ss RNA
 C) ds RNA D) Both A and B

LECTURE -9 TOMATO

Damping off - *Pythium aphanidermatum*

Symptoms:

- The disease may attack the seedlings before the emergence of seedlings from the soil or after the emergence of seedlings.
- The affected seedlings become pale and suddenly collapse.
- The basal cortical region begins to rot resulting in toppling of the seedlings.
- Dark brown lesions also appear on stem and the affected tissues soon become rotten.

Fungi:

Pythium aphanidermatum, *Pythium myriotylum*, *Rhizoctonia solani* and *Phytophthora nicotianae* var. *parasitica*.

Early blight - *Alternaria solani*

Symptoms

- In the affected leaves circular to angular, dark brown to black spots with concentric rings appear.
- The spots coalesce and cause drying and defoliation of leaves.
- Dark spots are found at the base of the stem near the ground level and the stem is gradually girdled.
- Spots are also found in the stem at the juncture of the side branches which are easily broken by wind.
- On the fruit, dark brown sunken spots are found. Immature fruits are shed.

Fungus:

Mycelium is septate, branched, light brown which become darker with age. Conidiophores are dark coloured. Conidia are muriform, beaked, dark coloured and borne singly. In each conidium 5 to 10 transverse and a few longitudinal septa are present.

MANAGEMENT

Spray chlorothalonil (2g/l) or mancozeb(2g/l) or propineb(2g/l) or copper hydroxide (2g/l) at fortnight intervals

Fusarium wilt - Fusarium oxysporum f.sp. lycopersici

Symptoms

- Affected plants exhibit yellowing and drooping of lower leaves followed by such symptoms in young leaves.
- Plants wilt and die in due course. Internal stem portion exhibits vascular browning.

Fungus:

Mycelium is septate. The fungus produces microconidia, macroconidia and chlamydospores. Microconidia are hyaline, oval, single celled or one septate. Macroconidia are sickle-shaped, 3-5 celled and hyaline. Chlamydospores are thick walled, round resting spores, produced terminally or intercalarily on older mycelium.

MANAGEMENT

- Follow deep summer ploughing
- Follow crop rotation with non solanaceous crops
- Remove or destroy debris after harvest
- Seed treatment with *Pseudomonas fluorescens* Pf1@ 10 g/kg of seed, followed by nursery application of Pf1@ 20 g/m².
- Seedling dip with Pf1 @ 5g/ l along with soil application of Pf1 @ 2.5 kg mixed with 50 kg FYM /ha at 30 days after transplanting
- Spot drench with Carbendazim @ 1g/lit for wilt affected plants, 2g/l Mancozeb-carbendazim 2g/l.
- Drenching with 1% Bordeaux mixture or Copper oxy chloride @ 2.5 g/lit.

Late blight - *Phytophthora infestans*

Symptoms

- Infection occurs on all the above ground plant parts. W

- Later –soaked lesions with faded green patches appear on the leaves.
- Infections spread fast to entire leaf and petiole. Dead areas appear in leaf tip and margins.
- Whitish mildew like growth appear on leaves under humid conditions. The leaves are blighted and become dry.
- Dark olivaceous greasy spots occur on the fruits. Fruit cracking and appearance of white fungal growth on it may be seen resulting in soft rot. In severe cases of attack the whole plant dies.

Fungus:

The fungus produces coenocytic, hyaline and branched mycelium. Haustoria are club-shaped. Zoosporangia are thin walled, hyaline, oval or pear-shaped with a distinct papilla at the apex. Zoospores are biflagellate. Oospores are spherical.

MANAGEMENT

Spray mancozeb or zineb or metalaxyl or metalaxyl+mancozeb 0.2% or bordeaux mixture 1% as a prophylactic measure

Buck eye rot / Fruit rot - *Phytophthora nicotianae* var. *parasitica*

Symptoms

- Brown, circular spots with concentric rings are seen on immature fruit at the blossom end.
- The fruits remain firm unless secondary organisms attack them. But affected fruits shrink and get mummified.
- The old fruits rot and drop.

Fungus:

Mycelium is hyaline and coenocytic. Sporangia are ovoid, papillate and deciduous. Oospores are aplerotic and thick walled. Chlamydospores are abundant at later stage, thick walled and yellowish brown.

Bacterial wilt - *Ralstonia solanacearum*

Symptoms

- Stunting, yellowing and wilting of foliage leading to collapse of the entire plant.
- Lower leaves droop before wilting. Cross section of the stem near the base will show vascular browning.
- When the affected stem is cut bacterial ooze can be seen.
- Adventitious roots from the stem are noticed. The affected plants collapse and die.

Bacterium:

It is Gram negative and rod-shaped bacterium occurs in pairs with 1-4 polar flagella.

MANAGEMENT

- Crop rotation with cereal crops or cruciferous vegetables avoiding solanaceous crops.
- Avoid water stagnation in the field
- Incorporate bleaching powder in soil at 15 kg/ha before transplanting
- Seedling roots in streptomycin 25 ppm (2.5g/100 lit of water) for 30minutes
- Drench soil with Bordeaux mixture 1%
- Foliar application/root drenching with Copper hydroxide (2g/l)

Bacterial canker - *Xanthomonas vesicatoria* (Syn. *Xanthomonas campestris* pv. *vesicatoria*)

Symptoms

- On the leaves, the symptom is seen as small translucent water-soaked spots in the beginning but soon enlarge into black greasy or dark-brown spots surrounded by yellow halo.
- Several spots cause chlorosis in the leaves and defoliation.
- Black cankerous spots appear on stem and petiole.
- Water-soaked lesions are observed on unripe green fruits.
- They become corky resembling small scabs with irregular margins.

Bacterium

It is a Gram negative, rod-shaped bacterium with single polar flagellum. Colonies are circular with bright yellowing colour.

MANAGEMENT:

- Follow crop rotation and summer ploughing
- Follow soil solarization in nursery bed to avoid seedling infection
- Collect seed from disease – free plants
- Dip the seeds in streptocycline 100 ppm or treat seeds in **hot water at 50°C for 25 minutes**.
- Spray bordeaux mixture 1% or streptomycin sulphate 250 ppm (0.025 g/lit) + Copper oxychloride 0.25%.

Mosaic - *Tomato mosaic virus*

Symptoms

- Typical mosaic pattern with dark green and light green areas on leaves.
- Leaflets are usually distorted, puckered and are small. At times leaflets exhibit, **Fern leaf** symptoms.
- Necrotic sunken lesions occur on fruits. Infection on matured fruits shows internal necrosis.

Leaf curl - *Tobacco leaf curl virus*

Vector: *Bemisia tabaci* (Whitefly)

Symptoms

- Typical downward curling and crinkling of leaves are seen.
- The size of the leaf is much reduced.
- Newly emerging leaves exhibit slight yellow colouration followed by curling symptoms.
- Older leaves become leathery and brittle.
- Small leaf-like growth called **enation** is observed on the midrib on the lower side of leaf.
- Mottling and vein-clearing symptoms are also seen.
- Diseased plants are stunted due to reduction in internodal length and become partially or completely sterile.

Tomato spotted wilt / Bronzy wilt - *Tomato spotted wilt virus* (TSWV)

Symptoms

- Leaves become reduced in size and exhibit thickened, bronzy veins.

- Crop rotation
- Grow resistant varieties.
- Maintain PH at 6.5-7.
- Treat the seeds with carbendazim 2g/kg.
- Provide proper drainage in the field .
- Spot drench with carbendazim 0.1 %.

Anthrachnose - *Colletotrichum lagenarium*

Symptoms

- All the above ground plant parts are attacked. Drying and death of young seedlings occur.
- In older plants spots on leaves are yellowish brown. Angular to roughly circular with a yellow halo.
- In severe cases, diseased and necrotic portion falls off leading to “shot hole”.
- Number of spots coalesces and leaves dry up subsequently. Stem infection results in the formation of shallow water soaked, brown coloured, sunken lesions, which later girdle the stem and cause death of shoots.
- Young fruits shrivel with dark colour. On matured fruits circular, black, sunken lesions of varying size appear.
- When moisture is present the centre of the spot shows gelatinous mass of pink coloured conidia.
- In the older lesions black acervuli arranged in concentric rings are seen.
- Affected fruits ripen and become yellow and the flesh becomes tough and insipid.
- Secondary microorganisms enter through the wounds in the lesions and cause rotting of fruits.

Fungus:

Black acervuli contain conidia, which are oblong, single celled and hyaline.

MANAGEMENT:

- Collect the seeds from disease free plants .
- Do not raise new crop near older crop of cucurbits.
- Maintain proper drainage in the field.
- Treat the seeds with **carbendazim 2g/kg**.
- Spray mancozeb or chlorothalonil 0.2%.

Downy mildew - *Pseudoperonospora cubensis*

Symptoms

- Irregular white patches of downy growth are seen on the surface of leaves.
- The corresponding upper surface shows yellow patches.
- These spots become angular and bounded by leaf veins.
- Entire leaf dries quickly.
- Young leaves are less susceptible than the older leaves. Fruits are dwarf, few and with poor taste.

Fungus:

It is an obligate parasite. The mycelium is coenocytic, intercellular and is with ovate haustoria. Sporangioophores arise in groups through stomata, dichotomously branched and bear sporangia. The sporangia are greyish, ovoid, thin walled provided with papilla at the distal ends. Oospores are not common.

MANAGEMENT:

- Grow resistant varieties .
- Maintain wider spacing , proper drainage .
- Destroy weed host .

- Spray mancozeb 0.2% \ Metalaxyl + mancozeb or chlorothaliniil 0.2%.
- Avoid copper fungicides which are phytotoxic to cucurbits .

Powdery mildew - *Erysiphe cichoracearum*

Symptoms

- White or dirty grey powdery growth is seen superficially on the upper surface of leaves in patches.
- Later they cover the entire leaf surface.
- The leaves turn brown and dry.
- Premature defoliation and death of vines occur. Fruits are undersized, deformed and the quality is also reduced.

Fungus:

Mycelium is hyaline, septate and superficial. Conidia are single celled, hyaline, barrel-shaped produced in long chains. Cleistothecia are globose and dark with myceloid appendages.

MANAGEMENT:

- Destroy affected plant parts.
- Follow adequate plant spacing .
- Remove and destroy debris ,weeds.
- Spray carbendazim 0.1% or chlorothalonil 0.2%.

Cercospora* leaf spot - *Cercospora lagenariae

Symptoms

- Commonly seen in snakegourd.
- Spots are small, circular to irregular with greyish centre and black margin.
- They coalesce to form large blotches.
- Leaves dry and die.
- Young succulent stems and petioles are also attacked.

Fungus:

Mycelium is septate and coloured. Conidiophores are light brown and geniculate. Conidia are hyaline, cylindrical and septate.

Bacterial wilt - *Erwinia tracheiphila*

Symptoms

- It affects the individual leaves, lateral shoots and entire plant
- Initial leaf symptom associated with cucumber beetle (Striped cucumber beetle: *Acalymma vittata*, spotted cucumber beetle: *Diabrotica undecimpunctata*) chewing injury
- Wilting starts from infected leaf, lateral shoot and then the entire plant.
- When older plants are infected, sometime only one shoot wilts initially. At fruiting entire plant may collapse.

Bacterium:

Motile rod with 4-8 peritrichous flagella and capsulated. Bacterium overwinters in cucumber beetle. Infected beetle remain infective for atleast 3 weeks.

Management :

- Add neem cake 150-250 kg/ha –at the time of planting to control beetles.
- Follow crop rotation to reduce beetle population.
- Spray streptocyclin 500 ppm

Angular leaf spot - *Pseudomonas syringae* pv. *lachrymans***Symptoms**

- Disease occurs on leaves, young green stems and fruits.
- Water-soaked, irregular or angular lesions appear on the leaves.
- In wet weather, bacterial ooze is seen on the water soaked areas which later dries to form white crusts.
- The spots enlarge and turn brown.
- The necrotic tissues dry and fall off leaving irregular holes. Circular spots appear superficially on fruits.

Bacterium:

Bacterium is rod-shaped, Gram negative and motile by 1 to 5 polar flagella. Yellowish green pigment is produced in the culture.

Cucumber mosaic - *Cucumber mosaic virus* (CMV)**Symptoms**

- Leaves show clear mosaic symptoms.
- Affected leaves are puckered and deformed.
- Internodes are shortened.
- Leaves attain only half the size of normal leaves.
- Flowers are dwarfed and few in number. Fruits are small with yellowish green mottling.

Vector: *Aphids craccivora*, *A. evonymi*, *A. gossypii* and *Myzus persicae* (Aphids). It is also transmitted by sap and grafting.

Management :

- Follow crop rotation .
- Grow tolerant varieties .
- Eradicate weed hosts and diseased plants.
- Spray imidacloprid 0.5ml /lit or systemic insecticides to control insect vector.

BITTER GOURD

Powdery mildew - *Sphaerotheca fuliginea*

Symptoms

- This disease is favored by high humidity and tends to occur on older leaves first.
- Symptoms first appear as white powdery residue primarily on the upper leaf surface.
- On the lower surface of the leaves circular patches or spots appear.
- In severe cases, these spread, coalesce and cover both the surfaces of the leaves and spread also to the petioles, stem, etc. Severely attacked leaves become brown and shrivelled and defoliation may occur.
- Fruits of the affected plants do not develop fully and remain small.

Fusarium wilt - *Fusarium oxysporum* f. sp. *Niveum*

Symptoms

- Initially the plants show temporary wilting symptoms, which becomes permanent and progressive, affecting more vines.
- The leaves of the affected plants show yellowing, loose turgidity and show drooping symptoms.
- Eventually, the plant dies.
- The roots are not affected.
- In older plants, leaves wilt suddenly and vascular bundles in the collar region become yellow or brown.

Downy mildew - *Pseudoperonospora cubensis*

Symptoms

- It is prevalent in areas of high humidity, especially when summer rains occur regularly.
- The disease is first seen as yellow angular spots on the upper surface of the leaves.
- Under conditions of high humidity, whitish powdery growth appears on the lower surface of the leaves.
- The disease spreads rapidly killing the plant quickly through rapid defoliation.

Bitter gourd mosaic - Virus

Symptoms

- This virus disease is mostly confined to the leaves with symptoms appearing on the leaves in the secondary branches produced at the apical end of the plant.
- Small irregular yellowish patches are seen on the leaves.
- Some leaves show vein clearing in one or two lobes of the leaf and severely infected plants show reduction in leaf size and elongation and/or suppression of one or two lobes.
- Young developing leaves are completely distorted and malformed with considerable reduction in their size.
- Some of the leaves show marked reduction in the development of lamina resulting in a shoestring effect.

Vector: The virus is transmitted by five species of aphids.

Bitter gourd witches' broom

Symptoms

- Malformation and proliferation of axillary buds.
- Diseased plants show many abnormally little leaves, which fail to attain full size.
- The diseased plants bear many flowers and blossom earlier than healthy plants. Flowers on infected plants show characteristic green, phyllody
- Fruit formation is noticed from the flowers partially infected with the disease.
- Fruits from these flowers are very small, cylindrical and deformed.
- The outer surface of the fruits is smooth and fruits are completely seedless.
- Plants showing severe witches' broom do not bear any fruit.

Questions

1. Anthracnose of cucurbits caused by
A) *Colletotrichum capsici* B) ***Colletotrichum lagenarium***
C) *Colletotrichum pisi* D) *Colletotrichum gloeosporioides*
2. Bacterial wilt causing *Erwinia tracheiphila* in cucumber is transmitted by
A) Beetle B) Honey bee
C) Whitefly D) Mite

LECTURE -11 CABBAGE, CAULIFLOWER, RADISH AND BEETROOT

Club root - *Plasmodiophora brassicae*

Symptoms

The symptoms first noticed will be a decline of the plant including yellowing of leaves, and a tendency to wilt during hot days. Examination of the roots will reveal swollen, club-shaped roots instead of the normal fine network of roots. In severe cases most roots will be affected. The swollen roots will begin to decay and eventually disintegrate. Since the fungus survives in soil and in dead crop debris, any movement of these may result in transfer of the fungus to a new site. Therefore, usually all of a small garden will be affected once the disease has become noticeable. Resting spores of the fungus are produced in the swollen clubroots and released into the soil when these disintegrate.

Most characteristic symptoms are seen on the roots. Affected roots are small and show spindle-shaped or club-shaped swellings due to hypertrophy and hyperplasia. Hypertrophy causes malfunctioning of xylem, which results in flagging of the leaves. The lateral roots and rootlets are also converted into spindle-like-swellings. Older and larger clubbed roots disintegrate before the end of the season because of invasion by bacteria and other fungi.

Clubroot is caused by the fungus *Plasmodiophora brassicae*. The important features of its life history include its longevity in soil, means of spread, and its reaction to soil pH. After the disease has occurred, the fungus can survive from seven to ten years without any susceptible plant ever being grown there. If any susceptible crops or weeds grow during this period, the fungus may become more prevalent.

Fungus:

The fungus produces plasmodia, resting spores (hyaline and spherical) and anteriorly biflagellate primary and secondary zoospores.

Management

- Soil fumigation with Methly bromide 1kg/10m² followed by covering with plastic film.
- Seed treatment with Captan/Thiram 4g/kg, followed by *T.viride* 4g/kg.
- Maintain a soil pH of 7.2 by liming (Field with pH 5.0 needs approximately 2.5t of lime/ ha).
- Soil drenching with Copper oxychloride 0.25%.

Black leg - *Phoma lingam*

All parts of susceptible plants, both above and below ground, may be affected from seedbed to harvest and even during storage. The earliest conspicuous symptoms often occur in the seedbed two or three weeks before transplanting time.

Seedlings. Cotyledon infection, which appears as pale gray lesions, usually causes the seedlings to die early (Figure 1). This loss often goes unnoticed in the seedbed. The fungus produces a tremendous number of microscopic spores (conidia) on the hypocotyls, cotyledons, and first true leaves of prematurely killed seedlings, and thus is able to cause many secondary infections in the seedbed and field.

Stems. An elongated, light brown, sunken area or lesion with a purplish margin forms on the stem near the soil line. The lesion gradually extends upward and downward until the stem is girdled and turns black. Numerous, tiny, black, fungus fruiting bodies (pycnidia) soon form in the diseased area. Affected plants often wilt suddenly and die, or they topple over later as the head enlarges.

Roots. The root system is gradually destroyed, although plants may be kept alive in damp soil when new roots form above the diseased parts. Badly affected cabbage plants may survive until fair-sized heads are formed. The wilting leaves usually remain attached to the stem instead of dropping off, as is characteristic of *Fusarium* yellows and black rot. Dark cankers develop in the fleshy roots of rutabaga, turnip, and other plants. Dry rot may develop on fleshy roots in storage, where severe losses may occur. Pycnidia are common on the surface of all decayed tissues.

Leaves. Inconspicuous, somewhat circular, light brown to grayish spots form on the leaves. The lesions soon become well defined and develop ash gray centers in which a large number of speck-sized, black pycnidia are scattered. These spots may later tear or drop out.

Heads. Heads from late-infected plants may appear healthy at harvest but later in storage develop sunken black lesions around their base. The presence of abundant, minute pycnidia on the cotyledons, stems, leaves, and roots distinguishes blackleg from other crucifer diseases.

Management

- Seed infection can be prevented by spraying the seed plants with copper oxychloride or with an organo mercuric compound.
- Seed treatment with Captan or Thiram 4g/kg of seed, followed by seed treatment with *Trichoderma viride* 4g/kg.
- Pusa Drumhead, a cabbage cultivar has been reported to be tolerant under field condition.

Cabbage yellows / *Fusarium* wilt - *Fusarium oxysporum* f. sp. *conglutinans*

Symptom:

- The disease affects the seedlings in nursery stage, however plants exhibit symptoms 2 to 4 weeks after transplanting.
- Disease development is promoted by warm weather conditions.
- Initial symptom appears as the development of yellowish green colour on one side of the plant. A lateral warping or curling of the stem and leaves occurs.
- The lower part of the leaf blade adjoining the petiole or midrib wilts and dies.
- The lower leaves turn yellow and later the upper leaves are affected. With time, the yellow leaves turn brown and the affected tissue becomes dry and brittle. The speed of progress of disease in the plant depends upon the degree of varietal susceptibility and the soil temperature.

Management

- Use only certified, disease free seeds/ transplants.
- Growing seedlings in seedbed disinfested by steam or soil fumigant.
- Early sowing of cabbage.
- Follow crop rotation with crops like lettuce, chilli, peas, tomato, sweetpotato or cotton
- Remove and destroy infected plant debris.

Black rot - *Xanthomonas campestris* pv. *campestris*

Symptoms

- This bacterial disease is common in areas having a warm and wet climate.
- Plants can be infected during any growth stage and the symptoms resemble nutritional deficiencies. Infected seedlings become yellow, drop lower leaves, and may die.
- Leaves may be affected on only one side of a seedling.
- Plants infected because of contaminated seed may not develop symptoms for many weeks.
- The classic symptom of black rot is caused by local infection that results when bacteria enter leaves through natural openings of leaf margins.
- Disease causes development of "v" shaped chlorotic to yellow lesions from the leaf margin.
- The infected tissue turns pale green-yellow and then turns brown and dies. Affected areas are usually wedge or V-shaped.
- These areas enlarge as the disease progresses, and severely affected leaves may drop off.
- Veins and veinlets turn black and the leaf tissues become necrotic and brittle.
- Lesions progress towards the midrib from where systemic infection spreads into stem and root.
- Vascular tissues in affected plants become conspicuously black followed by internal breakdown of fleshy tissues.
- Black sunken spots are seen on succulent seed stalks and siliqua.
- Heads of cauliflower are invaded and discoloured.
- The heads of the infected plants remains small and its quality is reduced making it unfit for marketing.
- Young plants may be killed in the seed bed.

Bacterium:

It is a Gram negative and rod-shaped bacterium with single polar flagellum.

Management

- Seed treatment with Aureomycin 1000ppm for 30 min is effective in killing both the internally and externally seed-borne pathogen.
- Drenching the nursery soil with formaldehyde 0.5% helps in checking the disease.
- Application of bleaching powder at 10.0 to 12.5 kg/ha controls the disease.

Downy mildew - *Perenospora parasitica*

Symptoms

- The disease is very serious in nursery and it can also appear in field planting. High humidity, fog, drizzling rains, and heavy dew favour the disease development and spread.
- The first symptom observed are small, light green-yellow lesions on the upper leaf surface, later showing on the undersurface.
- The spots turn yellow as they enlarge.
- During periods of high humidity, a grayish white moldy growth is developed on the undersurface of the leaf.
- Later the leaf may become papery and die.
- Cabbage heads develop sunken black spots.
- Though, some plants are infected at the seedling stage, the symptoms does not become apparent until near harvest.

Management

- Seed treatment with Metalaxyl (Apron 6g/kg of seed).
- Foliar spraying with Metalaxyl (Ridomil) 0.4%.

Black leaf spot / *Alternaria* leaf spot and blight - *Alternaria brassicae* and *A. brassiciola*

Symptom:

- It is a destructive disease on seed crop.
- Older leaves are more susceptible.
- The initial symptoms are in the form of small dark yellow spots on the leaf surface.
- Later on the spots enlarge to circular areas with concentric rings and possibly surrounded by yellow halos.
- Affected leaves become yellow and fall off.
- Lesions on stems and petioles are linear.
- The fungus attacks cabbage heads mostly after harvest and with *Rhizopus* it causes brown rot.
- In severe cases, the entire plant defoliates.
- Violets to tan spots develop on infected cabbage seed pods which intensifies in wet weather.

Fungus:

Conidiophores are thick and brown. Conidiophores are thick and geniculate. Conidia are both transversely (11-15 septa) and vertically septate (0-3 septate), coloured and beaked. Conidia are mostly solitary or in chains

Management

- First foliar spraying with Tridemorph 0.1% followed by spraying with Mancozeb 0.25% a month interval.

Sclerotinia rot/ White mould - *Sclerotinia sclerotiorum*

Symptoms

Symptoms often first appear as water soaked spots on lower or upper cabbage leaves. As water soaked spots enlarge, infected tissue becomes soft, and some outer leaves begin to wilt. A white cottony growth becomes evident on the leaves as the disease progresses. Eventually the entire cabbage head is covered with this white cottony growth and the overwintering sclerotia begin to form. Initially sclerotia are white and round and later become black, hard and irregular in shape. The black sclerotia become visible on the outside of the cabbage head, but they also form inside the head.

Damping off - *Pythium debaryanum*

Symptoms

- The disease causes severe damage in the nursery.
- Cool, cloudy weather, high humidity, wet soils, compacted soil, and overcrowding especially favor development of damping-off.
- Damping-off kills seedlings before or soon after they emerge. Infection before seedling emergence results in poor germination.
- If the decay is after seedlings emergence, they fall over or die which is referred to as "damp-off."
- The destructiveness of the disease depends on the amount of pathogen in the soil and on environmental conditions.
- Seedlings that emerge develop a lesion near where the tender stem contacts the soil surface.
- The tissues beneath the lesion become soft due to which the seedlings collapse.

White rust - *Albugo candida*. (*Cystopus candida*)

Symptoms

- Prominent white or creamy yellow pustules of 1 to 2 mm dia are mainly observed on the lower surface of the leaves.
- The upper surface correspondingly exhibits yellow patches.
- Blisters appear on the stem and inflorescence.
- When young stems and inflorescence are infected or when the infection has occurred from soil-borne oospores in the seedling stage, the fungus becomes systemic and causes hypertrophy and hyperplasia of floral tissues, which leads to swellings and distortions.
- Affected inflorescence increase 12 to 15 times in size.
- Axis of inflorescence and flower stalks are enormously thickened.
- Floral organs become partly or wholly swollen, fleshy, green or violet in colour.
- Petals will look like sepals and stamens become leaf-like.
- Ovules and pollen grain are atrophied.
- Ovary is sterile. Early infection causes stunting of plants.

Fungus:

It is an obligate parasite. Mycelium is intercellular. Sporangioophores are club-shaped and hyaline. Sporangia are single celled, spherical, hyaline and are arranged in chain.

Downy mildew - *Peronospora parasitica*

Symptoms

- The fungus infects leaves, stems and inflorescence.
- Greyish white downy fungal growth appears on the under surface of the leaves while the corresponding upper surface show yellowish spots.
- Infected leaves dry up and fall off.
- Floral parts are deformed.
- Cauliflower curds look brownish at the top.
- The stems show dark brown and depressed lesions, which later develop downy growth of the fungus.
- Infection at the seedling stage may cause complete death of seedlings.

Fungus:

It is an obligate parasite. Mycelium is inter- and intra-cellular, haustoria are finger-shaped. Sporangiophores are erect, dichotomously branched at acute angles and final branches (sterigmata) are with curved pointed tips. Dichotomous branching occurs 6 to 8 times at the tip of the final branches. Each sterigma bears a sporangium at its tip. Sporangia are not papillate and germinate by germ tubes and not by zoospores. Oospores are globose and yellow.

Cauliflower mosaic - Cauliflower Mosaic Virus

Symptoms

- Leaves are mottled with a pattern of light and dark green
- Plants are stunted with smaller leaves.
- Mild infection leads to production of small and poor quality heads.
- Transmission by aphids, *Brevicoryne brassicae* and *Myzus persicae*

MANAGEMENT

- Use resistant varieties.
- Removal of infected seedlings.
- Use insecticides like methyl demeton 0.1% to control aphids.
- Establish seed bed away from susceptible crops.

Disorders

Whiptail

Whiptail disorder is caused due to deficiency of molybdenum.

Symptoms

- In young plants the deficiency symptom is chlorosis of leaf margins and the whole leaves may turn white.
- The leaf blades do not develop properly.
- When the deficiency is severe, only the midribs develop.
- This condition is commonly known as 'Whiptail'.

- The growing point of the plant is also deformed which prevents the curd development.
- The deficiency of molybdenum generally occurs in acid soils when the soil pH is below 5.5.

BEET ROOT

1. *Cercospora* leaf spot

Symptoms

- The lower leaves near the ground are attacked first.
- The spots are small, circular ashcoloured in the centre with deep violet or reddish-purple borders.
- They coalesce to form bigger and the leaves wrinkle and dry.

Causal organism: *Cercospora beticola*

Mode of survival and spread: Through seeds and secondary spreads through air borne conidia. The pathogen survive in the debris and on seeds.

Management

- Deep ploughing of debris.
- Three year rotation.
- The seeds should be disease free
- Seed treatment with Captan or thiram 4g/kg of seeds.
- Foliar spray with mancozeb 0.25% or carbendazim 0.1% at 15 days interval

2. *Sclerotium* root rot

Symptoms

- The most important sign of the diseases is presence of white strands of fungal mycelium.
- Numerous mustard like sclerotium on the decaying parts are seen yellowing and wilting of plants.
- The fleshy root are found completely or partially decayed.

Causal organism: *Sclerotium rolfsii*

Favourable conditions: High temperature (above 28°C) and aeration in the field.

Mode of survival and spread: It survives in the soil as saprophyte on crop refuse. Spreads from infected debris and through irrigation.

Management

- Destruction of crop refuse
- Application of penta chloronitro benzene or Carbendazim 0.1% as soil drench.
- Seed treatment with Carbendazim 2g/kg of seeds

CARROT

1. *Cercospora* leaf blight - *Cercospora carotae*

Symptoms

- The disease produce severe blighting on carrot leaves and petioles if wet weather is prolonged during the growing season.
- Entire leaves and petioles may die on severely infected plants.
- The symptoms first appear along the margins of the leaves, often causing the leaves to curl. Spots inside the leaf edges are small, roughly circular, and tan or gray to brown with a dead center.
- As the lesions increase in number and size, the entire leaflet withers and dies.
- The fungus attacks younger leaves and plants in preference to older ones.
- In heavily infested fields, however, both older and younger leaves are subject to attack. The pathogen also produces lesions on the petioles and stems.
- The lesions may merge and girdle the stems, causing the leaves to die.

2. *Alternaria* blight - *Alternaria dauci*

Symptoms

- *Alternaria* leaf spots first appear at the margin of the leaflets and are dark brown to black and irregular in shape.
- Lesions produced on the petioles and stems are dark brown and often coalesce and girdle the stems.
- As the disease progresses entire leaflets may shrivel and die, appearing scorched.
- *Alternaria* leaf lesions are generally more prevalent on older foliage and plants than on young foliage.
- The disease spreads rapidly on the older leaves of a maturing crop after the rows have closed.
- This is due in part to poor air circulation among the older lower leaves in the canopy and to the moisture-holding capacity of the dense foliage.

3. Watery soft rot - *Sclerotinia sclerotiorum*

Symptoms

- Carrots are susceptible to this disease, especially late in the season and during storage.
- The disease is present in soil or storage areas and often shows up after the crop has been harvested.
- Symptoms can be identified in the field as characteristic white mold with black sclerotia present on the crown of infected carrots. In storage, a soft, watery rot with white mold and black sclerotia characterizes the disease.

4. Black rot - *Alternaria radicina*

Symptoms

- This disease can be seed and soil-borne and is characterized by a shiny black decay at the crown area and a greenish-black mold on the taproot.

- The infected tissue is greenish black to jet black due presence of masses of black spores.
- This disease affects the roots in the field well as in storage.

5. Bacterial soft rot - *Erwinia carotovora* p.v. *carotovora* and *Erwinia carotovora* p.v. *atroseptica*

Symptoms

- Bacterial soft rots of carrots occur only when soil conditions are wet or storage conditions are poor.
- Soft water-soaked, irregular lesions appear on the roots.
- Initially these lesions are superficial but soon spread to cover the inner tissues.
- The foliage may remain green until the disease on the tuber advances considerably.
- The entire plant wilts when complete rotting of the tuber takes place.
- A foul odour is given out from the decayed roots.
- Abundant moisture on the root surface favours disease incidence.

Questions

1. Finger and Toe disease of Cabbage is caused by
 A) *Phoma lingam* B) *Thanetophorus solani*
 C) *Albugo candida* D) ***Plasmidiophora brassicae***
2. Damping off & wire stem in seedlings, plants bend or twisted without breaking in cabbage is caused by
 A) ***Thanetophorus solani*** B) *Phoma lingam*
 C) *Albugo candida* D) *Fusarium solani*
3. The pathogen which Stimulates hypertrophy and hyperplasia in radish and produce sporangia in chains
 A) ***Albugo candida*** B) *Pythium aphanidermatum*
 C) *Phytophthora parasitica* D) *Peronospora parasitica*
4. V shaped chlorotic to yellow lesions develop from the leaf margin of Cabbage indisease
 A) Black Leg B) Wire Stem
 C) **Black rot** D) Cabbage Yellows
5. Cauliflower mosaic virus is avirus
 A) Single strand DNA B) **Double strand DNA**
 C) Single strand RNA D) Double strand RNA
6. Write the causal agent for white rust of raddish
 A) *Albugo bliti* B) ***Albugo Candida***
 C) *Puccinia striformis* D) *Puccinia tritici*
- 7.. Club root disease can be managed by application of
 A) Gypsum B) **Lime**
 C) Carbendazim D) Bleaching powder
8. *Phythium* and *Phytophthora* disease can be managed with
 A) Carbendazim + Mancozeb B) **Metalaxyl + Mancozeb**

C) Sulphur + carbendazim

D) Carbendazim + Thiram

LECTURE -12 POTATO, SWEET POTATO, CASSAVA

EARLY BLIGHT - *Alternaria solani*

Symptoms

- Disease is present both in hills and plains.
- Brown spots are found on the surface of older leaf and subsequently spread to top younger leaves.
- They are oval, circular or irregular with concentric rings.
- They are less than 1 cm in dia, dry and become brittle.
- Several spots coalesce and cover the entire leaf.
- Symptoms are observed on petioles and stem as brown lesions.
- The leaves show dark brown, circular or irregular sunken spots.
- Internal tissues turn brown and corky.

Fungus:

Mycelium is brown and septate. Conidiophores emerge through stomata and are dark brown, erect and septate. Conidia are yellowish brown with vertical and cross septations (5 to 10) and provided with a prominent beak.. They are formed singly at the tip of conidiophore.

LATE BLIGHT - *Phytophthora infestans*

Symptoms

On Leaves

The first symptoms are olive to dark green spots which appear on the upper surface of the leaves close to the leaf tip or leaf margins. They can be dry but will often look water-soaked. Under light, the margins of the leaf zone that have been infected will look watery and light green, indicating the continuing progression of the fungus. These areas spread as the disease progresses, turn brown and die. These symptoms first appear on the lower leaves of the plant except in very wet conditions.

When it is cool and humid, the underside of the leaves in blight-infected plants will be covered with a whitish or greyish mold-like fungal growth: the mycelium. In dry weather, blighted leaves will curl and shrivel and become dark and crisp. These symptoms should not be confused with those of early blight or grey mold. Symptoms of early blight are not confined to leaf edges and have a dart-board appearance. Grey mold will first show up on leaf tips and margins like late blight, but the effected areas will be covered with lots of greyish coloured mycelium and spore mats.

On the Stem

On the stem, infected parts will appear brown just below the growing point - sort of dark strips running along the length of the stem. Infected areas on the stem do not appear as markedly water-soaked as the leaves can. In extreme cases, infection of the stem will kill the leaves just above the point of infection.

On Tubers

Once blight is present on the plant, it can infect the tubers if rain leaches its spores into the soil. Symptoms on tubers will appear as **purplish-brown sunken areas of irregular size and shape**. These are often located in and around the eyes. A dry reddish brown rot spreads under the skin causing infected potatoes to eventually rot in storage.

Fungus:

Mycelium is hyaline and coenocytic. The sporangiophores emerge through stomatal opening with branches. The branches will have nodular swellings. Sporangia are pear-shaped or lemon-shaped, hyaline and single celled with papilla. Each sporangium releases 3 to 8 zoospores.

MANAGEMENT

- Disease free tubers
- Destruction of infected crop debris
- Proper fertilization
- Fungicides such as Mancozeb 0.2 % or Bordeaux mixture 1 % or captan 0.2% or zineb 0.2 % can effectively control the disease.
- Chlorothalonil used for late blight, also control this disease
- Kufri Sindhuri is moderately resistant

3. Black scurf and stem canker - *Rhizoctonia solani*

Symptoms

- Brown, sunken, circular or elongated lesions on the lower portion of sprouts.
- Tubers exhibit brown discolouration.
- Black irregular sclerotia are found in the skin are observed on the tubers.

Fungus:

Mycelium is hyaline to coloured, septate and branches at right angle to main axis. Sclerotia on plant tissues are black. The basidiospores are hyaline, elliptical to obclavate and thin-walled.

Management

- Use disease free tubers.
- Treat seed tubers with 1 % acetic acid and 0.05 % zinc sulphate or carbedazim 1% for 15 min or mercuric chloride solution for 1½ h.
- Long rotation using cereals (maize)
- Go summer cultivation to expose the soil to high temperature
- Plant well sprouted seedlings in shallow
- Fallowing for 2 years

4. Brown Rot/ Bacterial wilt / Ring disease - *Burkholderia solanacearum*

Symptoms

- It occurs in Deccan and Central plateau, Assam, West Bengal Orissa, hills, of Uttar Pradesh and Nilgiris.

- The plants wilt at tuber formation stage.
- The wilt may be restricted to one branch.
- The wilt plants initially recover in the morning or evening but with in the afternoon.
- Later they die. Stems, petioles of the lower leaves and roots become brown; on cutting the infected materials slimy mass of bacteria oozes out.
- Such tubers may be easily recognized by adhering soil particles.
- When tubers are cut browning of the vascular region can be seen.
- When pressed a slimy bacterial ooze emerge. The tubers may rot at harvest, during storage.

Bacterium:

The bacterium is Gram negative, rod-shaped and motile by 1 - 4 polar flagella.

5. Soft rot and black leg - *Erwinia carotovora* subsp. *carotovora*

Symptoms

- It occurs in two phases, black leg of shoots and soft rot of tubers.
- In black leg phase, black lesions appear at base of stem followed by yellowing, rolling of top leaves and death.
- Tubers develop water soaked areas, soft rot and an offensive odour.
- Small sunken areas develop on tuber surface.

Management

- Sanitation at harvest and storage
- Proper drainage
- Drying and disinfecting seed tubers before storage.
- Disinfection of cutting knife in methylated spirit.
- Spray formaldehyde in walls and floors of storage yard.
- Seed tubers are to be treated with streptomycin 100-200 ppm for 30 minutes
- Crop rotation with cereals and beans

6. Common scab - *Streptomyces scabies*

Symptoms

- Tubers show small reddish or brownish spots which develop into lesions.
- The lesions may be shallow, corky, russetting, pitted or star shaped cracks.
- Heavy incidences have been reported in some parts of Maharashtra, Punjab, Bihar and western UP.

Management

- Use disease free tubers for planting
- Dip seed tubers in mercuric chloride 0.1 % for 1½ h or 2 h dipping in 1:240 formalin solution
- Regular irrigation (prevent drying of soil) from tuber formation to maturity
- Crop rotation with alfalfa
- Green manuring
- Severe in alkaline soil – application of gypsum is recommended or avoid alkaline fertilizers

7. Wart - *Synchytrium endobioticum*

Symptoms

- It is restricted to Darjeeling district of West Bengal, Bhutan and Nepal.
- White to brown tumour like outgrowths develop on stems and tubers.
- They are loose structures and become black with age and rot.

Management

- Adopt phytosanitary measures.
- Banning the movement of potato tubers from infected to non-infected areas through quarantine.
- Grow immune varieties viz., Kufri jyoti, Kufri jeevan and Kufri muthu
- Steam sterilization or soil application of HgCl_2 / CuSO_4 / formalin 5%

8. Powdery scab - *Spongospora subterranean*

Symptoms

- Small light coloured blister like swellings which turn in to dark open pustules 3 to 7 mm diameter appear on tuber surface.
- The disease reduces market value of the produce.

Management

- Rotate with non-solanaceous crops
- Treat seed tubers with 0.5 per cent MEMC (Agallol) for 10 min.
- Sulphur 900kg/ha

9. Leaf roll

Symptoms

- It is widely prevalent in plains and plateau region.
- Upward rolling of margin of leaves.
- Leaves are thick, leathery, brittle and make rattling sound when disturbed.
- The infected plants are stunted, produce short stem and few tubers clustered around the stems.
- Tubers may develop necrosis.

Transmission *Myzus persicae*

Management

- Resistant varieties
- Field sanitation
- Selection of disease free seed materials
- Roguing of infected plants
- Vector control

10. Purple top roll - *Phytoplasma*

Symptoms

- Chlorosis of younger leaves, followed by rolling starting from base to tip and development of purple colouration.
- The diseased plants are stunted, with profuse axillary growth swelling at nodes and formation of aerial tubers.
- The disease is spread by leafhoppers.

11. Spindle tuber - Potato spindle tuber viroid (PSTVd)

Symptoms

- Plants are erect but stunted.
- Leaves appear dark green.
- Tubers are elongated and spindle shaped.
- The viroid spreads by mechanical means.

Questions

1. Wart disease of potato caused by *Synchytrium endobioticum* is an example for
a) **Endemic disease** b) Epidemic disease c) Pandemic disease d) Sporadic disease
2. Hollow black heart of potato is due
a) Fungi b) **High temp and deficiency of oxygen**
c) Bacteria d) All of the above
3. Early blight of potato is caused by
a) *Phytophthora infestans* b) *Erysiphe polygoni*
c) ***Alternaria solani*** d) *Fusarium oxysporum*

SWEETPOTATO

1. *Cercospora* leaf spot

Symptoms

- Small brown angular spots on leaves. Severe case leaves drop from the base produce shot hole symptom.

Causal organism: *Cercospora ipomoeae*

Mode of survival and spread: Primary infection through air-borne conidia. Conidia spread through wind and by rain. Survive in weed host and debris.

Favourable conditions: 32°C – 35°C day temperature with 90-95% relative humidity, intermittent rain fall.

Management

- Two spraying with zineb 0.2% at 15 days interval

2. Black rot

Symptoms

- Infect underground parts of the plant.
- Small sunken black spots on tuber.
- Spots enlarge and cover the whole tuber.
- Infected tuber have black lesion.
- Tuber give unpleasant taste when cooked

Causal organism: *Ceratocystis fimbriata*

Mode of survival and spread: Survive in soil debris Spread through infected tuber.

Favourable conditions: 23-27°C is optimum for disease development

Management

- Use disease free planting material
- Cultivate sweet potato once in 2-3 years
- Dipping tuber in 0.1% Thiabendazole

3. Stem rot / Wilt / Surface rot

Symptoms

- Yellowing of the youngest leaves.
- Vascular system blackened.
- Plant wilt and die
- Blackened ring on the surface of tuber

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

Mode of survival and spread: Fungus survive in soil as chlamydospore. Spread through infected tuber and irrigation water.

Favourable conditions: 32-37°C favour this disease

Management

- Use healthy seed material
- Adopt crop rotation once in 3 years
- Dipping seed material in 0.17, carbendazim for 20 mts.

4. Soft rot / Rhizopus rot

Symptoms

- Broken skin with straw colour oozing.
- Tuber decay within 4-5 days.
- Fungal growth covers the surface of tuber.
- Tissue turns brown. Emit bad odour

Causal organism: *Rhizopus nigricans*, *R. stolonifer*

Mode of survival and spread: Survive in crop refuse for a longer period. Spread through infected tuber

Favourable conditions:

Optimum temperature 23-28°C

Decay occur at 15-23°C RH 75-85%

Management

- Avoid wound in tuber at storage
- Dry the tuber 1-2 hours before storage
- Clean storage house washed with 2.5% copper sulphate solution.

TAPIOCA / CASSAVA

1. Brown leaf spot

Symptoms

- Spots are seen on both the sides of the leaves.
- On the upper surface, the spots appear uniformly brown with a distinct dark brown border.
- The spots are irregular or angular and restricted by leaf margin or veinlets and measure 3 to 12 mm in dia.
- On the lower surface the lesions have less distinct margins and in the centre brown spots assume a greyish lust because of conidiophores and conidia.
- Small veins within the lesions appear black.
- Indefinite halo is seen around the lesions.
- As the disease progress the leaves turn yellow, dry and drop off.

Fungus: *Cercospora henningsii* (*Mycosphaerella manihotis*). Conidiophores are olivaceous brown, geniculate and sparingly septate. Conidia are produced singly at the apex of each conidiophore. They are slightly curved with both ends bluntly rounded, 2 to 8 septate and pale olivaceous. Perithecia are brown to black. Asci are elongate, clavate, eight spored and sessile. Ascospores are ovoid, uniseptate and constricted at the septum.

Mode of survival and spread

Debris of diseased foliage and stromata and conidia are air borne.

Favourable conditions: Humid weather

Management

- Removal of affected leaves
- Spray 0.25% COC or 0.1% Carbendazim or Bordeaux mixture 1.0 % or benomyl 0.1 % or thiophanate 0.2 % at monthly interval
- Balanced fertilization
- Resistant varieties – Sree Prakash, H 97, Sree Sahaya

2. Sett rot (stem rot)

Symptoms

- Vascular discolouration () and necrosis from wounds. Blisters with black mass of pycnidia

Causal organism: *Diplodia natalensis*

Management

- 7 Seed tubers of potato are to be treated with streptocycline 100-200 ppm for 30 minutes fordisease
- | | |
|----------------|---------------------|
| A) Black scurf | B) Black leg |
| C) Wart | D) Late blight |
- 8 White blister disease of Sweet potato caused by
- | | |
|----------------------------------|---------------------------------|
| A) <i>Peronospora parasitica</i> | B) <i>Exobasidium vexans</i> |
| C) <i>Sclerotium rolfsii</i> | D) <i>Albugo ipomoea</i> |

LECTURE 13 YAM, COLACASIA, BEAN & PEA

YAM

Anthracnose : *Colletotrichum gloeosporioides* f. sp. *alatae* (Teleomorph: *Glomerella cingulata*).

Symptoms

- Small, brown spots with yellow margin appear mainly on lower leaves and stems.
- Infected leaves wither and the stem gives a blackened appearance.
- Brown to black acervuli is observed on the lesions of the leaves and stem in concentric rings.
- Severe infection leads to rapid death of the plant.

Fungus

Mode of survival: Survives in crop debris.

PS: from crop debris. SS: through rain splashes.

Management

- Remove and burn the infected crop debris.
- Use disease resistant or tolerant varieties.
- Spray benomyl 0.1% or mancozeb or zineb 0.2% and avoid copper fungicides since they cause phytotoxicity.

DRY ROT - *Lasiodiplodia theobromae*

Symptoms:

- The symptoms though vary with varying coloration depending on the invading Pathogen, the infected tissues become hard and dry. The infected tubers first turned grey and then black, such tubers become pulverulent, breaking into small dry particles. In case of *Fusarium* inducing pinkish with yellowish border on the infected tissues

Pathogen: Inside the pycnidia, conidiogenous cells produce hyaline thin walled pycnidiospores which become

brown, thick walled, two celled with longitudinal striations.

Mode of spread: Primary and Secondary spread is through Air borne conidia

COLLAR ROT: *Athelia (Sclerotium) rolfsii* or *Thanetophorus (Rhizoctonia) solani*

Symptoms:

- Collar rot caused by *Athelia (Sclerotium) rolfsii* and *Thanetophorus (Rhizoctonia) solani* is commonly found in two to three months old plants.
- The collar region is get rot which leads to death of the plants.
- In severe cases leaf become brownish and dry leads to death of the plant.

Management

- Drench the soil with carbendazim 0.1%

Leaf spot / leaf blight

Symptoms

- Dark brown angular spots appear on leaves which coalesce to cover the larger areas.

Severely affected leaves fall prematurely.

Fungus: *Cercospora carbonaceae*, *C. golaghatii*, *C. dioscoreae* and *Pseudocercospora contraria*

The fungi survive on crop debris serve as primary inoculums and the secondary spread by rain.

Management

Spray captan or mancozeb or zineb 0.2%

***Fusarium* tuber rot**

Symptoms

- It is a storage disease.
- Infected tubers are lighter than healthy ones and lack firmness when pressed.
- If the tubers are cut transversely, brown dry rot is seen centrally and is surrounded by blackish zone where considerable nematode damage or secondary bacterial infection is present.

Fungus: *Fusarium solani*

Management

Follow crop rotation

Dipping the tubers in systemic fungicides like benomyl or thiabendazole 0.1% is found effective.

***Rhizopus* tuber rot**

Symptoms

- Browning of tissues and oozing of liquid from the infected tissues.
- The infection spreads to entire tuber except the vascular tissues.
- Affected tubers are mummified.
- The tubers shrink and the skin wrinkled.

Fungus: *Rhizopus nodosus*

Management

- Follow crop rotation
- Select disease free planting materials
- As the nematodes facilitate entry of the pathogen, careful watch and appropriate control measures are to be taken to control nematode damage.

COLOCASIA

Leaf blight *Phytophthora colocasiae*

Symptoms

Small, dark brown lesions appear on leaves with chlorotic halo.

Exudation of liquid from the spot and turn yellow or purple when dry

The spots coalesce and have characteristic rings

It also infects petioles and corms and making the plant to collapse.

Fungus

Pathogen survives as oospores in leaf debris, corms in the soil.

Secondary spread by rain splashes.

Management

- Hot Water Disinfestations

- Follows for Disease Suppression.
- Isolate plantings (e.g., three small, separate patches instead of one large patch).
- Prepare the soil well and amend it before planting if calcium, magnesium, or phosphorus are needed.
- Monitor plant calcium levels by leaf analysis, and maintain calcium at recommended concentrations to prevent disease
- Add lime material before planting to raise soil pH to 6.0-6.8.
- Rotate taro with other crops.
- Incorporate compost and apply surface mulch.
- Rogue (kill and remove) diseased plants, taking them far from the planting area and destroying them by burying, burning (if allowed), or composting
- Spray copper oxychloride 0.25%

Corm soft rot / root rot: *Pythium aphanidermatum*.

Symptoms

- Infected young plants are stunted & killed without producing leaves.
- The grown up plants exhibit wilting, chlorosis, stunting followed by collapse of the plants
- The rotting of corm starts from the base and covers the entire corm.
- The rotted tissue is mushy and malodorous dark purple with offensive smell.
- Roots decay in association with the corms.
- In some cases, there is little damage to the corm but many roots are killed leaving the plant loose in the ground.

Fungi

The fungi survive in crop residues found in soil (soil-borne). Primary spread from soil-borne oospores and the secondary spread by zoospores.

Management

- Rogue out and destroy infected plants.
- Provide proper drainage
- Use bioagents for corm treatment at 5g/kg before planting
- Dip the planting materials in metalaxyl + mancozeb 0.2%.
- Drench the soil with Bordeaux mixture 1.0%.

MOSAIC- *Dasheen Mosaic virus*

Symptoms:

- Plants generally become asymptomatic three to four months after initial symptom expression. The foliar symptoms include a dispersed and veinal mosaic pattern on the leaves. Leaf distortion is generally mild to moderate.
- It is a stylet-borne virus carried by aphids *Myzus persicae*.

***Alternaria* leaf spot**

Symptoms

- Circular to irregular, brown necrotic lesions appear at the tips and margins of the leaves.
- These lesions cover the entire leaf causing blighted appearance.

- Young and matured leaves are affected and the affected plants collapse.

Fungus: *Alternaria tenuissima*

Management

- Spray mancozeb 0.2%

Brown leaf spot : *Cladosporium colocasiae*.

Symptoms

- Dark reddish brown spots of 5-10mm develop on both sides of the leaves.
- The entire leaf becomes covered with numerous lesions, turns yellow and eventually dies.

Management

- Spray mancozeb 0.2%

BEAN

1. Anthracnose

Symptoms

- Black sunken lesions are seen on pods. Black spots are seen in the leave, stem and pods.
- The central portions of the spots show pinkish colour under lying seeds in the pods will be discoloured.
- On the leaves black dots are seen on the lower surface.
- Dots enlarges and become angular. Infected seeds if it is sown total failure of germination or the seedlings die at an early stage.

Causal organism: *Colletotrichum lindimuthianum* (*Glomerella lindimuthianum*)

Favourable conditions:

High humidity (92%) and 17°C are highly favourable.

Disease intensity increases with age of the plant.

Mode of survival and spread It survives in the seeds and also in the debris. The pathogen is seed-borne and it spreads from debris also. Primary infection through seeds and secondary by air borne conidia

Management

- Healthy pods should be selected to collect seeds.
- Deep ploughing to incorporate the debris.
- Seed treatment with carbendazim 2g/kg
- Foliar spray with carbendazim 0.1%. 15 days interval.
- 0-2% mancozeb.or 0.1% Chlorothalonil 7-10 days interval starting from 30 DAS

2. Rust

Symptoms

- Reddish brown pustules are seen on the lower surface of the leaves.
- Later it turns black due to formation of Telia.

- The leaves turn yellow and dry or fall off.
- If the infection is 3 percent the loss is about 2.7 % . If it is 79 percent the loss will be 37%.

Causal organism: *Uromyces phaseoli*

Favourable conditions:

For the production of Uredospores 15° to 20°C

Teleospores 10° to 15°C

Long day hours favour.

Mode of survival and spread: Through repeating spores (uredospores) and due to repeated cultivation

Survival: The teliospores survive into the debris.

Management

- Destruction of diseased crop debris
- Long rotation.
- Wider spacing.
- Spraying mancozeb 0.25% or Chlorothalonil 0.1% at 7 days interval.

3. Dry root rot

Symptoms

- It attacks Seedling and also grown up plants.
- Sunken canker are seen below the cotyledonary node and form black.
- Such seedlings soon die.
- Leaf yellowing.
- Dark lesions on the stem near the base and discolouration of roots and stem.
- The affected tissues shows dry rot and very large number of fruiting bodies (Sclerotia or pycnidium) are seen.

Favourable conditions: Dry weather and high temperature

Mode of survival and spread Survives as sclerotia in the soil. Primary spread through sclerotia and secondary spread through air borne conidia.

Management

- Long rotation.
- Removal of infected debris.
- Seed treatment with carbendazim 2g/kg of seeds.
- Trichoderma viride seed application 4g/kg.
- Spot drenching with 0.1% Carbendazim

4. Bean common mosaic

Symptoms

- Leaf becomes chlorotic, small in size and stiff.
- Light and dark green areas are formed on the leaves.

- The light green colour are usually along the margins of the leaves.
- Abnormal growth of the tissues causes veins to bend down ward.
- The leaves may look cupped.
- Diseased plants produce fewer pods which are small in size.
- Downward curling of the leaves and yellow mosaic is common symptom.

Causal organism: Virus

Mode of survival and spread: Transmission in the field through aphids. Myzospersical, Acyrthosiphum pisum, A.gossypii Seed transmission is common and most important source of initial infection in the crop.

Management

- Select seeds from healthy plants.
- Control of insect vectors by spraying systemic insecticides like monocrotophos or methyldematon.

5. Bacterial blight

Symptoms

- 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 which coalesce.
- On green pods water soaked spots are seen and it turn reddish.
- The seeds in severely affected pods do not develop and shriveled.
- Vascular browning and surface cankers may seen.

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

Mode of survival and spread

Primarily through seeds and it survive in the seed for more than two years. The bacterium lives in the diseased debris. The secondary spread through bacterial ooze that develops on the leaves and 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.

PEA

1. Powdery mildew

Symptoms

- On both the surface of the leaves powdery growth can be seen.
- Usually attacks or occurs in late season (after pod formation stage) pods and tendrils are also affected.
- The pods turn black, seeds become wrinkle.

Causal organism: *Erysiphe polygoni*

Mode of survival and spread: Primarily it is a seed borne and secondary spread through air borne conidia which are produced in chains.

Cleistothecium survive in the soil in debris,

Favourable conditions: Dry weather.

Management

- Removal of debris and destroy.
- Protective spray with Dinocarb (Karathane) 0.07 or Calixin (Tridemorph) 0.05%
- Growing resistant varieties – T-10 P-388 T-56, P-185

2. Rust

Symptoms

- The leaves develop yellow and turn brown.
- Large number of brown rusty pustules are seen on the lower surface.
- Later it turns black due to the production of telia.
- In tendrils and in stem also black telial sori develops

Causal organism: *Uromyces fabae* V. *pisi*

Mode of survival and spread:

It survives in debris. Weeds and Lathiras act as a collateral host. The telia survive in debris and spread through air borne uredospores.

Management:

- Debris should be removed and burnt.
- Long rotation
- Avoid growing Lathiras
- Weed hosts has to be destroyed
- Seed treatment with captan or thiram 4g/kg
- Spraying with Tridemorph 0.05% or mancozeb 0.25%

5. Foot rot and blight

Symptoms

- Small purple spots on the leaves, increases in size, turn brown and become zonate.
- Leaves dry and hang down.

- Stem infection starts as a browning and blackening of the basal portion.
- Similar to those on leaves.
- The lesions extends upward and down ward end coalesce.
- The spots are also produced on green pods. The wall of the pod shrinks and seeds are deformed.

Causal organism: *Aschochyta pinodes*

Favourable conditions:

Temperature – 16°C cool weather with abundance of water on the leaves. Frequent rains.

Mode of spread and survival: Survives in debris and also in seeds. Primary infection through seeds and secondary spreads through conidia (*pycnidia*) and ascospores (*perithecia*)

Management

- Production of healthy seeds.
- Crop rotation.
- Burning the debris.
- Seed treatment with Captan or Thiram 4g/kg of seeds
- Spraying mancozeb 0.25%

Questions

1. Write symptoms & management of *Fusarium* tuber rot of Yam
2. Write symptoms& management of *Dasheen Mosaic virus* of Colacasia
3. How will you manage bean anthracnose?
4. Give a brief note on Foot rot and blight

LECTURE -14 ONION AND GARLIC

1. Purple blotch / Scald disease

Symptoms

- This occurs mainly at the top of the leaves.
- The infection starts with whitish minute dots on the leaves with irregular chlorotic areas on tip portion of the leaves.
- Later circular to oblong concentric black velvety rings of fruiting bodies appear in the chlorotic area.
- The lesions develop towards the base of the leaf. Sometimes a yellow halo develops around each lesions.
- The leaves break at the point of infection and hang down.
- The infection is also seen on the outer scales of the bulb.
- The disease causes premature drying of the foliage which results in poor development of bulbs.
- Bulbs become dry and papery.

Fungus: *Alternaria porri*. Mycelium is branched, coloured and septate. Conidiophores arise singly or in groups, straight or flexuous, sometimes geniculate, septate and mid brown. Conidia are solitary, straight or curved and obclavate. The body of the conidium may be ellipsoid, tapering to the beak. The beak is about

the same length as the body, mid-golden brown and smooth. They are with 8 to 12 transverse septa and zero to several longitudinal septa. The beak is flexuous, pale and is tapering.

Mode of survival and spread: Survives as dormant mycelium in the infected debris and seed bulbs. Secondary spread through air-borne conidia

Favourable conditions:

Optimum temperature 23-27°C

High humidity

Cloudy weather with slight drizzling.

Management

- Use disease free bulb.
- Diseased dry leaves are to be clipped and burnt
- Spray mancozeb 0.25% or chlorothalonil 0.2% or zineb 0.2 % or difolatan 0.3 % + sticking agent
- Spraying of tebuconazole (0.15 %) is also effective in checking the disease
- Varieties New Selection and Red Creole are resistant.

2. Basal rot / Bulb rot

Symptoms

- The disease is seen from 30 days old crop.
- It occurs in patches.
- The leaves turn yellow and then dry up slowly.
- The affected plant shows drying of the leaf tip downwards.
- The entire plant shows complete drying of the foliage.
- The bulb shows soft rotting and they get rotted.
- There will be a whitish mouldy growth on the bulb scales. The bulbs decay in storage.

Fungus: *Fusarium oxysporum* f.sp. *cepae*. The fungus produces many chlamydospores which are thick walled resting spores and microconidia (one celled thick walled).

Favourable conditions:

Optimum soil temperature 28-32°C. Disease is mostly occurs during maturity period when the soil is exposed to high temperature. The invasion is facilitated by wounds normally

Mode of survival and spread: Soil borne – as chlamydospores
Spread through irrigation water and agricultural operations

Management

- Removal of infected plants and spot drench with carbendazim 0.1%.
- Avoid nematode injuries to bulb.
- Proper curing of bulbs is required
- Providing proper drainage
- Bulb treatment with *Pseudomonas fluorescens* (5 g) + *Trichoderma viride* (5 g) per kg of bulb.

3. Smut

Symptoms

- The fungus attacks seedlings.
- Dark lesions occur on the cotyledons as they emerge.
- These lesions develop into thickened areas of several millimeters in size.
- The lesions burst open and release masses of black spores.
- Infected plants are killed within 3 to 4 weeks of emergence.
- Surviving plants are stunted with short, brittle, distorted leaves bearing lesions throughout their length.
- In the matured plants numerous black blisters are found both on the leaves and bulb scales. Bulbs are usually small.

Fungus: *Urocystis cepulae*. The sori of *Urocystis* contain dark coloured and powdery spore masses. The spores are found in permanent balls. Each ball consists of an enveloping cortex of tinted, sterile bladder-like cells with one or two central dark coloured thick-walled chlamydospores (smut spores). The sterile cells are smaller than the spores. The spores germinate by means of a short promycelium while still in the ball. The promycelium does not produce the apical whorl of sporidia, instead hyphae break apart into independent units and these cells function as spores producing thalli.

Mode of survival and spread: Through soil-borne chlamydospores (smut spores) and air borne basidiospores.

Management

- Crop rotation
- Seed treatment with sulphur 2 g/kg seed or thiram @ 3 g/kg
- Use of disease free seed
- Nursery drenching with sulphur (wetable) 3 g/litre of water
- Removal of crop debris and spraying of captan or folpet

4. Downy mildew

Symptoms

- In systemic infection (when the plants are grown from a diseased bulb) the plants remain stunted distorted and pale green.
- In humid atmosphere the downy growth of the fungus develops over the entire leave surface. In dry weather and only white spots are seen.
- In local infections caused by wind-borne conidia, oval to cylindrical pale spots are formed on the leaves containing alternating green and chlorotic zones.
- In humid weather, the fungus develops as white to purplish downy growth on these spots.
- Usually the older leaves are attacked first and the infection spread to the sheath.
- Inner leaves are then affected but new and young central leaves remain healthy.
- If the leaf is attacked in the middle part, it drops from the point of infection and the tip dries.
- The plants are stunted with succulent neck. Such plants produce only undersized bulbs.

- Succulent necks are subject to attack by fungi and bacteria in storage. The fungus can invade floral parts and can infect a small proportion of the seed.

Fungus: *Peronospora destructor*. Mycelium is coenocytic and intercellular with filamentous haustoria. The conidiophores are non-septate and swollen at the base. Branching is dichotomous. Sterigmata are subacute or acute. Conidia are pyriform and attached to the sterigmata by their pointed end. These conidia germinate by one or two germ tubes. Oogonia are formed in the intercellular spaces.

Management:

Spraying mancozeb

1. Smudge

Symptoms

- It is a disease of scales of the bulb and appears at any time in the plant and during transport or storage.
- Subcuticular black smudge (black stroma of the fungus) is seen on bulb, neck or green leaves which are clinging to the bulb after digging.
- The black colour may be uniform or it is with circular lesions with concentric rings of dark stroma and mycelium.
- When seen with hand lens bristles can be seen inner scales show small, sunken and yellow lesions.
- Under humid weather pinkish mass of spores are seen.

Fungus: *Colletotrichum circinans*. Mycelium is septate and branched. The fungus produces acervuli which contain thick walled, dark, 0-3 septate setae. Conidia are hyaline, fusiform and one celled. They germinate by one or two germ tubes.

Management

- Onion with red scales are resistant (Pusa Red, Pusa Ratna)
- Chemical responsible for resistance in scales of coloured onions - proto- catechuic acid (3,4-dihydroxybenzoic acid)
- Bulbs should be dried properly before storage by hot air at 37-48°C (sun drying is not recommended).
- Spray mancozeb 0.2%

GARLIC

1. Neck rot and bulb rot

Symptoms

- It is commonly found on bulbs at the time of harvest.
- Affected scale tissue become soft. Dense layer of grey mould appear at the neck.
- The infection spreads down the scales which have been originally infected.
- Dark sclerotia appear on the older decayed tissue.
- In the case of bulb rot caused by *Fusarium* failure of germination and drying of leaves from the tip can be noticed. Rotting of bulb and production of side shoots produces clump of shoots.

Fungi: *Botrytis allii* and *Fusarium oxysporum*.

Favourable conditions:

Botrytis allii requires cool, moist weather. Infection and decay of bulbs favoured between 15 and 20°C. Fusarial bulb rot is favoured by excess rainfall followed by a dry spell of 10 to 15 days. The feeding injury by the garlic mite *Rhizoglyphus echinopus* favours bulb rot.

Mode of survival and spread

Both the pathogens survive in the field as well as in storage.

Botrytis allii survives as sclerotia while *Fusarium* survives as chlamydospores in soil and also in bulbs.

Management

- Selection and collection of seed materials from disease free area.
- Bulb treatment with Thiram, Captan 4 g or Carbendazim 2 g/kg.
- Spray carbendazim 0.1%.
- Selection and collection of seed materials from disease free area.
- Bulb treatment with Thiram, Captan Vinclozolin 4 g/kg or Carbendazim 2 g/kg.
- Spraying vinclozolin 0.1% of carbendazim 0.1%.

2. Pink root

Symptoms

- The roots turn pink or reddish and sometimes darken to a red or purple colour.
- Black spores form on the diseased roots which eventually shrivel and die.
- Diseased plants can be easily pulled.
- The above ground symptoms are stunting and yellowing, tip burn and die-back of the leaves.

Fungus: *Pyrenochaeta terrestris* (Syn: *Phoma terrestris*).

3. Aspergillus rot / Black mould blemish

Symptoms

- It is also storage rot.
- It manifests itself with the copious growth of a dust-like fungal mass which remains concealed mostly between the scales.
- The whole tissues are transformed into a black powdery mass.
- The individual bulbs shrivel and are light in weight.
- Infected bulbs lose their pungency and smell.

Fungus: *Aspergillus niger*, *A.alliaceus* and *A.sclerotium*

Questions

- 1 Purple blotch of onion is caused by
- | | | | |
|----|---------------------------|----|-----------------------------|
| A) | <i>Lewia porri</i> | B) | <i>Glomerella circinans</i> |
| C) | <i>Botrytis allii</i> | D) | <i>Sclerotium rolfsii</i> |

- 2 Red scale onions are highly resistant to smudge disease due to high
- | | |
|------------------|-------------------------------|
| A) Oxalic acid | B) Salicylic acid |
| C) Jasmonic acid | D) Protocatechuic acid |

LECTURE 15 POST HARVEST DISEASES: TOMATO, POTATO, CARROT, ONION TOMATO

1. Grey Mold : *Botrytis cinerea*
2. Rhizopus rot: *Rhizopus stolanifer*
3. Anthracnose : *Colletotrichum coccoides*, *C. gloeosporoides*, *C. dematium*
4. Early Blight : *Alternaria solani*
5. Bacterial Soft Rot and Hollow Stem : *Erwinia carotovora* pv. *carotovora*
6. Phoma Rot : *Phoma destructiva*
7. Southern Blight : *Sclerotium rolfsii*
8. Fusarium rot -*Fusarium oxysporum* f. sp. *lycopersici* races 1-3

Grey Mold : *Botrytis cinerea*

Symptoms

1. Lesion - a watery area with a light brown or tan-colored central region.
2. Converted into a soft, watery mass within a few days.
3. Skin is broken, the grayish mycelium and spore clusters develop within a few hours.
4. Halo forms around the point of entry -small whitish rings approximately - develop on young green fruit.
5. "ghost spots" are usually single rings but may be solid white spots;the center of which contain dark-brown specks.
6. High relative humidities are necessary for prolific spore production.
7. Optimum temperatures for infection are between 65° and 75° F (18° and 24° C), and infection can occur within 5 hours.
8. High temperatures, above 82° F (28° C), suppress growth and spore production.

Rhizopus rot: *R. stolanifer*

Symptoms

1. On tomatoes, Rhizopus rot appears water-soaked and may exude a clear liquid
2. lesion surface may be covered with thin, cotton-like fungal structures (especially under humid conditions).
3. Dark sporulation may crown the white tuft of *Rhizopus*.
4. mycelium can infect adjacent fruit through natural openings or mechanical wounds, creating nests of mold and diseased fruit
5. Range of temp. 5, 15 and 25oC reaching disease incidence of 97-100% RH
6. Air currents, pathogen grows very aggressively even on refrigerated fruit.
7. Pallets and cartons, and it may survive for months in fruit residues left in picking containers and field bins.

Anthracnose : *Colletotrichum coccoides*, *C. gloeosporoides*, *C. dematium*

Symptoms:

1. Ripe to overripe fruit - can cause serious losses
2. Fruit infection - during green stages but disease develop. ripening.
3. Small lesions are circular & depressed-enlarge to greater than 12 mm in dia with zonate markings.
4. lesion surface may appear salmon-colored due to spore production and be dotted with black specks
5. Infected fruit have a short shelf life.
6. High temp.and RH, wounds & bruises, opt. temp. for conidial germn. 30oC, RH- 85-to 100%.

Early Blight : *Alternaria solani*

Symptoms:

- The fruit become infected-through the calyx or stem attachment, either in the green or ripe stage. Concentric ring present on the fruit surface.
- Appear leathery and may be covered by a velvety mass of black spores.
- Infected fruit frequently drop, and losses of 50% of the immature fruit may occur.

Bacterial Soft Rot and Hollow Stem :*Erwinia carotovora* pv. *Carotovora*

Symptoms

1. Fruit -soft watery decay of fruit, starting at one or more points, as very small spots.
2. Enlarge-very rapidly until the entire fruit -soft watery mass.
3. Pathogen liquefies fruit tissue by breaking down the pectate "glue" that holds plant cells together
4. leakage-internal collapse resembling a shriveled water balloon.
5. Bacteria -single-celled - rapidly multiply and spread-in water.
6. During wet weather and High humidity,
7. Heavy rain fall or irrigation

6. Phoma Rot : *Phoma destructiva*

Symptoms

1. distinguished from other rots by the black color of this spot
2. Small, black, pimple-like eruptions.
3. Specks are the pycnidia or fruiting bodies of the fungus.
4. Moderate temperature and high humidity.

Southern Blight : *Sclerotium rolfsii*

Symptoms

1. Hot weather disease.
2. Mature plants are attacked just below the soil surface and are completely girdled.
3. The tops wilt and die rapidly.
4. Mycelium often grows over the diseased tissue and surrounding soil forming a white mat of mycelial threads with the typical tan-to brown, at the crown mustard-seed-sized sclerotia.
5. Often the entire root system is destroyed.
6. Fungus is exceedingly destructive on ground crops and attacks the fruit where they contact the soil.

7. Slightly sunken, yellow spots develop on invaded fruit, which rapidly decay, collapse, and become covered by a white fungal mass with numerous sclerotia.
8. Soil borne, machinery or water-moved infested soil, survives on numerous weed and crop hosts

VEGETABLES

1. Alternaria rot : *Alternaria tenuis*
2. Phoma rot : *Phoma destructiva*
3. Phytophthora rot : *Phytophthora infestans*
4. Bacterial soft rot : *Erwinia carotovora* sub sp. *carotovora*

1. Alternaria rot : *Alternaria tenuis*

Symptoms

Brown to black lesion with definite margin. Lesion slightly sunken in advanced stage. Mould growth on the lesion.

2. Phoma rot : *Phoma destructiva*

Symptoms

Slightly sunken brown spots at the edge of stem scar. Spot extends and become circular. In the center of the spot brown to black pycnidia form.

3. Phytophthora rot : *Phytophthora infestans*

Symptom

Affected area becomes less firm, water soaked. White fungal growth in advanced stage.

4. Bacterial soft rot : *Erwinia carotovora* sub sp. *carotovora*

Symptoms

Depressed water soaked spots. Spots enlarge become soft and watery. Emit foul odour.

Favourable conditions:

High moisture. High temperature. Vegetables harvested with wounds. Latent infection. Chilling injury.

Management

Good field sanitation. Preharvest spraying with 0.25% Mancozeb before 10 days of harvest. Careful harvesting and handling of vegetables to avoid wounds and bruises. Harvesting at correct stage. Harvesting and handling when the weather is dry. Infected vegetables have to be removed from the lot. The storage containers, warehouse and shipping yards should be clean and disinfected with formaldehyde, or copper sulphate. Controlled atmosphere (CA) storage and transport using low oxygen- 5 %, or increased CO₂ – 5 -20 %. to reduce respiration of the produce and pathogen. Fumigation of produce with SO₂ can also be done during storage and transport.

LECTURE -16 CHILLIES

Damping off

Symptoms

- Infection is observed in young seedling.
- Collar region becomes water-soaked and the affected portion is soft and weak. Seedlings collapse and topple down at soil level and die.
- Gappiness in the nursery is noticed due to death of seedlings in patches.

Fungus: *Pythium aphanidermatum*. Mycelium is coenocytic, hyaline and branched. They are intercellular and intracellular. Sporangia are lobed and hyaline. The oospores are spherical and thick walled.

Favourable conditions:

Excessive soil moisture
High humidity
Over crowding of seedling

Mode of survival and spread:

Survival: Through oospores present in the soil.

Spread: Soil-borne - Through irrigation water, implement during cultural operations etc.

Management

- Partial sterilization of soil by burning trash helps to check the disease.
- Follow thin planting (600-750g seed per cent) on raised seedbeds.
- Use of light textured soils provides better drainage and aeration.
- Use of well decomposed manure.
- Soil sterilization by drenching the soil 4" deep with Formaldehyde diluted 50 times with water
- Soil drenching with 1% Bordeaux mixture or 0.25 % Copper oxychloride at 12 and 20 days after sowing is also useful.
- Seed treatment with 4 g Captan or Thiram or *T. viride* / kg seed

2. Die-back and fruit rot

Symptoms

- Symptoms are seen on stem and fruits.
- Stem shows **die-back** symptoms.
- Branches die from tip downward.
- Such branches are devoid of leaves and flowers.
- Black dot-like acervuli are found scattered on affected stem.
- Infection at pedicel and tips of branches causes shedding of flowers and flower buds.
- Water-soaked lesions are noticed on fruits.
- Affected portion becomes dirty white, fruits shrivel, dry and fall off.
- Acervuli are also seen on surface of the buds.
- The fruits become white in colour and lose their pungency.

Fungus: *Colletotrichum capsici*. In the acervulus, dark brown and septate, rigid sterile structures called setae arise from the stoma. In between setae a layer of hyaline single celled conidiophores are produced. They bear single celled, hyaline and sickle-shaped conidia.

Favorable condition:

Optimum temperature 22-25° C

Humid weather with rainfall at frequent intervals.

Mode of survival and spread: Fungus is externally seed-borne and the secondary spread is through air-borne inoculum. The disease spreads by wind blown rains during rainy season.

Fungus may not survive long in the soil but may survive on the dead twigs stored under dry conditions.

Management

- Collect seeds only from fruits without infection.
- Crop debris should be collected and destroyed.
- Seed treatment with 4 g Captan or Thiran 4g/kg or Mancozeb per kg seed.
- Spraying with captafol at 0.2% followed by copper oxychloride at 0.25% and Carbendazim at 0.1%.

3. *Alternaria* leaf spot

Symptoms

- Irregular, brown to dark brown spots with concentric rings observed on the leaves.
- Diseased leaves become yellow and fall prematurely.
- Fruits show brown irregular spots with dark brown margin.
- Seeds in affected fruits are discoloured.

Fungus: *Alternaria solani*. The fungus produces brown, septate, inter- and intra-cellular mycelium. Conidia are single muriform with both cross (5-10) and vertical septa and provided with a beak at the tip.

4. *Cercospora* leaf spot

Symptoms

- Oval or oblong spots appear on leaves.
- These spots are with grey centre and brown margin.
- Spots are seen on the stalks and stems also.
- Infected leaves drop off prematurely.

Fungus: *Cercospora capsici*. Conidia needle-shaped, broad at the base and taper towards the tip, sub-hyaline to coloured multiseptate.

5. Powdery mildew

Symptoms

- White talcum powder- like growth is seen on the lower surface of leaves.
- Very often it covers entire leaf surface.
- Corresponding upper surface turns yellow.
- Severely diseased leaves become yellow and are shed.

Fungus: *Leveillula taurica*. Mycelium is purely endophytic. Conidiophores emerge through stomatal opening in clusters of 3 or 4. Conidiophores are long, hyaline and septate. Conidia are club or pear-shaped, single celled and hyaline.

Mode of survival and spread:

Survival: As dormant mycelium in the infected crop debris.

Spread: Through air-borne conidia

Favourable conditions: Same, as for the other powdery mildews.

Management

- Spray thrice at 10-15 days interval with 1ml Dinocap or 2g wettable sulphur per litre of water.
- Before flowering, dusting 8-10 kg sulphur per acre is also useful.

6. *Fusarium* wilt**Symptoms**

- *Fusarium* wilt is characterised by wilting of the plant and upward and inward rolling of the leaves.
- The leaves turn yellow and die.
- 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. By the time above - ground symptoms are evident,
- The vascular system of the plant is discoloured, particularly in the lower stem and roots.
- Roots of affected plants brown and poorly developed.

Mode of survival and spread: Disease is most likely occur in poorly drained soils.

Fungus: *Fusarium solani*. The pathogen produces microconidia (hyaline, cylindrical and 2 celled), macroconidia (falcate with blunt apical cells) and chlamydospores (globose or oval, smooth or rough walled, intercalary or terminal).

Management

- Use of wilt resistant varieties.
- Drenching with 1% Bordeaux mixture or 0.25 % copper oxy chloride may give protection.
- 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.
- Provide proper drainage facilities

7. Bacterial leaf spot**Symptoms**

- Water-soaked, scattered brown spots appear on the leaves.
- Spots are circular or irregular and cankerous.
- The spot bulges and turns purple with black centre.
- A narrow halo surrounds each spot.
- Petioles and young stems are also attacked.

- On the green fruits round, brown coloured, raised spots with depression in the centre are seen.
- Diseased green fruits turn brown or black.

Bacterium: *Xanthomonas vesicatoria* (Syn. *Xanthomonas campestris* pv. *vesicatoria*). It is a rod shaped bacterium with polar flagellum.

Mode of survival and spread: the bacterium was seed borne primarily and secondary spread by rain splash.

Management

- Crop rotation is essential.
- Seeds should be collected from healthy fruits,
- Spray copper fungicide such as Bordeaux mixture or
- Spray 2 or 3g of Plantomycin or Paushamycin mixed with 30g of copper oxychloride per 10 lit of water twice or thrice at 15 days interval depending on the severity of the disease.

8. Mosaic diseases

Symptoms

- Light green and dark green patches on the leaves.
- Stunted plant growth with poor root development.
- Mosaic mottling, distortion and filiform shape of leaves.
- Infected plants bear few flowers and fruits.
- Mottling also seen on fruits

Viruses: Tomato mosaic virus
Potato viruses
Cucumber mosaic virus
Mild Mottle virus
Tomato spotted wilt virus

Spread: Aphids (*Aphis craccivora*, *A. gossypii*, *Myzus persicae*)

Management

- The infected plants should be uprooted and burnt or buried to avoid further infection.
- Avoid monoculture of chilli crop.
- Selection of healthy and disease - free seed.
- Nursery beds should be covered with nylon net or straw to protect the seedlings from viral infection.
- Raise 2-3 rows of maize or sorghum as border crop to restrict the spread of aphid vectors.
- Apply carbofuran 3G @ 4-5 kg/acre in the main field to control insect vectors.
Spray monocrotophos 1.5 ml or dimethoate 2 ml of Acephate 1g or profenophos 2 ml per litre of water.
- Collect and destroy infected virus plants as soon as they are noticed.

9. Leaf curl

Symptoms

Lower and upper curling of leaves accompanied by puckering and blistering of interveinal areas and thickening and swelling of veins are the main symptoms. Internodes are shortened and plants are stunted. Fruiting is stopped and if formed they are small and deformed.

Causal agent: *Tobacco leaf curl virus* (TLCV).

Vector: *Bemisia tabaci* (Whitefly).

Questions

1. Write symptoms & management of Chillies cercospora leaf spot
2. Write symptoms& management of Bacterial leaf spot of Chillies
3. How will you manage Chillies leaf curl ?
4. Give a brief note on Die-back and fruit rot

Questions

1. Post harvest diseases of vegetables can be controlled by
 - A) **Low Temperature**
 - B) High humidity
 - C) High moisture
 - D) High Sugar content

UP TO MID SEMESTER

.....

AFTER MID TERM

LECTURE -18 PEPPER AND BETELVINE

PEPPER

1. *Phytophthora* foot rot

Symptoms

- Dark spots with fimbriate margins appear on the leaves, which spread rapidly resulting in defoliation.
- The infections on the stem are seen as black lesions which result in blight.
- The symptoms on the roots appear as rotting of the entire root system.

Management:

- Spraying Bordeaux mixture 1% and drenching with copper oxychloride 0.2 % at monthly intervals prevents the disease.
- Sterilize the potting mixture either by fumigants such as methyl bromide or through solarization.
- To the sterilized mixture, biocontrol agents such as VAM @ 100 g/kg of mixture and *Trichoderma* @ 10 g/kg of soil may be added at the time of filling of nursery mixture in polybags.

2. Quick wilt / *Phytophthora* foot rot

Symptoms

It produces five types of symptoms

Leaf infection

- One or more dark brown or black spots appear on the leaves (from leaf tip) which enlarge causing concentric zonation with grey centre.

Spike infection

- Infection of spikes and berries leads to spike shedding.
- Affected leaves and spikes shed.
- **Die-back**
- Infection on aerial branches causes rotting of stem and die-back.
- A dark patch appears on the stem.
- Stem breaks off at the nodes.
- Leaves turn yellow flaccid and droop.
- The vine dies in 3-4 weeks (Quick wilt).

Foot rot or collar rot

- Infection at collar region is fatal and it causes death of vines within 3 weeks.
- Affected portion emits bad odour.
- Infection spreads to root system also

Root rot:

- Root symptom appears without foot rot symptom.
- Roots weakened due to death of vine particularly during Oct -Nov.
- These vines may recover after the rain and survive for more than two seasons till the root infection culminates in collar rot and death of the vine

Fungus: *Phytophthora capsici*.

Favourable conditions:

The leaf infection is serious in irrigated areca-pepper mixed plantations.

Collar infection is severe in pure plantations.

Mode of survival and spread: The inoculum survives in infected debris and soil.

Spreads through soil and water. Sporangia are produced in infected leaves of runner shoots and are carried to upper leaves by rain splashed, thereby spreading in a ladder like fashion. Secondary by spread: Termites and snails. (chlamydospores and oospores)

Management

Phytosanitation

- Removal and destruction of dead vines along with root system from the garden is essential as this reduces the build up of inoculum (fungal population).
- Planting material must be collected from disease free gardens and the nursery raised preferably in fumigated or solarized soil.

Cultural practices

- Adequate drainage should be provided to reduce water stagnation.
- Injury to the root system should be avoided.
- The freshly emerging runner shoots should not be allowed to trail on the ground. They must either be tied back to the standard or pruned off.

- The branches of support trees must be pruned at the onset of monsoon to avoid build up of humidity and for better penetration of sunlight.
- Reduced humidity and presence of sunlight reduces the intensity of leaf infection.

Chemical control

- Any of the following chemical control measures can be adopted.
- Drench the soil (45- 50 cm radius) with copper oxychloride 0.2% or potassium phosphonate 0.3% or metalaxyl + mancozeb @ 5-10 litres/vine during May – June followed by foliar spray with Bordeaux mixture 1% or potassium phosphonate 0.3 % or metalaxy + mancozeb.
- Drenching and spraying are to be repeated once again during August-September and during October if the monsoon is prolonged.
- Apply *Trichoderma* around the base of the vine @ 50g/vine at the onset of monsoon (May-June) and again during August - Sept.

3. Pollu disease / Anthracnose

Symptoms

- Spots on leaves are brown to dark brown.
- Spots exhibit coalescence and form bigger lesions with concentric zonations.
- A yellow halo surrounds each spot. On the berries water-soaked dirty brown sunken areas appear.
- Discoloured berries occur in groups of two to five.
- Berries split at the lesion site.
- Berries dry up resulting in hollow and chaffy berries. The word “pollu” in malayalam means a hollow.

Fungus: *Colletotrichum gloeosporioides*. Mycelium is septate and dark. Conidia are hyaline, single celled and oval in shape.

Management

- Spray Bordeaux mixture 1% alternating with carbendazim 0.1%
- Regulate shade.
- A combination spray of (0.1%) Ekalux and (0.2%) mancozeb during September controls both the “Pollu” beetle and disease.

4. Leaf rot and blight

Symptoms

- Greyish sunken spots appear on leaves and the infected leaves.
- On stems, the infection occurs as dark brown lesions which spread both upwards and downwards.
- The new flushes gradually droop and dry up.

Causal organism: *Rhizoctonia solani*

Management

- Spray Bordeaux mixture 1% alternating with carbendazim 0.1%.

5. Basal wilt

Symptoms

- Greyish lesions appear on stems and leaves.
- On the leaves white mycelium are seen at the advancing edges of the lesions.
- The mycelial threads later girdle the stem resulting in drooping of leaves beyond the point of infection and in advanced stages the rooted cuttings dry up.
- Small whitish grain like sclerotial bodies appears on lesions.

Causal organisms: *Sclerotium rolfsii*

Management

- The affected cuttings along with defoliated leaves should be removed and destroyed.
- Later all the cuttings should be sprayed with carbendazim 0.1% or Bordeaux mixture 1%.

9. Slow decline – nematode and fungal complex

Symptoms

- Foliar yellowing, defoliation and die-back are the aerial symptoms of this disease.
- The affected vines exhibit varying degrees of root degeneration due to infestation by plant parasitic nematodes.
- The diseased vines exhibit foliar yellowing coinciding with depletion of soil moisture and recover with the onset of monsoon.
- However, the symptoms reappear in subsequent seasons after the cessation of the monsoon and the diseased vines gradually lose their vigour and productivity.
- The affected vines show varying degrees of feeder root loss, necrosis and presence of root galls due to infestation by plant parasitic nematodes such as *Radopholus similis* and *Meloidogyne incognita* leading to rotting of feeder roots.

Causal organisms: The damage to feeder roots is caused by these nematodes and *Phytophthora capsici* either independently or together in combination.

Management

- Severely affected vines should be removed and destroyed.
- The pits for planting should be treated with phorate 10 G @ 15g or carbofuran 3 G @ 50 g at the time of planting.
- Nematode free rooted cuttings raised in fumigated or solarized nursery mixture should be used for planting in the field.
- Phorate 10 G @ 30 g or carbofuran 3 G @ 100 g/vine should be applied during May/June (with the onset of south west monsoon) and September/October. Along with phorate the basins should be drenched with either copper oxychloride 0.2% or potassium phosphonate 0.3% or metalaxyl + mancozeb
- Ensure sufficient soil moisture at the time of nematicide application.

BETELVINE

1. *Phytophthora* foot rot and leaf rot / Stem rot

Symptoms

Foot rot:

- The fungus attacks the veins at all stages of crop growth.
- The initial symptoms of the disease are sudden wilting of vines rows after rows.
- The affected vines show yellowing and drooping of leaves with tip downwards.
- The leaves become dull due to the loss of lustre.
- The affected plants dry up completely within two or three days.
- The succulent stem turns brown, brittle and dry as stick.
- The lower portion of the stem near the soil region shows irregular, water-soaked lesions.
- The roots at the nodal region show black discolouration and rotting.
- The stem portion buried in the soil snaps at the nodes due to rotting.
- The diseased internodes undergo a wet rot and the tissues become soft, slimy and completely rotten exposing the fibrous parts.

Stem rot:

- The rotting due to the fungus is mainly confined to the stem portion buried in the soil and above the soil level.
- If the seed vines are planted late during cold weather the establishment of the vine is very poor.
- Seed vines snap at the nodes and get rotten. This results in gappiness in the field.

Leaf rot:

- Leaf rot is seen in the young crop.
- The leaves near the soil region show circular to irregular water-soaked spots.
- In the early stages, the affected leaves show yellowing on the upper surface with a downy fungal growth on the corresponding lower surface of the leaf.
- Later these spots turn brown.
- Such affected leaves fall off prematurely. Sometimes affected spots rot and disintegrate.

Fungus: *Phytophthora capsici*. Sporagia with papillum borne singly. Oospores are the sexual spores

Favourable conditions:

Favourable period - September to February

Low temperature (23°C and below) and high relative humidity favour the spread

Mode of Survival: Survives in the soil and crop debris as oospores and chlamydospores.

Management:

- Select well matured vines from field.
- Clean cultivation and alternate cropping
- Collection, removal and destruction of infected plants and plant parts.
- Frequency of irrigation should be reduced during cold weather period.
- Soak the seed vines in Streptocycline 500 ppm + Bordeaux mixture 0.5 % for 30 min.
- Soil drenching with 0.5% Bordeaux mixture at monthly intervals @ 500 ml/hill
- Application of neem cake or neemcake urea @ 150 kg N/ha/year near the root zone.

2. *Sclerotium* wilt

Symptoms

- The vine is susceptible at all stages of its growth.
- The plants are usually affected at the collar region.
- Whitish cottony mass of fungal mycelial growth is seen on the stem and roots.
- The stem rots at the point of attack and darkens up to 10 to 12 mm above the soil line.
- The affected plants show drooping of leaves and they dry up ultimately.
- Darkened portion of the stem shrinks, becomes soft and the bark peels off easily.
- Darkening stem turns black in colour.
- Brown coloured mustard-like sclerotia are formed on the stem and also on the soil near the basal part of the plant.

Fungus: *Corticium rolfsii* (*Sclerotium rolfsii* Sacc.). The hyphae are hyaline when young and become white to ash coloured with age. Sclerotia are spherical, brown to dark brown, shiny, smooth and are found mixed with mycelium.

Mode of survival and spread: The fungus survives in the soil as well as in the infected debris as sclerotia. The fungus is mainly soil borne and it multiplies in the soil where there is copious supply of organic matter and moisture. It also spreads through irrigation water

Management

- Removal of affected vines and burning
- Application of soil amendments check the disease spread
- Apply more neem cake, mustard cake or green manure
- Soil drenching with 0.1 % carbendazim

3. Powdery mildew

Symptoms

- The disease occurs on the tender shoots, buds and leaves and affects the crop at all stages.
- The disease appears as whitish powdery patches on both the surfaces of the leaves.
- Affected leaves get shriveled and deformed and the margins of the leaves turn inwards.
- Such leaves turn pale and fall off easily.
- In older leaves the fungus causes light brown blotches and such affected leaves are rejected when the leaves are picked for marketing.

Fungus: *Oidium piperis*. Mycelium is septate. Haustoria are sac-like. Conidiophores are simple, 2 to 3 septate and bear conidia in chains of 3 to 10. Conidia are cut off in basipetal succession. They are unicellular, hyaline and barrel shaped.

Favourable conditions:

Dry humid weather favours the development (May to July)

Mode of survival and spread: The fungus is mainly air-borne. The spores of the fungus also carried through irrigation water. It survives in crop debris in the soil

Management

- Collect and destroy the infected vines and leaves
- Spray wettable sulphur 0.2 % or sulphur dusting at 25 kg/ha

4. *Cercospora* leaf spot

Symptoms

- The disease appears as minute deep brown to black dots especially on the margins and tips of older leaves.
- The dots develop close to each other in cluster.
- The area surrounding the spots show yellow halo.
- Affected leaves fall off prematurely.

Fungus: *Cercospora piperis-betle*. Conidiophores are non-fasciculate, septate, non-geniculate, olive-brown. Conidia are sub-hyaline straight or curved, 5 to 15 septate, truncate at the base with acute tips.

5. Anthracnose

Symptoms

- Generally older leaves show small, brownish black and circular spots.
- These spots enlarge in size and develop to a size of 2 cm dia. The spots become concentric with a light yellow halo.
- Acervuli as black dots are seen on the spots.
- The affected leaves turn pale yellow and dry up.
- The infected regions gradually become thin and dry and do not undergo any rotting.
- When the spots are present on the margin of the leaves, leaf blade tends to droop owing to the shrinkage of tissues.
- Such infected leaves are generally rejected at the time of picking or harvest. Some times the central dead portion of the spot is found to fall off causing a **shot-hole** symptom.
- Infected leaves fall off prematurely.
- On the stem, black, circular specks appear under the green bark.
- These specks increase in size and form into narrow streaks.
- Later, two or three streaks coalesce and encircle the stem completely.
- The stem above the diseased internode wilts rapidly.
- Acervuli of the fungus are found on stem lesions.

Fungus: *Colletotrichum capsici*.

Mode of survival and spread: Dormant mycelium inside the infected vine responsible for primary spread and the sec. spread through rain and water splashes

Management:

- Collect and destroy the infected vines and leaves
- Spray 0.2 % ziram or 0.5 % Bordeaux mixture

6. Bacterial leaf spot

Symptoms

- This disease is common in wet weather.
- The affected leaves show minute water-soaked angular spots on the lower surface of the leaves.
- These spots become angular and are surrounded by a yellow halo.
- Sometimes the spots are confined to the interveinal space.
- The infection spreads to a larger area and becomes necrotic.
- These leaves lose their lustre and turn yellow and fall off.
- Gummy ooze is seen during wet weather from these spots and the ooze turn into yellow deposits on the lower surfaces of the leaves.
- The vine above the point of stem infection gets killed ultimately.
- The stem infection spreads to the adjoining vine also in the same standard through injuries that occur during the tying operation of vines.

Bacterium: *Xanthomonas campestris* pv. *betlicola*. The bacterium is Gram-negative, rod shaped and is motile by polar flagellum. The bacterium produces yellow, slimy, circular and shiny colony on the medium.

Favourable conditions:

Cloudy weather with high humidity coupled with intermittant rains favour the disease development. More than two years old crop is more vulnerable.

Mode of survival and spread: The infected leaves and stems serve as a source of inoculum. The bacterium enters through the injuries and stomata. It also spreads through irrigation water when splash irrigation is given.

Management

- Affected leaves should be removed and destroyed
- Infected vines should be removed and burnt.
- Removal and burning of crop residues
- Regulate irrigation
- Spraying Bordeaux mixture 0.25% + 0.05% streptomycin should be done after harvesting the leaves.
- Spray streptomycin 400 ppm + Bordeaux mixture 0.25 %

LECTURE -19 FENUGREEK, CINNAMON, NUTMEG, CLOVE AND CORIANDER

FENUGREEK

1. Powdery mildew:

Symptoms:

- The symptoms of the disease appear as white, floury patches on both sides of the leaves as well as on other green parts of the plant (Plate-1).
- The floury patches consist of the mycelium, conidiophore and conidia of the fungus.

Pathogen:

- The disease is caused by *Erysiphe polygoni* DC.
- Fungus *Oidiopsis taurica* (imperfect stage of *Leveillula taurica*) has also been reported to be associated with this disease.
- The mycelium of *Erysiphe* is generally fine and persistent, rarely thick.
- The haustoria develop as outgrowths from lobed swellings. The haustorium penetrates the cell wall and forms a sac in the epidermal cell.
- Conidiophores arise vertically and each bears several spores in chain.
- In dry temperate zone, perithecia appear as sharp black specks, scattered on the surface of the white mycelium.
- During following season, they disintegrate and liberate ascospores which germinate and infect the new crop.

Disease cycle and epidemiology:

- Wherever the perithecia are formed they explain the mode of perrenation.
- In other areas the pathogen survives as mycelium and conidia on the host and on other annual and perennial hosts.
- The disease is more prevalent in dry weather and moderate temperatures.

Management:

- Sow the crop by the end of the October.
- Use resistant variety like Prabha. Lines GC-39UM-32, GC-7, GC-20 and UM-34 have also been reported as resistant and can be utilized in breeding programme.
- With the initiation of the disease spray the crop with wettable sulphur (0.2%), or hexaconazole (0.05%) or dinocap (0.06%) or difenoconazole (0.04%) and repeat at 10-14 days interval.

2. Root rot

Symptoms:

- The symptoms of the disease appear in 30-45 days old plants as rotting of roots leading to yellowing of foliage.
- The affected plants wither and dry up.

Pathogen: *Rhizoctonia solani* Kuhn.

Disease cycle and epidemiology: The fungus is soil borne and survives in the form of sclerotia.

Management:

- Follow 3-4 years crop rotation.
- Soil amendment with neem cake (1 t/ha) alone and in combination with Trichoderma reduces root rot.

- Seed treatment with carbendazim (0.2%) followed by drenching @ 0.1 per cent effectively controls this disease.

CINNAMON

1. LEAF SPOT AND DIE-BACK

A severe leaf spot and die-back disease of this crop has been observed in many parts of Kerala which is serious both in nurseries and grownup trees.

Symptoms:

- Small spots develop on leaf lamina which gradually enlarge and coalesce to form irregular patches.
- the leaves dry up and the pathogen spreads to the stem resulting in die-back symptoms. Young seedlings are killed.
- In mature trees, small specks appear which increase in size resulting in necrotic blotches. Light to deep brown concentric zones develop on the spots during alternate dry and wet conditions.
- Shot hole symptoms are rarely noticed.

Pathogen: *Colletotrichum gloeosporioides* (Penz.)

Management:

- i) Collect and destroy the infected plant debris.
- ii) With the initiation of the disease, spray the crop with Bordeaux mixture (5:5:50) or copper oxychloride (0.3%) or combination of mancozeb (0.25%) and carbendazim (0.1%) and repeat at 14 days interval.

2. CANKER

Symptoms:

- irregular and vertical necrotic stripes (1-5 cm) appear on affected plants. The cankers are sunken with zonations and separated from the healthy tissue by a black line.

Pathogen: *Phytophthora cinnamomi* Rands.

The hyphae are broad, hyphal swellings typically spherical (42 µm). Sporangioophore are thin (3 µm) and occasionally branched. Sporangia are broadly ellipsoidal or ovoid (33 x 57 µm), papilla absent. Oogonia (40 µm) have smooth walls and become yellow or golden with age. Antheridia amphigenous, long and measure 21-23 x 17 µm. Oospores hyaline, nearly filling the oogonium and thick.

Disease cycle and epidemiology

The optimum temperature for growth of the fungus is 24-28° C.

Management:

- i) Soil application of sulphur has been recommended for the control of this disease.

NUTMEG

Leaf spot and shot hole: *Colletotrichum gloeosporioides*

Symptoms

- Sunken spots surrounded by a yellow halo are the initial symptoms.
- Subsequently the central portion of the necrotic region drops off resulting in shot hole symptoms.
- Dieback symptoms are also observed in some of the mature branches.
- On young seedlings drying of the leaves and subsequent defoliation are seen.

Management

- The disease can be controlled by spraying 1% Bordeaux mixture two or three times during rainy season.

Fruit rot: *Colletotrichum gloeosporioides* and *Botryodiplodia theobromae*

Symptoms

- This is caused by *Colletotrichum gloeosporioides* and *Botryodiplodia theobromae*.
- Water soaked lesions are seen on the fruits, the tissues of which become discoloured and disintegrated.
- Premature splitting of the pericarp and rotting of mace and seed are the main symptoms of the disease.
- The internal tissues are found rotten. The fallen fruits become enveloped with the growth of the organism

Management

- The disease can be controlled by spraying 1% Bordeaux mixture

CLOVE

1. **Seedling Wilt:** *Fusarium* sp., *Colletotrichum* sp., and *Rhizoctonia*
2. **Leaf rot:** *Cylindrocladium quinquiseptatum*
3. **Last Spot, Twig Blight and Flower Bud shedding:** *Gloeosporium gloeosporioides*

1. **Seedling Wilt:** *Cylindrocladium* sp., *Fusarium* sp., *Colletotrichum* sp., *Rhizoctonia* sp., and *Trichoderma* sp

Symptom

- Seedling wilt is found mainly in nurseries and causes five to 40% death of seedlings. Leaves of affected seedlings lose natural lustre, tend to droop and ultimately die.
- The root system and collar region of the seedling show varying degrees of, discolouration and decay.

Management

- Since the infected seedlings promote spread of the disease they are to be removed and destroyed and the nursery is drenched with Copper oxychloride 0.25 %.

2. Leaf rot: *Cylindrocladium quinquiseptatum*

Symptom

- It is noticed in the nurseries as well as in the main field both at young and mature stages.
- Infection starts as dark spots at the leaf margin and spreads sometimes with no definite pattern.
- Rotting may be in the whole leaf or at the tip resulting in defoliation.

Management

- Seedling and young plants can be sprayed with systemic fungicides Carbendazim 0.1%.

3. Last Spot, Twig Blight and Flower Bud shedding: *Gloeosporium gleosporioides*

Symptom

- Necrotic spots of variable size and shapes are noticed on the leaves.
- Severely affected leaves wither, droop down and dry up.
- In nursery seedlings die back symptoms are seen. Twigs are infected as the symptoms extend from the leaves through petioles.
- The affected branches stand without leaves or only with young leaves at tips. Flower buds are attacked by spreading infection from the twigs.
- Shedding of flower buds occurs during periods of heavy and continuous rainfall.

Management

- Spraying 0.25% Copper oxychloride at monthly interval reduces disease intensity, defoliation and flower bud shedding.
- Initial spray is given just prior to flower bud formation and continued till the harvest of buds.

CORIANDER

1. Stem gall / Tumour

Symptoms

- The disease appears in the form of tumour-like swellings of leaf veins, leaf stalks, peduncles, stem and fruits.
- The swellings on the veins give a swollen hanging appearance to the leaves.
- The swellings are usually elongated and 9-12 mm x 3-5 mm dia.
- The size of the swellings vary according to the dimension of the part infected.
- The fungus is restricted to tumours and become rough. In very severe cases the plants are killed.

Fungus: *Protomyces macrosporus*. The fungus hyphae are intercellular, septate and broad. Scattered cells in the hyphae swell and form ellipsoidal or globose bodies which later develop into chlamydospores. As they mature they become surrounded by a thick, hyaline, three layered wall and attain a dia of 50 – 60 microns.

Exospore is thick and brown. Meso and endospores are thin. Chlamydospores germinate in water and form sporangia and spores. The released spores from sporangia are connected in pairs and later they fuse.

Favourable conditions: High soil moisture, and shade favours ph. 7.4 in more suitable.

Mode of survival and spread: Primarily through seed and soil. The fungus survives in seed and soil as chlamydospores. Chlamydospores show 10 % germination after six years.

Management

- Use clean and healthy seeds.
- Field sanitation and crop rotation.
- Diseased crop refuse should not be left in the field.
- Seed treatment with captan or thiram 4g/kg seeds

2. Wilt

Symptoms

- The plants are attacked at all stages of growth.
- The severity of disease increases with age.
- Wilting is sudden instead of being gradual.
- The disease can be easily recognized in the field by drooping of the terminal portions, followed by withering and drying of leaves, eventually resulting in death.
- Discolouration of vascular system of the root is observed.
- Partial wilting is also found. Sterility is often noticed in such plants.
- Seeds if formed are immature and light. Severe infection in the early stage results in total failure of the crop.

Fungus: *Fusarium oxysporum* f. sp. *corianderii*. The fungus produces macro, micro conidia and chlamydospores. The pathogen remains viable in the seed for five months and can survive for longer period in the soil. Soil-borne inoculum is the primary source of infection.

Mode of survival and spread: Pathogen survive both in seed and soil. Soil-borne inoculum is the primary source of infection

Minor diseases

1. **Powdery mildew** – *Erysiphe polygoni*
2. **Grain mould** – *Alternaria* sp., *Curvularia* sp., *Fusarium* sp. and *Helminthosporium* sp.

Questions

- 1 Stem gall of coriander is caused by.....
- | | |
|-----------------------------------|---|
| A) <i>Glomerella circinans</i> | B) <i>Protomyces macrosporus</i> |
| C) <i>Macrophomina phaseolina</i> | D) <i>Sclerotium rolfsii</i> |

LECTURE -20 TURMERIC AND GINGER

TURMERIC

1. Rhizome rot

Symptoms

- Affected plants become pale, leaf tips turn yellow and infection gradually spreads down to the leaf blade and leaf sheath along the margin.
- Often the middle portion of the lamina remains green while margins turn yellow.
- Leaves droop, plants wither and dry.
- Infected plants can be pulled out from the soil easily.
- Root systems are heavily damaged. Rhizomes get discoloured, brown, mis-shaped, soft and form a putrefying mass.
- It is a complex disease and is more predominant.

Fungus: *Pythium aphanidermatum*. The mycelium is hyaline and coenocytic. Sporangium is lobulate, zoospores are reniform in shape and biflagellate. Oospores are produced.

Management

- Treating the seed rhizomes with mancozeb 0.3% for 30 min prior to storage and at the time of sowing prevents the disease.
- Crop rotation with non-hosts
- Grow turmeric in light soils with good drainage
- Use disease free rhizomes for planting
- Rhizomes should be dipped in Metalaxyl@2.5g/l or Bordeaux mixture@1% solution for 40 minutes
- Drench the soil at root region with captan@2 g or COC@2.5 g or metalaxyl@1 g per liter in the initial stages of the disease
- Turmeric varieties, PCT-13 and PCT-14 are resistant to this disease

2. *Colletotrichum* leaf spot

Symptoms

- The spots are elliptic and oblong with greyish white centre, brown margin and yellow halo.
- Spots coalesce and leaves dry.

Fungus: *Colletotrichum capsici*. Mycelium is inter-and intra-cellular. Internal mycelium forms stroma and setae. Conidia borne on conidiophores are hyaline, single celled and falcate.

Favourable conditions: August-September when there is high humidity.

Mode of survival and spread Conidia are disseminated by wind and rain. Also carried over as dormant stromata between the rhizome scales.

Management

- 1% Bordeaux mixture or 0.2% mancozeb in early August before the appearance of the disease.
- Select seed rhizomes from healthy areas, avoid excess shade adopt mixed cropping.

3. Leaf blotch

Symptoms

- Spots appear on both the surfaces of the leaves.
- It first appears as apple yellow discolouration turning to dirty yellow and then brown with chlorotic halo.
- Spots coalesce forming large necrotic blotches. Ultimately the leaves dry up.

Fungus: *Taphrina maculans*. Mycelium is intercellular and haustoria are branched or lobed. Each ascus contains eight ascospores.

Favourable conditions: 80% RH and 21-23°C.

Mode of survival and spread: Soil debris

Management

- Spray 1% Bordeaux mixture or 0.2% Copper oxychloride or mancozeb 0.2%.

GINGER

1. Rhizome rot / Soft rot

Symptoms

- The infection starts at the collar region of the pseudostems and progresses upwards as well as downwards.
- The collar region of the affected pseudostem becomes water soaked and the rotting spreads to the rhizome resulting in soft rot.
- At a later stage root infection is also noticed. Foliar symptoms appear as light yellowing of the tips of lower leaves which gradually spreads to the leaf blades.
- In early stages of the disease, the middle portion of the leaves remain green while the margins become yellow.
- The yellowing spreads to all leaves of the plant from the lower region upwards and is followed by drooping, withering and drying of pseudostems.

Fungus: *Pythium aphanidermatum*, *P. myriotylum*, *P. graminicolum*, *P. gracile*, *P. deliense*, *P. indicum* and *P. vexans*. Soft rot is the most destructive disease of ginger which results in total loss of affected clumps. The disease is soil-borne and is caused by *Pythium aphanidermatum*. The fungus multiplies with build up of soil moisture with the onset of south west monsoon. Younger sprouts are the most susceptible to the pathogen.

Mode of survival and spread: Survives in soil and seed rhizomes scales as oospores, and plant debris.

Management

- Treatment of seed rhizomes with mancozeb 0.3% for 30 minutes before storage and once again before planting reduces the incidence of the disease.

- Selection of well drained soils for planting.
- Select seed rhizomes from disease free gardens, since the disease is also seed borne.
- Once the disease is located in the field, removal of affected clumps and drenching the affected and surrounding beds with COC 0.3% checks the spread of the disease

2. *Colletotrichum* leaf spot : As in turmeric

3. Leaf blotch : As in turmeric

4. Yellow

Symptoms

- Yellowing of the margins of the lower leaves which gradually spreads to the entire leaf;
- The affected plant wilts and dries but does not fall down, rhizomes show creamy discoloration of the vascular system and a cortical rot.

Fungus: *Fusarium oxysporum*

Favourable conditions: Very high humidity (87-95%) and 23-29°C.

Mode of survival and spread:

Infected rhizomes, secondary spread by conidia carried by rain water.

Management

- Crop rotation, seed treatment with organo mercurial fungicide drench soil with 0.3% Dithane M-45 or 0.1% Benlate (or) Bavistin.

5. Leaf spot

Symptoms

- Small, oval, elongated spots of 1 to 10 x 0.5 mm size appear on the leaves.
- Matured spots will have a dark brown margin, papery white centre and yellow halo.
- The spots coalesce and cause extensive discolouration. It is followed by premature leaf fall.

Fungus: *Phyllosticta zingiberi*. The fungus produces pycnidia. The conidia are hyaline, oblong and are with rounded ends.

Favourable conditions: Growing without natural shade.

Mode of spread: Rain splashes

Management

- Spray (0.2%) Dithane Z-78 or 1% Bordeaux mixture or Captafol
- Spray Bordeaux mixture 1% or mancozeb 0.2%.

6. Bacterial wilt

Symptoms

- Water soaked spots appear at the collar region of the pseudostem and progresses upwards and downwards.
- The first conspicuous symptom is mild drooping and curling of leaf margins of the lower leaves which spread upwards.
- Yellowing starts from the lowermost leaves and gradually progresses to the upper leaves.
- In the advanced stage, the plants exhibit severe yellowing and wilting symptoms.
- The vascular tissues of the affected pseudostems shows dark streaks.
- The affected pseudostem and rhizome when pressed gently extrudes a milky ooze from the vascular strands

Causal organism: *Ralstonia solanacearum*

Favourable conditions: Ill-drained soils and damp weather.

Mode of survival and spread: The pathogen has a wide host range infecting several solanaceous crops. Soil and seed borne disease

Management

- The cultural practices adopted for managing soft rot are also to be adopted for bacterial wilt.
- The seed rhizomes may be treated with Streptocycline 200 ppm for 30 minutes and shade dried before planting.
- Once the disease is noticed in the field all beds should be drenched with Bordeaux mixture 1% or copper oxychloride 0.2%.

Questions:

1. Leaf blotch of turmeric is caused by
A) ***Taphrina maculans*** B) *Colletotrichum capsici*
C) *Pythium aphanidermatum* D) *Phytophthora palmivora*
2. Ginger Rhizome rot is caused by
A) *Taphrina maculans* B) *Colletotrichum capsici*
C) ***Pythium aphanidermatum*** D) *Phytophthora palmivora*

LECTURE -21 TEA

1. Blister blight

Symptoms

- It is a disease in the nursery and planted crop.
- The first visible symptom is circular, oily, yellowish, translucent spot on the tender leaf and later it turns into deep red shiny blisters.

- The circular spot gradually enlarges to 3 to 13 mm dia. bulged on the under surface of the leaf with concave trough-like depression on the upper surface forming a classic blistered lesion.
- Leaves become curled and distorted.
- The disease attacks first flush of 2 to 3 young leaves and kills the young shoots and buds.
- Matured leaves are less affected.
- The disease occurs in the nursery when the stem is 15 cm in height.
- Repeated attacks cause death of seedlings.

Fungus: *Exobasidium vexans*. Mycelium is septate. It produces two kinds of spores viz., conidia and basidiospores. The conidia are borne singly at the tips of long stalks. They are hyaline, elliptical, straight or slightly curved. Basidia are long, club-shaped and thin walled. The basidiospores are ovate or oblong and hyaline.

Favourable conditions:

- Relative humidity plays an important role in the epidemics of blister blight.
- The RH degree 80% for 5 days the rate of infection decrease.
- It was above 83% for 7 to 10 days, the infection was moderate to serious.
- Temperature above 35°C inhibit the disease,
- Medium pruned tea is particularly susceptible as it provides vigorous succulent shoots and large tender leaves.
- Bushes in low, moist and shady localities suffer more.

Mode of survival and spread: The fungus completes its life span in 11-28 days and several generations of spores are produced in a season. It produces conidia and basidiospores in the same blister. Spores are airborne. No resting stage seen in bush. Abandoned nurseries and badly kept gardens harbour the pathogen. It first appears in the borders of nearby plantations.

Management

- Pruning and removal of affected shoots.
- Bordeaux mixture 1 % or copper oxychloride 0.25 % are superior to other formulations and economical. Repeated sprays are required. But copper stimulates the development of mites.
- Nickel chloride is used as an eradicant. It does not stimulate mites, and could kill fungus which is already in the leaf tissue.
- Among the systemic fungicides, Tridemorph 0.1% (Calixin) or Hexaconazole 0.1 % (Contaf 5 EC) or chlorothalonil or mancozeb or Bitertanol or Bayleton offer good disease control and give increased yield more than copper fungicides.

2. Grey blight

Symptoms

- The disease appears as minute, brown spots on older leaves, which soon turn grey.
- The spots are mostly irregular and several of them may coalesce to form irregular patches.
- The spots have fine concentric lines.
- Acervuli appear as black dots in the older spots on the upper surface.

- The fungus attacks plucking points and causes die-back.

Fungus: *Pestalotiopsis theae*. Acervuli are globose, sub-epidermal erumpent and dehiscent rupturing epidermis by a pore. Conidiophores are hyaline and cylindrical. Conidia are cylindrical and 5-celled with 3 filiform setulae.

Favourable conditions

The incidence is more frequent on weak bushes, especially if potassium is deficient. The infection is also predisposed by sun scorch, insect puncture and plucking wounds.

Mode of survival and spread: Basidiospores wind borne. First appears on borders adjacent to jungles.

Management

- Addition of Potash promotes recovery
- Bordeaux mixture 1 % or copper oxychloride 0.25 % is effective.

3. Pink disease

Symptoms

- Number of fine silky threads united into a thin film appears on the stem.
- They are not found on the leaves.
- The fungus forms pink fructifications over affected stems.
- Young branches on the outside of the bush lose their leaves and die-back.
- The pink concentrations crack into smaller fractions at right angles.
- They are generally confined to lower or more shaded side of branches.
- Barks are killed in patches.
- Pink tissues become white when they become old.

Fungus: *Corticium salmonicolor* (*Pellicularia salmonicolor*)

Mode of survival and spread: Basidiospores are wind borne. First appears on borders adjacent to jungles.

Management

- Addition of potash promotes recovery
- Difficult to eradicate by removal of affected parts.

4. Black rot

Symptoms

- The disease appears normally at the end of May or early June.
- Small dark-brown irregular spots appear on the leaves.
- They coalesce to form dark brown patches, which eventually cover the whole leaf.
- Diseased leaves fall off.
- Before the leaves turn black the lower surface assumes a white powdery appearance.

Fungi: *Corticium invisum* and *C. theae*.

Mode of survival and spread Basidiospores carried by workers as clothes. The disease develops rapidly when temperature is high and air is humid. At the beginning of rainfall they germinate and produce hyphal which starts fresh infection Basidiospores carried by they workers and germinate only in wet weather or when leaves are covered with dew.

Management

- Pruning of affected branches.
- Prunes in December end remove the prunings immediately, burn after drying.
- Collect all dead and dried leaves.
- Spray a copper fungicide in 3rd week of April.

5. Red rust

Symptoms

- Small translucent watery spots appear on the leaves.
- On the upper surface of the leaves, they become purple red and then black with a purple margin.
- On the under surface it is purple red and it becomes grey brown when old.
- Infection on new stem reduces vigour or causes death.

Alga: *Cephaleuros mycoidea* and *C. parasiticus*.

Favourable conditions

- Disease of weak bush – weakness due to lack of drainage, shallow soil, hard pan, hard plucking and improper pruning.
- Too severe pruning of young plants weakening by red spider attack drought logging favour the disease.

Mode of survival and spread: Sporangia, zoospores spread by wind or rain

Management

- Spray Bordeaux mixture 1 % or COC 0.25 % immediately after pruning.
- Rectify soil defects.
- Bushes should be kept in good vigour by proper fertilization.
- Badly diseased bushes should be removed.

6. Sooty mould

Symptoms

- A black superficial fungal growth (mycelium and spores) is seen on the leaf, stem, branches and shoot of tea plants.
- The infection is superficial and associated with the presence of scale insects and aphids.
- The disease reduces photosynthetic activity of the plant.

Fungus: *Capnodium* spp.

ROOT DISEASES

7. Stump rot- *Ustilina zonata*

- Tea bushes die in patches as if suffering from drought.
- Brown or white mycelium with fan shaped fructifications is seen when bark is removed in root but the roots do not show any external mycelium.

8. Brown root rot-*Fomes lamoenis*

- The mycelial mat at the root surface produces tawny-brown cushions and deep-brown honey comb-like lines in the wood.
- Fructification is rarely seen.
- This is a faster killer than charcoal stump rot

Black root: *Rosellina areuata*

Symptoms

The fungus originate from the dead heaped leaves of 5 – 7.5 above the soil level. From there it spreads to roots region of tea bushes. When bark is removed star like growth of mycelium can be seen. At the surface of the soil the mycelium surrounds the stem and kills the bark for the length of 7.5 – 10.0 cm. A swollen ring of tissue is formed round the stem above the dead patch.

Pathogen

The fungus produces two kinds of fructification, a conidial stage and a perithecial stage. The conidia are borne on short bristle like stalks. The perithecia are black and spherical. They bear asci which in turn bear ascospores.

Mode of spread

The disease is spread by wind

Management:

Removal and destruction of infected plant. Clean cultivation with out fallen leaves

Dig a drench around the infected bush to provide sunlight in the drench which prevent the spread of mycelium.

10. Armillaria root rot- *Armillaria mellea*

- It produces longitudinal splits at the collar region below the bark, which gets filled with mycelium.
- Brown rhizomorphs are formed on bark and roots.
- Mushroom like basidiocarps are formed in advanced stages.

11. Red root rot- *Poria hypolateritia*

- When root bark is removed, reddish mycelial strands become visible.
- The bark gets softened and wood becomes discolored.

Management

- Isolation of infected bushes by trenching (4 feet deep, 1.5 feet wide) to avoid root contacts.
- Apply lime in the trench.
- Pruning shade trees to permit more sun light. Field sanitation by uprooting infected, dead bushes and burning them.
- Adequate manuring to keep the bushes to promote vigorous growth.
- Soil fumigation is the best method of control, though expensive.
- Vapam and Metham sodium may be applied into an apparently ring of bushes, 20-25cm away from the collar region of the living plant to avoid phytotoxicity. They are injected into drilled holes to a depth of 20 cm at a distance of 30cm.

Questions

1. Write symptoms & management of blister blight of Tea
2. Write symptoms& management of Black rot
3. How will you manage Grey blight of Tea?
4. Give a brief note on Root diseases of Tea

LECTURE -22 COFFEE

1. Collar rot / Damping off

Symptoms

Pre-emergence damping off:

- Embryo and endosperm are invaded by fungus before germination and radicle during germination.
- Seeds rot and disintegrate

Post-emergence rot:

- Seedlings show brownish discolouration on the stem near the ground level leading to rotting of the tissue.
- Growing apex wilts and the seedlings collapses and dies

Favourable condition: Over crowding of seedlings, thick overhead shade, hot and humid climate, excessive soil moisture in the nursery beds

Fungus: *Rhizoctonia solani*

Management

- Expose the nursery soil to the sun for 2-3 months
- Prepare raised seed beds and drain off the excess moisture
- Avoid excessive watering
- Avoid over crowding of seedlings by proper spacing
- Provide filtered overhead shade using green leaves / coir mats / nylon mats
- Remove and destroy the affected seedlings by burning to prevent further spread
- Treat coffee seeds with carbendazim 1.0 g/kg or drench the nursery beds with 0.4 % captan or mancozeb
- Remove affected seedlings and spray with any of the fungicides viz. carbendazim @ 1.0 g per lit or captafol @ 3.75 g per lit of water to protect the seedlings

2. Leaf rust

Symptoms

- Small, yellow translucent oily spots appear on upper surface of the young leaves.
- Spots enlarge into round shape of 10 to 15 mm in dia.
- Spots later turn into orange yellow colour.
- The corresponding lower surface is covered with orange brown, dusty, powdery growth of uredospores.
- The affected leaves are shed. In severe cases complete defoliation is seen.
- Berries from diseased plants remain small.

Fungus: *Hemileia vastatrix*. The dusty powder consists of uredospores, which are orange-segment shaped. The convex surface is echinulated and the concave surface is smooth. Teleutospores are thick walled, smooth and turnip-shaped. Aecial and pycnial stages are not noticed.

Mode of survival and spread: Air-borne uredospores and teliospores. Intermittent rain and sun shine Mist or rain during dry weather from December to March. Thin or no overhead shade during the monsoon.

Management:

- Resistant material: Grow resistant / tolerant cultivars viz., Selection. 5 B, 9.
- Cultural methods: Following crop harvest, prune the dead and dying twigs including die-back affected twigs.
- Apply balanced nutrient to maintain plant vigour and to balance the plant biomass.
- Maintain good overhead shade in plantations
- Biological control: Fungus, *Verticillium hemileiae* is useful for a short period during winter months as biocontrol agent.
- Chemical control: Prophylactic spray of Bordeaux mixture 0.5 % or copper oxychloride 0.25 % before and during monsoon period. Alkaline Bordeaux mixture is more effective (OR)
- Spraying of Bayleton 25 WP 160 g or Hexaconazole (Contaf 5 EC) @ 400 ml Triadimefon 0.05 % in 200 lit of water during August-September is effective
- Plantvax 20 EC @ 300 ml in 200 litres of water may also be sprayed with caution (it leads to defoliation sometimes)
- Foliar nutrients (urea, ZnSO₄ and MOP) are compatible with BM and Bayleton.
- Spreaders and stickers like Teepol or linseed oil increase the fungicide efficacy.

3. Anthracnose / Nilgiri twig disease

Symptoms

- Greyish spots are observed on leaves, twigs and berries.
- On the leaves and branches spots are necrotic.
- Elongated brown or black lesions are seen on the branches, which result in blackening of twigs and dying from tip downwards.
- Spots on berries are black and irregular.
- Berries fail to mature and form *kattikai*.

Fungus: *Colletotrichum coffeanum* (Syn. *Glomerella cingulata*). Acervuli producing single celled conidia are noticed.

Favourable conditions: Dry period following the monsoon rain

Mode of survival and spread: Wind-borne conidia

Management

- Provide drainage and apply balanced fertilizer
- Spray Bordeaux mixture 1% of Ferbam 0.2%

4. Brown eye spot / Berry blotch

Symptoms

- Disease is severe on nursery seedlings and young crop.
- Spots on leaf are black and necrotic and have dark margin and grey centre and are surrounded by yellow haloes.
- Berries turn dark brown or black with irregular sunken blotch with a purple halo.
- They shrink and fall off. The skin of the fruits becomes dry and hard, making it difficult to pulp.

Fungus: *Cercospora coffeicola*. Conidia are sub-cylindrical, hyaline and 2 or 3 septate.

Mode of survival and spread: The pathogen is seed borne, conidia spread by wind.

Management

- Maintain adequate shade to avoid sun scorching on berries.
- Bordeaux mixture 1% or captan or mancozeb or ferbam or ziram 0.2 % or carbendazim (0.05%) spray gives effective control.

5. Sooty mould

Symptoms

- Leaves, stem and berries are covered with a black fungal growth (mycelium and spores) resulting in reduced photosynthetic activity.
- Wherever heavy attack of aphids and scale insects are found sooty mould occurs.
- The fungus feeds on the secretions of these insects.

Fungus: *Capnodium braziliense*.

Mode of survival and spread: It spreads on leaf surface forming a black growth which cuts off light from green leaves.

Management:

- Control aphids and scales with fish oil rosin soap.

- Boil maida 1 kg with 5 lit of water, cool, dilute to 20 lit (5%) and spray. The mouldy growth will peel off.

5. Koleroga / Black rot

Symptoms

- Affected leaves, twigs and berries change into black colour (Black rot).
- The under surface of the affected leaves is covered by a thin, hyaline, spreading web of fungal mycelium.
- Leaves and berries become brown and finally black.

Fungus: *Corticium koleroge* (Syn. *Pellicularia koleroga*). Mycelium is hyaline, septate, profusely branched with numerous basidia, which arise in groups of 4 or 5 on short branches. Basidiospores are hyaline and thin-walled.

Management

- Centering the bushes to allow sunlight and air.
- Pruning of dead leaves and twigs.
- Spray 1% Bordeaux mixture before and during monsoon.

Questions

1. Write symptoms & management of Coffee rust
2. Write symptoms& management of Berry blotch
3. How will you manage Black rot of Coffee?
4. Give a brief note on Anthracnose / Nilgiri twig disease of Coffee

LECTURE 23 COCONUT & ARECANUT

COCONUT

1. Basal stem rot

Symptoms: The diseased trees show the following typical symptoms in different parts of the palm viz., stem, leaves, inflorescence and roots.

a. Stem:

- The first visible symptom of the disease is found on the basal portion of the stem.
- Diseased palm show exudation of reddish brown, viscous liquid from the basal portion of the stem, up to three metres.
- Discolouration of the stem and internal rotting are commonly noticed up to the height of bleeding (exudation).
- In advanced stages the basal portion of the stem decays completely.
- Some palms show wilting symptoms without external bleeding.
- In some trees, the bark of the stem peels off.
- In diseased palms in the advanced phase or in dead palms the fructifications of the fungus can be observed at the base of the tree just above the ground level as a bracket.

b. Leaves:

- In the diseased palms the leaflets in the outer one or two whorls show yellowing and drooping.

- In advanced stages of infection, the remaining leaves droop down in quick succession leaving the spindle leaf alone.
- Delayed production of new leaves and reduction in the size of leaves are the other symptoms.
- Outer leaves fall off. The spindles become short and do not unfold properly.

c. **Inflorescence and nuts:**

- Development of flowers is arrested and button shedding is common.
- As the leaves of diseased palms droop down, the subtended bunches hang down.
- The quality of kernels from such bunches is poor.
- Nuts are barren.
- When the disease progress is slow, only very few normal nuts are produced.
- Most of the coconut trees bear profusely just prior to and at the time of initiation of symptoms.
- In severely diseased palms, nut and kernel weight, water content, copra weight and oil content decrease.

d. **Roots:**

- Decay and death of finer roots (70 %) proceeds bleeding symptoms in the stem.
- Production of new roots in a diseased palm is very poor.

Fungus: *Ganoderma lucidum*. Mycelium is hyaline, thin-walled, branches with frequent clamp connections. Chlamydospores are ellipsoid and slightly thick-walled. They may be terminal or intercalary and sometimes found in chains. The fruit body is perennial, stipitate, usually lateral and sometimes sessile. It is corky at first and become woody later. Fruit bodies upto 30 cm size occur. Hymenial surface is white or cream at first and turn brown later. Pores are small and round. Basidiospores are thick-walled, brown, minutely verrucose and truncate at one end.

Favourable conditions

Trees grown in sandy loam and sandy soil. Water logging. Low soil moisture during summer months. Damages caused by beetles and weevils

Mode of survival and spread: Soil-borne, irrigation water and rain water

Management

- Remove and burn severely infected trees
- Isolate severely infected tree by digging trench around the tree
- Irrigate at least once in 15 days during summer months
- Apply heavy doses of FYM or compost or green manure @ 50 kg/ year/ tree along with 5 kg neem cake/tree
- Drench the soil with 40 lit of Bordeaux mixture 1 % solution
- Apply aureofungin sol 2 g + copper sulphate 1 g in 100 ml of water or tridemorph 2 ml/100 ml of water through root feeding
- Apply *P. fluorescens* @ 200 g/tree + *T. viride* 200 g/tree/ year
- Apply 200g phosphobacteria+200 g Azotobacter+50 kg FYM / tree
- In situ ploughing of green manure crop around the palm tree

2. Bud rot

Symptoms

- Primary symptoms consist of pale colour, bending over, browning and breaking down of the heart leaf or central shoot.
- The affected heart leaf comes off easily when it is pulled.
- The young leaves lose colour and droop before the heart leaf breaks down.
- At the base of these young leaves brown sunken spots develop affecting a long strip of leaf tissue.
- When rotting extends downward the surrounding whorl become dull yellow. Later it becomes brown.
- Young nuts cease to develop and fall off prematurely.
- The softer infected portion will be rotten and degenerated to slimy mass emitting foul smell.
- When the growing bud is affected the tree is killed. Trees of all ages are affected. But young trees are severely infected.
- The period taken for withering of heart leaf depends on the point of infection and relative humidity.

Fungus: *Phytophthora palmivora*. The hyphae are intercellular. Sporangia are ovoid with the widest part near the base, papillate and with a short pedicel. The base of the sporangium is usually rounded and attached with the sporangiophore almost at right angle. The zoospores are biflagellate and motile. Chlamydospores are 30 to 40 mm in dia. Oospores are 30 mm in size.

Favourable Conditions

High rainfall, high humidity, low temperature and wound caused by *Rhinoceros* beetles

Management

- Remove and burn badly affected trees
- In the early stage of infection, cut the infected spindle and apply Bordeaux paste
- Give prophylactic spray with Bordeaux mixture 1.0 %

3. Stem bleeding

Symptoms

- The characteristic symptom of the disease is the exudation of a dark reddish brown fluid from cracks in the outer tissue of the stem.
- The fluid turns black as it dries up on the bark. The tissues beneath the bleeding patches decay and become yellow.
- In the early stages, the decay of the internal tissue is localized but as the disease progresses, these patches coalesce resulting in a general decay.
- The infection may occur anywhere on the trunk but is rarely observed on the soft portion immediately below the crown.
- The symptoms exhibited by young trees are different. On young palms the spread of the disease is more rapid.
- The external patches do not indicate the extent of the internal decay.
- The infected trees are not killed generally but their yield is reduced. The trees may become very thin at the top and they are likely to be broken by wind.

Fungus: *Ceratostomella paradoxa*.(Thielaviopsis paradoxa). *T.paradoxa* produces pale brown to brown hyphae. Conidiophores are slender, arising laterally from the hyphae and produce cylindrical endoconidia. Matured endoconidia are hyaline to pale brown and smooth walled. Chlamydospores are terminal in chains, oval, thick-walled and brown. The perithecial stage is *Ceratostomella* (=Ceratomyces) *paradoxa*. Perithecia are partly immersed and light brown. Perithecia are ostiolate. Ascospores are ellipsoid with unequally curved sides, hyaline, non-septate and smooth.

Favourable Conditions

Copious irrigation or rainfall followed by drought, poor maintenance of gardens and damage by beetles

Mode of survival and spread: Soil-borne and secondary. spread by wind-borne conidia, irrigation and rain water.

Management

- Maintain the garden with proper fertilization
- Scoop out the diseased portion and swab with Bordeaux paste
- Irrigate the crop in summer months

4. Grey leaf spot / Blight

Symptoms

- The disease symptoms develop on the outer whorl of leaves.
- At first minute yellow spots encircled by a greyish band are seen on the leaflets.
- They increase up to 5 cm. Gradually the centre of these spots turn greyish white with brown margin.
- Several such spots coalesce into irregular and grey necrotic patches. On the upper leaf surface globose or rectangular or ovoid, black, minute, acervuli are formed.
- In advanced stages, the tips and the margins and at times the whole leaflets dry and shrivel giving the leaf a burnt appearance.

Fungus: *Pestalotiopsis* (= *Pestalotia*) *palmarum*. The fungus produces acervuli. Conidiophores are cylindrical to ovoid. Conidia are 5-celled straight or curved. The three median cells are coloured and the terminal cells are hyaline. Apical cell tapering, crowned with three setulae.

Favourable Conditions: Ill drained soil, continuous rainy weather

Mode of survival and spread: Infected plant debris and wind-borne conidia

Management

- Remove and burn the infected fallen leaves periodically
- Apply heavy doses of potash
- Improve the drainage condition of the soil
- Spray the crown with copper oxychloride 0.25 % or Bordeaux mixture 1.0 % before the onset of rain

5. Root (wilt) disease / Kerala wilt

First observed after serious flood of 1882 in Travancore state

Symptom

- Important diagnostic symptom is flaccidity of leaves i.e., they curve abnormally inwards, resembling the ribs of mammals.
- Yellowing of leaves and marginal necrosis of leaflets.
- Wilting of leaves from middle to outer whorl and shedding of buttons and immature nuts
- Size of mature nuts are small with thin kernel
- Reduced crown size and the tree is unproductive
- Roots show rotting symptom which rot tip backwards
- Accelerated transpiration and reduced absorption by the roots may be causes of wilting predisposes the plant to leaf rot infection by *Bipolaris halodes*

Causal agent: Though various agents (fungi, bacteria, virus) were attributed for the cause of disease, MLO bodies are observed in the phloem cells of apical meristem, petioles and root tips. Phytoplasma

Favourable Condition: Sandy loam soil, severe flood, abundance of lace wing bug, *Stephanitis typica*

Mode of survival and spread: Infected tree sap and lace wing bug, *Stephanitis typica*

Management

- Remove all infected uneconomic trees
- Spray the foliage with 0.01 % monocrotophos or endosulfan to kill the vector.
- Apply balanced doses of fertilizers
- Apply 50 kg of FYM / palm / year
- Control leaf rot infection by spraying Bordeaux mixture 1 % or copper oxychloride 0.3 %
- Avoid water logging by providing proper drainage during rainy seasons.
- Raise intercrops like tapioca, yam, fodder crops

ARECANUT

1. *Mahali* disease / Koleroga / Fruit rot

Symptoms

- Characteristic symptoms include rotting and excessive shedding of immature nuts from the trees.
- The first visible symptom appears as water-soaked lesions on the surface of affected nuts. Infected nuts lose their lustre.
- The lesions gradually spread and cover the entire nut which later rot and shed from the bunches.
- White mycelial mat develops on the fallen nuts.
- Fruit stalks and rachis of inflorescence are also affected.
- Affected nuts are lighter in weight, deteriorate and become unsuitable for chewing.

Fungus: *Phytophthora arecae* var. *arecae*. Sporangia are pear-shaped, single celled and papillate.

Mode of survival and spread: Survive in affected nuts. Rain play major role in spread

Favourable conditions:

Low temperature and high humidity favour the growth

Management

- Field sanitation
- Spray 1% Bordeaux mixture with adhesive or vegetative oil

2. *Anabe roga* / Foot rot**Symptoms**

- The first symptom is slight discolouration of the leaflets in the outer whorl of the leaves.
- This pale discolouration spreads to the whole leaf and the entire crown becomes yellow with the outer whorl drooping down and covering the stem.
- Later the leaves in the inner whorl also become yellow.
- Development of the inflorescence and nuts is arrested. Infected palms exhibit symptoms similar to drought.
- Subsequently the leaves dry up, droop and fall off leaving the base stem.
- The infected stem is easily broken off during heavy wind.
- The base of the stem shows brown discolouration and oozing of dark fluid. On cutting open the affected trunk, dark brown discolouration of internal tissues upto one metre from the ground level can be seen.
- Bracket-shaped fructification of the fungus called ***anabe*** appears at the base of the trunk. Roots of affected palms are brittle, discoloured and dried.

Fungus: *Ganoderma lucidum*. The fungus forms hard leathery brackets with brown polished upper surface and dirty white lower surface with numerous pores.

Favourable conditions:

Fungus grow well in PH 3-9 and soil moisture 40-80%

More severe in neglected, ill-drained and overcrowded gardens.

Mode of Survival and spread:

Fungus is soil borne and spreads through irrigation water and root contact and spread secondarily by airborne spores. Fungus survive in soil

Management

- Collect and burn dead stumps roots and fungal fruiting bodies.
- Improve drainage facility
- Avoid close spacing
- Maintain good sanitation
- Digging deep trenches to avoid root contact from diseased to healthy.
- Drench 1% Bordeaux mixture at frequent interval.

3. Inflorescence die-back and button shedding

Symptoms

- The disease appears on the rachillae of the male flowers and then on the main rachis as brown patches which soon spread from tip downwards covering the entire rachis and cause wilting.
- Affected female flowers are shed. Embryo of female flowers is attacked which shrivel up and show brown discolouration.
- The inflorescence die-back in severe infection.

Fungus: *Colletotrichum gloeosporioides*. The fungus produces conidia which are single celled, subhyaline, cylindrical, straight with obtuse ends with one or two oil globules. Conidia in mass looks pink.

Favourable conditions:

Disease present through out the year more during February-May

Mode of survival and spread: Survival in infected plant parts. Spread through rain water and air

Management

- Removal of affected plant parts
- Spraying carbendazim 0.1%

4. Bud rot

Symptoms

- Discolouration of spindle from yellow to brown rotting of young leaves
- Infection spreads inside and rotting of growing point occur
- Spindle can be drawn with a gentle pull
- Bad odour come out due to invasion of secondary pathogen

Fungus: *Phytophthora arecae*

Management

- Remove the infected portion
- Apply Bordeaux paste

5. Stem bleeding

Symptoms

- During initial stages, small, discoloured depressions appear on the basal portion of the stem.
- Later the spots coalesce and cracks develop on the stem.
- Hollowness develop inside the stem upto varying depths.
- Crowns of affected palms get reduced in size followed by reduction in yield. Finally a dark brown liquid oozes out from the cracks.

Fungus: *Thielaviopsis paradoxa*.

Management:

- Improve drainage facility
- Application of Bordeaux paste on the basal portion

6. Yellow leaf disease**Symptoms**

- Yellowing of leaves and shedding of matured and immature nuts.
- In advanced stage leaves size reduced stiff and closely bunched
- Root tips turn dark and rot.
- Brown necrotic streaks run parallel to lamina in unfolded leaves

Causal organism: A complex disease

Management

- Basal treatment with blue copper
- Application of neem cake
- application of farm yard manure
- Regular manuring practice with NPD + lime + zinc increased the yield

Questions

1. List out the major diseases of Coconut and explain in detail about basal stem rot.
2. Write symptoms and management of Keralawilt in coconut.
3. Give a brief note on Inflorescence die-back and button shedding of Arecanut.
4. Give a brief note on bud rot in Arecanut.

LECTURE -24 RUBBER**1. Powdery mildew****Symptoms**

- Newly formed tender leaves are infected from Jan-March.
- White powdery growth on tender leaflets.
- Diseased leaflets curl, crinkle and their edges roll inwards and fall off, giving a broom-stick appearance.
- On older leaves, necrotic spots occur and reduces photosynthetic efficiency.
- Infected shoots dry and cause die-back. Infected flowers and tender fruits shed

Causal organism: *Oidium heveae*

Management

- Dusting of sulphur or tridemorph 1.5 % D
- Spraying of carbendazim 0.1 %

2. Abnormal leaf fall**Symptoms**

- It induces shedding of leaves during June-August, while general leaf fall occurs in December.

- Leaf shed prematurely either green or after turning coppery red within a fortnight.
- A thick carpet of rotting foliage fallen on the ground emit foul odour.
- Initially the affected leaves show water soaked lesions with dull green colour.
- The petioles exhibit sunken spots; young leaf buds and fruits are rotten.
- Rotting of bark near tapping cut results in reduced latex yield.
- Green pods are affected causing pod rot and loss in viability of seeds.

Fungus: *Phytophthora* spp. (*Phytophthora palmivora*, *P. meadi*, *P. nicotianae* var. *parasitica* & *P. botryosa*)

Favourable condition:

Rainfall, high RH more than 80 %, low temperature of less than 29°C and less than 3 h of sunshine favour the disease.

Management:

- Prophylactic sprays of the foliage with Bordeaux mixture 1 %
- Addition of zinc sulphate 0.2% improves the efficacy

3. Secondary leaf fall

Symptoms

- Disease attacks tender and immature leave.
- Numerous, minute, erumpent, circular brown spots appear on leaves.
- The spots coalesce and dry up.
- Young leaflets get crinkled and shed quickly.
- Young green stems are also attacked and dries up.
- Matured and dark green leaflets are not infected

Causal organism: *Glomerella cingulata*

Favourable conditions:

Moist climate with intermittent rainfall.

Weak plants growing under water logged conditions are more susceptible

Mode of survival: Survive in infected fruits during dry season

Management

- Removal of affected parts and destroyed
- Stop tapping during monsoon
- Exposed surface should be smeared with tar
- Regular shade avoid dense shade
- Spraying Bordeaux mixture 1% or zineb 0.2% control effectively

4. Pink disease

Symptoms

- Occur in old trees.
- Pink encrustation on the affected portion.
- Fungus encircle the stem, penetrate bark, and cortical tissues.
- Bark easily split and peeled off.
- Tree is killed after rainy season if not recognised early.
- Latex coagulate and become dark is the characteristic feature

Causal organism: *Corticium salmonicolor* (or) *C. javanicum*

Mode of survival and spread: Survive in affected plant parts. Primary infection through wind blown spores.

Favourable conditions:

Moisture is the most essential factor in all root diseases.

Management

- Cut ends should be protected with Bordeaux paste (or)
- Painting tar on the affected portion.

5. White root disease

Symptoms

- Presence of white rhizo morph in the affected region.
- Advance stage root decay
- Leaves turn brown due to root decay.
- Fungus form yellow margin with concentric rings.

Fungus: *Fomes lignosus*

Mode of survival and spread:

Primary spread through air borne spores.

Secondary spread through root contact.

Survival in the infected plant parts

Management

- Removal of affected portion
- Cut ends should be poisoned with sodium arsenate
- Avoid contact of infected roots by making a trench
- Drench the soil with 1% Bordeaux mixture

6. Dry root rot

Symptoms

- Affected portion show dry rot.
- On outer surface of wood characteristic black lines can be observed.

- Brown discolouration in between lines.
- Seen fructification in the base of the stem when the tree is about to die.

Causal organism: *Ustilina zonata*

Mode of survival and spread: Through winds

Management

- Removal of infected roots.
- Cut end protected with copper sulphate

Questions

1. List out the major leaf fall diseases of Rubber
2. Write symptoms and management of Rubber powdery mildew.
3. Give a brief note on pink disease of Rubber

LECTURE -25 COCOA, VANILLA AND CARDAMOM

COCOA

Seedling blight: *Phytophthora palmivora*

Symptoms

- The symptoms develop on the leaves and stem of seedlings or budded plants.
- On leaves, small water soaked lesions appear which later coalesce in the blighting of leaves.
- On stem, water soaked lesions develop initially and later turn to black colour.
- Stem infections develop any point on the stem causing the death of seedlings.

Management

- Remove and destroy the affected seedlings.
- Spray with 1 percent Bordeaux mixture or 0.2% copper oxychloride just before the onset of monsoon and thereafter at frequent intervals.

Black Pod rot: *Phytophthora palmivora*, *P. megakarya*, *P. citrophthora* and *P. capsici*

Symptoms

- Infection appears as chocolate brown spot, which spreads rapidly and soon occupies the entire surface of the pod.
- As the disease advances, a whitish growth of fungus consisting of fungal sporangia is produced over the affected pod surface. Ultimately, the affected pods turn brown to black.
- The internal tissues as well as the beans become discolored as a result of infection.

Management

- Periodically remove the infected pods.
- Spray 1 per cent Bordeaux mixture with on set of monsoon and also frequent intervals.
- Provide frequent drainage and regulate shade to increases aeration.

- *Pseudomonas fluorescens* (Pf1) liquid formulations @ 0.5% as soil and foliar spray (3 times per year- June, October & February) was found to be effective in reducing the Cocoa Pod rot and Stem canker.

Stem Canker: *Phytophthora palmivora*

Symptoms

- The cankers appear either on the main trunk, jorquettes or fan branches.
- The earliest symptom is the appearance of a greyish brown water soaked lesion on the outer bark.
- A reddish brown liquid oozes out from these lesions, which later dries up to form rusty deposits.
- The tissues beneath the outer lesion show reddish brown discoloration due to rotting.

Management

- It can be controlled in the initial stages by the excision of diseased bark followed by wound dressing with Bordeaux mixture or copper oxychloride paste.
- Wilted branches should be cut and removed.

Vascular Streak Dieback (VSD): *Oncobasidium theobromae*

Symptoms

- The first indication of the disease is a characteristic yellowing of one or two leaves on the second or third flush behind the growing tip.
- Diseased leaves fall within a few days of turning yellow and the other leaves on the shoot show similar symptoms.
- When the infected shoot is split lengthwise there is always a characteristic brown streaking.

Management

- The disease can be controlled by disposing diseased branches and regular pruning of chupons on the trunk.
- Cocoa nurseries should not be located near the diseased area.
- Avoid getting seedlings from diseased tracts.
- Kerala Agriculture University has developed some VSD resistant and high yielding varieties CCRP-1 to CCRP-7.

Cherelle Rot: *Colletotrichum gloeosporioides*

Symptoms

- The shriveling and mummifying of some young fruits are a familiar sight in all cocoa gardens.
- In the early stages the fruits lose their lustre and in four to seven days they shrivel.
- The fruits may wilt but do not abscise.
- Many other factors like insects, diseases, nutrient competition and over production may also be associated with this problem. Hence, remedial measures will depend upon the nature of the causative factors involved.

VANIILA

Root rot: *Fusarium* sp., *Sclerotium* sp.

Symptoms

- Browning of roots leading to rotting and decay.
- Yellowing of leaves, stem and leaves becoming flaccid, shriveled and giving a drooping appearance.

Management

- Cut and remove the affected roots, reduce mulch.
- Soil drench and spray the plant with 0.2 % Copper oxychloride @ 2 or 3 litre per plant.

Stem rot: *Fusarium* sp.

Symptoms

- Water soaked lesions giving stem a brown coloured appearance resulting in rotting of tissues, leaves turning yellowish and drying off.

Management

- Cut and remove the affected portion
- Spray 0.2% Carbendazim, repeat spray after one month.

Bean rot: *Phytophthora* sp.

Symptoms

- Rotting and shedding of beans

Management

- Spray 0.1% Carbendazim and 1 % Bordeaux mixture alternatively at weekly intervals

Shoot tip rot: *Fusarium*, *Sclerotium*

Symptoms

- Decaying of shoot tip and leaves at the tip

Management

- Spray 0.1% Carbendazim at 15 days interval.

Vanilla mosaic: *Vanilla mosaic virus*

Symptoms

- Mosaic pattern or mottling on foliage.
- Stunting sterility and leaf distortion

Management

- Uproot and destroy the affected plant

Important Prophylactic Measures

- Timely shade management
- Avoid excess moisture
- Allow free movement of air
- Avoid overcrowding of vines by keeping adequate spacing
- Avoid excessive mulching during rainy season and mulching with materials that are not easily decomposed
- Avoid excessive manuring and use of fresh cow dung.
- Apply recommended doses of bio agents like *Trichoderma*, *Pseudomonas*, *Bacillus* etc.
- Collect and destroy the parts of plants showing disease symptoms.

To prevent the chances of multiplication of these fungi and spread of these diseases, the following should be adhered to,

- Avoid excessive use of manure, mulch and irrigation
- Cut and remove disease affected plant parts and burn them.
- Do not use planting materials procured from infected gardens.
- Avoid close planting of vines and over crowding. Follow the recommended spacing.
- Viral disease affected vines should be uprooted and burnt.
- Do not use implements, which have been used on disease-affected plants on healthy plants without thoroughly washing and cleaning them.

CARADAMOM

1. Katte diseases

Symptoms

- Spindle shaped chlorotic flecks (2.5mm) appear on the youngest leaves in an infected clump; these flecks progress into light green, discontinuous stripes which run parallel to the vein.
- Mosaic symptoms are also frequently mixed. As the virus is systemic, the disease spreads throughout the clump.
- It takes 15-20 days for a young seedling to express the symptoms, 30-45 days for a grown up clump in the active growing period and over 3 months in winter months.
- After an year reduction in leaf size and stature of the plant is visible.
- The affected clumps produce slender tillers and shorter panicles.
- The loss is total when young seedlings are infected 35 and 70% one and two years after infection.

Causal organism: Virus

Mode of survival and spread: It is a non-persistent virus transmitted by the aphid *Pentalonia nigronervosa*, use of infected planting stock.

Management

- In new plantations, only healthy seedlings (raised from seeds) are to be used, locate nurseries away from the “Katte” areas.
- For gap filling avoid clones from diseased gardens.
- Infected plants are cut, close to the base, during September-October when there is less vector population.
- The pseudostems are not much disturbed, allowed to lie down, dry and decay.
- The rhizomes are also to be destroyed.

2. Capsule rot

Symptoms

- Leaves, tillers, panicles and capsules are infected.
- Water soaked regions appear on the capsule which become dull brown.
- The infected capsules emit a foul smell and snap off from the rachis.
- Tender shoots, decay.
- Leaves show water soaked, greenish lesions spread and become necrotic.

Fungus: *Phytophthora meadii*

Favourable conditions: High rainfall areas, south west monsoon period August-September high relative humidity and soil moisture.

Mode of survival and spread: The fungus is soil borne.

Management

- Remove diseased and dead parts.
- Drench soil with 1% Bordeaux mixture (4L) or 0.3% Aliette (1L) per clump 2 to 3 times.
- Fresh mulch of infected clump.
- Provide adequate drainage and remove dampness.

3. Clump rot of rhizome rot

Symptoms

- Yellowing of leaves from the tip. Rhizomes decay resulting in death of the clumps

Causal organism: *Pythium vexans*

Management

- Provide drainage, drench soil with 1% Bordeaux mixture (or 0.25% Emisan or 0.2% Brassicol 75 WP), apply lime followed by at 100g superphosphate per clump before the monsoon.

4. Chenthal

Symptoms

- Elongated water soaked lesions on the lower surface of the young leaves.
- They turn yellow, then dark brown with a pale yellow halo.
- When the lesions are many, the leaves wither and the pseudostems wilt.
- The panicles dry from tipdownwards and the flowers fail to develop

Causal organisms: *Corynebacterium* sp.

Favourable conditions: Insufficient shade.

Management

- Provide adequate shade and adopt phytosanitation

5. Foorkey disease or large cardamon dwarf bush virus

Symptoms

- Clustering of leaves, acceleration of vegetative growth dwarfing and stunting of plants.

Mode of survival and spread: Aphid vectors viz., *Pentalonia nigronervosa* and *Micromyzus kalimpongensis*.

Management

- Rogue diseased clumps, plant healthy seedling and spray insecticides to control the aphid vectors.

6. Chirkey disease / Mosaic

Symptoms

- Chlorotic and necrotic streak along the lateral veins of leaves.

Causal organism: Virus

Mode of spread: Aphids viz., *Rhopalosiphum maidis*, *R. padi* and *Sitobion avenae*.

Management

- Some local cultivars viz, Surumpa, Sawney and Kopringer are tolerant use healthy planting material.

Questions

1. List out the major leaf fall diseases of Cocoa and explain in detail Cocoa pod rot
2. Write symptoms and management of Chenthal disease of Cocoa.
3. Give a brief note on Katte diseases of Cardamon

LECTURE 26 JASMINE & ROSE

JASMINE

1. *Fusarium* wilt

Symptoms

- Plants of all age are attacked and wilt occurs in patches.
- Top leaves wilt and bottom leaves show yellowing.
- Yellowing spreads upward resulting in death of the plant.
- Roots show black discolouration.

Fungus: *Fusarium solani*

Mode of survival and spread:

The pathogen is soil – borne and spreads through irrigation water. It survives in soil as chlamydospores

Management

- Soil drenching 1% Bordeaux mixture or 0.1% carbendazim.

2. Alternaria leaf blight

Symptoms

- Affects both young and matured leaves and causes dark brown spots with concentric rings
- Blighted leaves exhibit burnt appearance and fall off
- Petioles, stem, calyx, tubular corolla are also affected.

Causal organism: *Alternaria jasmini*

Favourable condition

Temperature 21-23°C

Relative humidity 80%

Mode of survival and spread: Air borne conidia. Survival through infected plant debris.

Management

- Spraying mancozeb or zinb 0.2%

3. Phyllody

Symptoms

- Clustering of the leaves and bushy appearance of the plants are the characteristic symptoms.
- The leaves become linear and small and are closely arranged. In the place of flowers, green, leafy and malformed flowers are seen.

Causal organism: Phytoplasma.

Vector: *Dialeurodes kirkaldii* (Whitefly)

Mode of spread

Grafting and by whitefly - *Dialeurodes kirkaldii*

Management

- Vector control with any systemic insecticide
- Cuttings should be from disease free plants
- Spraying tetracycline reduces disease severity.

ROSE

1. Powdery mildew

Symptoms

- Raised blister-like areas with greyish white powdery growth are seen on the leaves.
- Young shoots and flower buds are also infected.
- Affected young leaves curl and are distorted. Older leaves show usually little distortion.
- Diseased flower buds may not open and dry later.

Fungus: *Sphaerotheca pannosa* var. *rosae*. (The fungus is of *Oidium* type). Mycelium is septate, white and sends globose haustoria into epidermal cell. Conidia are oval-shaped and are produced in chains (5 to 10) on short, erect conidiophores. The fungus produces cleistothecia with myceloid appendages. Each cleistothecium (ascocarp) contains only one large ascus. Asci are subglobose and each ascus contains eight ascospores. Ascospores are spherical.

Mode spread and survival: Fungus overwinters as mycelium in dormant buds and shoots conidia are wind borne.

Management

- Collect and burn diseased leaves
- Spray wettable sulphur 0.3 % or carbendazim 0.1 % or dinocap 0.07 % at 10 days interval
- Sulphur dust at 25 kg/ ha or wettable sulphur should not be used when the temp reaches 30° C
- Excess N fertilizer should be avoided

2. Black spot

Symptoms

- Characteristic black spots appear on the leaves.
- Spots are more or less circular with fringed margin.
- Black colour of the spot is prominently seen on the upper leaf surface.
- Yellow halo is present around matured spots.
- Affected leaves become yellow and fall off, prematurely leaving the canes almost completely defoliated.
- Raised, purple to red blotches are seen on immature wood of first-year canes.

Fungus: *Diplocarpon rosae*. The fungus produces ascospores in tiny apothecia and Marssonina type conidia in acervuli.

Favourable conditions: Winter frosts

Management

- Spray tridemorph / captan/ carbendazim
- Shade and excess irrigation to be avoided
- Remove and burn the affected leaves.

3. Die-back

Symptoms

- Pruned twigs of the bushes show drying from tip downwards and become black.
- The disease passes from the branch / twig to the main stem and from there to the roots killing the whole plant.
- Stem and roots show browning of the internal tissues.

Fungus: *Diplodia rosarum*. The fungus produces pycnidia and pycnidiospores.

Mode survival and spread

The fungus persists in dead twigs and the stalks of the withered blooms

Management

- Avoid damage by digger wasp
- Prune affected shoots
- Pruned ends should be immediately coated with a paint made up of 4 parts of copper carbonate, 4 parts of red lead and 5 parts of linseed oil or Bordeaux paste with 0.1 % BHC or DDT to ward off the digger wasp.
- Spraycopper oxychloride 0.25% or difolatan or chlorothalonil or mancozeb 0.2 %

4. Rust

Symptoms

- Orange to lemon yellow coloured pustules are seen on the under surface of the leaves which later turn to brick red in colour (uredial stage).
- Minute black hair-like tufts are produced on the under surface of the leaves (telial stage).
- Diseased leaves turn yellow and fall prematurely.
- Bushes are weakened and may die-back.

Fungus: *Phragmidium mucronatum*. Aeciospores are orange yellow. Uredospores are single celled, ellipsoid or ovate, echinulate, orange-yellow and stalked. Teliospores are dark, cylindrical, 6 to 8 celled with a pointed papilla.

Mode of survival and spread

Fungus overwinters as mycelium in dormant buds and shoots conidia are wind borne.

Management

- Spray wettable sulphur 0.3 % or Karathane 0.07% or carbendazim 0.1% or Dusting with sulphur at 20 kg/ha at 15 days interval

Questions

1. Drying of twigs from tip down wards and Blackening of the twigs in rose is caused by
 A) *Diplodia rosarum* B) *Sphaerotheca pannosa*
 C) *Diplocarbon rosae* D) *Phragmidium mucronatum*
2. Write symptom and management of Alternaria leaf blight of Jasmine

LECTURE 27 CROSSANDRA & CHRYSANTHEMUM

CROSSANDRA

1. Wilt

Symptoms

- The disease is noticed in plants one month after transplanting.
- Initially leaves turn pale green or yellow and later change into pink colour.
- Drooping of leaves and wilting of plants are noticed.

Fungus: *Fusarium solani*. Mycelium is hyaline and septate. Microconidia, macroconidia and chlamydospores are produced. The disease is associated with the root lesion nematode, *Pratylenchus delatrei*.

Favourable conditions

Incidence more in the presence of root lesion nematode, *Pratylenchus delatrei*.

Mode of survival and spread: Chlamydomonas survive in soil spread by irrigation water.

Management

- Remove and destroy the infected plants
- Application of phorate @ 1 g/plant 10 DAT will minimize nematode incidence
- Soil drenching with carbendazim 0.1 % or copper oxychloride 0.25% at 25 days interval from 30 days after planting
- Combined application of wet cerasan 0.1 % + phorate 1 g/plant was found effective for both nematode and disease incidence

Root rot

Symptoms

- Sudden wilting of plants in patches is noticed.
- The leaves droop, dry and the plant dies.
- The roots rot, bark shreds and decay and show large number of sclerotia.

Fungus: *Macrophomina phaseolina*. The mycelium is dark coloured and septate. The sclerotia are brown to black and spherical to irregular in shape.

Stem rot: *Rhizoctonia solani*

The pathogen also causes pre-emergence damping off, Brown to black lesions develop on stem just above soil level and result in girdling of the stem. The lesions extend to the upper part of the stem. The lesions extend to the upper part of the stem and result in collapse of seedlings. The roots are also rotted.

Management :

- Drenching with Fosesty1-A1 has been found effective in the control of the disease.

Leaf blight: *Colletotrichum crossandrae***Symptoms :**

The symptoms of leaves consist of the development of brownish, depressed necrotic areas surrounded by reddish and slightly raised margins. Initially the spots appear as brownish specks but become darker as they expand. The lesions are more prominent on lower leaves and confined to the margins. Infected leaves roll up, shrivel and drop off, leaving a barren stem with a whorl of young leaves at the top.

Management:

- Spraying with benomyl 0.1% (or) Mancozeb 0.2% (or) Carbendazim 0.1%

Alternaria leaf spot: *Alternaria amaranthi* var. *crossandrae***Symptoms:**

This disease was first reported from Tamil Nadu during 1972. Infected leaves show small, circular or irregular yellow spots on the upper surface. They soon enlarge turn brown and develop dark brown concentric rings. Infected leaves become yellow and drop off prematurely.

Management:
Spraying with Benomyl 0.1% (or) Mancozeb 0.2% (or) Carbendazim 0.1%.

CHRYSANTHEMUM

1. Blotch / Leaf spot

Symptoms

- Blackish-brown.
- Circular to irregular spots appear on leaves.
- Each spot is surrounded by yellow halo.
- They coalesce with one another and form large patches covering major portion of the leaf. In severe infection, the leaves remain small and curl.
- The dead leaves hang on the stem for sometime.

Fungus: *Septoria chrysanthemella*. Pycnidia are numerous, dark, sub-epidermal, globose and ostiolate. Conidia are hyaline, filiform, straight or flexuous, often curved or worm-like, transversely septate (1-4 septate).

2. Rust

Symptoms

- Yellowish green spots on upper surface of leaves lower surface brown powdery pustules.
- Advanced stage drying up of leaves.

Causal organism: *Puccinia chrysanthemi*

Mode of survival and spread: Infected plant debris, weed host. Spread through air borne uredospores

Management

- 0.2% wettable sulphur, 0.1% Tridemorph.

3. Leaf spots

Symptoms

- Leaf drying is a common symptom in all Leaf spot pathogens.

Causal organism: *Cercospora chrysanthemi*, – *Alternaria tenuis* and *A. chrysanthemi* and *Phyllosticta Chrysanthemi*

Management

- Destroying the infected leaves
- Avoid wetting leaves while watering
- Weekly application of mancozeb or zineb 0.2%

4. Powdery mildew

Symptoms

- Whitish, ash grey powdery growth on upper surface.
- Discoloured corresponding lower surface.

Causal organism: *Erysiphe cichoracearum* and *Oidium chrysanthemi*

Mode of spread: Air borne conidia

Favourable conditions: Dry weather

Management

- Wettable sulphur 0.2%
- Karathane 0.07%.

5. Bacterial blight

Symptoms

- Rotting in upper part of stem
- Occasionally marginal leaf scorch
- Wilting and collapse of plant

Causal organism: *Erwinia chrysanthemi*

Mode of survival and spread: Infected plants, soil, weed host. Spread through rain drops

Favourable conditions:

High humid weather

Management

- Select disease free cuttings
- Cutting dipped in Antibiotic solution for 4 hours

6. Wilt

Symptoms

- Initial symptoms are in the form of yellowing and browning of leaves.
- Affected leaves die from the base of the plant upward. Infected plants are stunted and often fail to produce flower.
- Wilting may cause rotting of root or the base of the stem.

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

Management

- Since the disease is a soil borne it is difficult to control with chemicals alone.
- Drenching the soil with Dexon or Carbendazim is very effective.
- Before planting dipping the rooted cuttings in a solution of Thiram @1.5g/litre of water.
- Since the disease spreads mostly through cuttings, it is important to use disease free planting material.
- Disease can further be minimised by following strict sanitation; periodical monitoring; crop rotation and roughing of infected plants.

7. Rust

Symptoms

- Rust is a serious disease especially in the early spring.
- The disease symptoms are in the form of brown blister-like swellings, which appear on the undersides of leaves.
- These burst open releasing masses of brown, powdery spores. Severely infected plants become very weak and fail to bloom properly.

Causal organism: *Puccinia chrysanthemi*

Management

- Early removal of infected leaves/plants helps to prevent the further spread of the disease.
- Spraying the plants with karathane @0.025% or dusting with wettable sulphur @0.2% is effective in controlling the disease.

8. *Septoria* leaf spot

Symptoms

- Leaf spots occur during cool-wet periods of the rainy season.
- Since the pathogens are spread through rain splashes the lowermost leaves get infected first.
- Serious infection may result in premature withering of the leaves; the dead leaves hang to the stem for some time.
- When flowering starts the infection occurs on flower buds, which rot completely.

Causal organism: *Septoria chrysanthemella*

Management

- These disease can be controlled by spraying Bavistin @0.05% six times at 15 days intervals
- from the end of July or spraying Benomyl (0.1%) followed by Captafol (0.2%) and Carbendazim (0.1%).
- Destruction of disease debris and avoiding excessive irrigation is recommended.

9. Stem rot

Symptoms

- The disease is noticed in cuttings, stock plants and flowering plants. It is serious during rainy weather.
- The affected plants show different symptoms such as leaf chlorosis, necrosis, decay and discoloration of internal portion of the stem.
- When the flower buds are about to open, small dark streaks are seen at the base of the stem.
- Root decay is noticed only in advanced stages of infection.
- In many cases the infection is devoid of any external symptoms and roots also look healthy.
- In some cases stem and root rot are confined to one side of the stem, the other side remaining healthy.

Causal organism: *Fusarium solani*

Management

- Cuttings should be taken from healthy plants.
- Following strict field sanitation, roughing of infected plants and crop rotation helps to minimize the disease incidence.
- Spraying with Bavistin (0.1%) or Bordeaux mixture (1%) and avoiding excessive moisture in beds help in checking the disease.

10. Powdery mildew

Symptoms

- Infection is more severe in older plants under humid conditions.
- The growth of the fungus on the leaves appears as powdery coating.
- Infected leaves turn yellow and dry out.
- Infected plants remains stunted and fail to flower.

Causal organisms: *Oidium chrysanthemi*

Management

- Disease can be effectively controlled with Sulphur fungicides or Captan (0.2%).
- Good ventilation and proper spacing for free circulation of air is recommended.

11. Stunt

Symptoms

- Plants and flowers are smaller and paler. Some flowers may appear bleached and inferior in quality.
- Flowers from diseased plants open 7 – 10 days earlier than flowers from healthy plant.
- Axillary buds often grow prematurely and produce excess number of branches and stolons. Cuttings from diseased plants root poorly.

Fungus: *Chrysanthemum stunt viroid*(ChSV)

Mode of spread: Through sap, knives, tools, cuttings.

Management

- Use of certified viroid-free stocks for planting.
- Removal and destruction of infected plants.

Questions

1. Write symptom and management of Crossandra wilt
2. How will you manage Septoria leaf spot of Chrysanthemum ?

LECTURE 28 MARIGOLD, CARNATION, LILIUM & TUBEROSE

MARIGOLD

1. Leaf spot

Symptoms

- Oval to irregular, smoky grey to black spots
- Minute black fruiting bodies on the leaflets
- Infection start from lower leaves and progresses upwards.

Causal organism: *Septoria tagetica*

Mode of survival and spread: Air borne conidia. Survive through infected plant debris

Management

- Spraying 0.25% copper oxychloride or dithiocarbamates.

2. Wilt and stem rot

Symptoms

- Stem become brown
- Shivel near soil line
- Causing root decay
- Foliage wilts and the whole plant dies.

Causal organism: *Phytophthora cryptogea*

Mode of survival and spread: Primary infection through zoospores. Survive as oospore

Management

- Removal of infected plants
- Drenching 1% Bordeaux mixture (or) 0.2%. COC.

3. Bacterial blight

Symptoms

- Minute light green water soaked lesions on the old leaf.
- Heavy infections cause severe drying and defoliation.

Causal organism: *Xanthomonas tagetis*

Management

- Removal of affected plant parts
- Spraying any Antibacterial antibiotic

4. Mosaic

Symptoms

- Mosaic mottling at early stage
- Leaf lamina distorted
- Plants remain stunted and produce poorly developed flowers

Causal organism: *Virus*

Vector: *Aphis craccivora*, *Aphis gossypii*, *Myzus persicae*

Management

- Removal of affected plants.
- Control vector by spraying any systemic insecticides.

CARNATION

Fusarium wilt: *Fusarium oxysporum* f.sp. *dianthi*

Symptoms

- In young plants, the first sign of the disease is fading or graying of the normal colour of the leaves with wilting of the leaves and young stems.
- It is followed by eventual collapse of the whole plant.
- When older plants are infected, similar symptoms are produced but the older leaves may show chlorosis followed by an indistinct purple-red discoloration.
- The vascular tissues of infected stems is stained dark brown.
- Mature plants show wilt symptoms over a period of several months before they die and eventually become straw coloured.

Management

- The diseased plants should be removed immediately after noticing the disease. Complete root system and surrounding soil should be dug out and disposed off carefully.
- Soil drenching with benomyl 0.1 per cent two weeks after planting and repeated for every three months has been shown to reduce the wilt disease.
- Soil solarization using clear transparent polyethylene film (0.1 mm thick) for 30 days gives satisfactory control.

Alternaria leaf spot: *Alternaria dianthi*

Symptoms

- The chief symptom is blight or rot at leaf bases and around nodes, which are girdled. Spots on leaves are ashy white.
- The centre of old spots are covered with dark brown to black fungal growth.
- Leaves may be constricted and twisted and the tip may be killed.
- Branches die-back at the girdled area and black crusts of conidia are formed on the cankers.

Management

- To reduce the disease incidence, humidity may be kept low by providing proper air circulation.
- Disease-free planting material should be used.
- Planting material should be sterilized with formalin 5.0 per cent solution.
- During propagation of planting materials, spraying with Carbendazim 0.1 per cent or Mancozeb 0.2 per cent controls the disease.

Bacterial wilt *Burkholderia caryophylli*

Symptoms

- The upper parts of established plants turn pale and wilt. The stem develops elongated discolored stripes and split open which is characteristic of the disease.
- The roots are rotted partially and the cortical tissues become sticky and shows discoloration, a tendency to straighten out instead of remaining curled.
- The leaves are twisted. The roots are generally lacking on one side and remain discolored. The base of the cutting is discolored, with an elongated brown area extending upwards.

Management

- Use of cuttings taken from upper parts of the healthy stock plants are less liable for infection and hence advocated as a control measure.
- Diseased plant debris should be collected and burnt. Overhead watering and splash watering should be avoided.
- Disease-free planting materials are to be used. Role cultivars viz., Elegance, Northland and Starlite are less susceptible to bacterial wilt.

LILIUM

Botrytis rot- *B.cinerea*

Symptom

- white spots on the leaves
- whole leaf and stem can become infected and the whole plant decay and collapse.
- Injury to plants, like frost or hail will make it easier for Botrytis spores to enter the leaf

Management:

- Planting lilies some distance apart will also control infection.
- Clean up and burn dead stems and leaves.
- Spray 0.1% Bordeaux mixture or Copper fungicide

Basal Rot – *Fusarium oxysporum var lili*

Symptoms

Premature streaky yellowing of the foliage. The disease can become present in warm moist soils.

Management:

avoid over-watering during warm summer months and provide good drainage.

remove the infected scales, dip the bulbs in a fungicide solution of Benlate 0.2%

Foot rot – *Phytophthora cactoum*

Management :

Soil drenching with Dithane M 45 200g per 100 m²

Blue Mold – *Penicillium* sp

Because lilies have a high sugar content, bruising or mechanical injury can cause a penicillin mold to form on the injured part of the bulb.

Management

This is harmless to the bulb and can be carefully removed. The bulb can be dusted with a fungicide powder and planted as usual.

Virus Diseases - Lily viruses are transmitted largely by aphids.

Symptoms:

Irregular mottling and flecking of the leaves.

Reduction in plant size and height.

Distorted, twisted growth. Color-breaking in the flowers and leaves. Brown ring patterns on bulb scales.

Management :

Destroy clumps of lilies that show severe infection

Remove plants showing infection early in the season.

Avoid planting lilies next to other host plants like Tulips or *Lilium tigrinum* (also known as the Tiger Lily).

Control aphid infections with the use of insecticides.

TUBEROSE

1. **Stem Rot:** *Sclerotium rolfsii*
2. **Botrytis Spot and Blight:** *Botrytis elliptica*

- **Stem Rot:** *Sclerotium rolfsii*

The disease symptoms are preceded by the appearance of prominent spots of loose green colour due to rotting which extend and cover the entire leaf. The infected leaves get detached from the plant.

More or less round sclerotic, brown spots are formed on and around the infected leaf. As a result, the infected plant becomes weak and unproductive.

Management

- The disease can be controlled by soil application of Brassicol (20%) @ 30kg/hectare.
2. **Botrytis Spot and Blight:** *Botrytis elliptica*

Symptoms

- The disease appears during the rainy season. Infected flowers show dark brown spots and ultimately the entire inflorescence dries up. The infection also occurs on the leaves and stalks

Management

- Spraying the plants with Carbendazim @2g/litre of water effectively controls the disease.
- The treatment should be repeated at 15 days interval.

Questions

1. Write symptom and management of Marigold leaf spot
2. Give a detailed note on Tube rose wilt and its management ?

LECTURE 29 MEDICINAL PLANTS - GLORIOSA , STEVIA

GLORIOSA SUPERBA

Leaf blight: *Alternaria alternata*

Symptoms

- Initially, small circular brown spots appear on the leaves. Later the spots enlarge with characteristic concentric rings and leads to blighting of entire leaves.

Management

- Spray propiconazole 0.1% or tebuconazole 0.1% two times at monthly interval.

Root rot and tuber rot: *Macrophomina phaseolina*

Symptoms

- Yellowing of leaves, discolouration and rotting of roots and dark brown lesions on the stem are the prominent symptoms. Rotting of tubers also occur.
- The presence of sclerotial bodies as small, black dot like structures are seen in the stem portions.

Management

- Tuber treatment with *Pseudomonas fluorescens* @ 2 g/lit of water for 20 minutes.
- Spray tebuconazole 0.1%

STEVIA

1. Stem and Root Rot : *Sclerotium rolfsii*

Symptoms :

- Moderate wilting or flagging of stems similar to symptoms of drought stress
- Wilting is followed by rapid necrosis and death of stems
- Abundant white to brown sclerotia are seen at the base of stems in soil line along with white cord-like mycelial growth
- Plants die in a period of 7 days

Fungus : It is a soil living saprophytic pathogen, produces ribbon like hyphae with clamp connections.

Basidia are club-shaped, bearing four smooth, ellipsoid basidiospores. Small, brownish sclerotia (hyphal propagules) are also formed

Mode of survival : As sclerotia in infected plant materials and in soil

Primary spread : Through irrigation water and implements

Favourable conditions : High soil moisture

Management :

- Follow crop rotation with corn or small grains
- Remove infected plants with roots and burn

2. Leaf Spot : *Alternaria alternata*

Symptoms :

- Small, light brown spots appear on leaves
- They become dark brown to grey with concentric zones measuring 2-18 mm in diameter
- Several spots coalesce to form large necrotic areas
- Concentric spots are more common at the tips of older leaves

Mode of survival : In diseased plant debris

Primary spread : From dormant mycelia in diseased plant debris

Secondary spread : Through wind-borne conidia

Favourable conditions : Nutritionally poor soil, rainy season, temperature of 28-35°C and relative humidity of 85-90 %

Management :

- Remove the affected plant parts
- Spray Mancozeb 0.2%

3. Charcoal Rot : *Macrophominaphaseolina*

Symptoms :

- Occurs mostly during early stage or at flowering.
- Necrosis and wilting of plants
- Rotting of roots with minute sclerotia on the root barks

Mode of survival: As sclerotia in infected plant materials in soil

Primary spread : From soil-borne sclerotia

Secondary spread : Through irrigation water

Favourable conditions : Hot dry weather and temperature between 28 and 35°C

Management :

- ✓ Pull out with roots and burn by fire
- ✓ Follow deep summer ploughing

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Questions

1. Basal stem rot of Aloe is caused by
A) ***Fusarium oxysporum*** B) *Sclerotium rolfsii*
C) *Verticillium dahliae* D) *Macrophomina phaseolina*
2. Tuber rot of Gloriosa is caused by
A) ***Sclerotium rolfsii*** B) *Fusarium oxysporum*
C) *Macrophomina phaseolina* D) *Verticillium dahliae*

LECTURE 30 COLEUS AND ALOE

COLEUS

1. Root rot / wilt : *Fusarium chlamydosporum*, *Fusarium solani*

Symptoms :

- Gradual yellowing, marginal necrosis and withering of leaves followed by loss in vigour and premature death
- Discolouration of roots and complete decaying of tap and lateral root system
- The root bark easily peels off
- Affected plants are finally killed due to severe root and collar rots
- The infected tubers show rotting and emit bad odour

Mode of survival : As chlamydospores in the soil

Primary spread :From soil-borne chlamydospores in infected plant debris

Secondary spread :Through irrigation water

Favourable condition : Humid weather

Management :

- Select and treat cuttings from disease-free plants
- Treat the cuttings in Carbendazim 0.1% before planting
- Apply FYM 12.5 ton/ ha + 500 g neem cake + T. viride 2.5 kg/ ha to soil before planting
- Drench the soil with Carbendazim or Propiconazole 0.1%

2. Root rot :*Macrophomina phaseolina*

Symptoms :

- Yellowing and drooping of the leaves followed by blackening of the stem, rotting of roots and basal stem
- Shredding of stem and root barks
- Small black microsclerotia seen on the rotten portion

Survival :As microsclerotia in infected roots in soil

Primary spread :From soil-borne sclerotia

Secondary spread :Through irrigation water

Management :

- Select and treat cuttings from disease-free plants
- Treat the cuttings in carbendazim 0.1% before planting
- Apply FYM 12.5 ton/ ha + 500 g neem cake/ha + T. viride 2.5 kg/ ha before planting
- Drench the soil with Carbendazim or Propiconazole 0.1%

3. Leaf Blight :*Rhizoctonia solani*

Symptoms :

- Grown water soaked spots appear on leaves that increase rapidly in size become necrotic
- Severe infection results in defoliation and death of the plants

Mode of survival :As sclerotia in soil and plant debris

Primary spread :From soil-borne sclerotia in infested soil

Secondary spread :Through irrigation water and farm implements.

Favourable conditions :Cool, cloudy weather, high humidity, wet and compact soil and overcrowding

Management :

- Select and treat cuttings from disease-free plants
- Apply FYM 12.5 ton/ ha + 500 g neem cake/ ha + T.viride 2.5 kg/ ha before planting
- Treat the cuttings in carbendazim 0.1% before planting
- Drench the soil with carbendazim 0.1% or propiconazole 0.1%

4. Bacterial wilt :*Ralstonia solanacearum*

Symptoms :

- Roots are attacked and turn brown later it becomes black due to decay, Oozing and putrefaction

Mode of survival :In soil for several years

Primary spread :From soil-borne inoculum

Secondary spread :Through irrigation water

Favourable conditions :Humid weather and high temperature

Management :

- *Remove and destroy infected plants*
- *Spot drench with streptocycline 300 ppm solution*

Aloe (*Aloe barbadensis*)

Bacterial soft rot : *Pectobacteriumchrysanthemi*

- Alternaria leaf spot : *Alternariaalternata*
- Basal stem rot : *Fusarium sp.*
- Rust : *Phakopsorapachyrhizi*

1. Bacterial soft rot :*Pectobacteriumchrysanthemi*

Symptoms :

- Water-soaked lesions appear at the base of the leaves (leafstalk) which is in contact with the soil
- Infected leaves turn watery and rot
- Infected leaves rot internally resulting in wilting of young leaves followed by collapse tip and dieback
- The diseased plants often emit foul odour

Bacterium :The bacterium is motile Gram - negative , non - sporing , straight rod with rounded ends and occurs singly or in pairs with peritrichous flagella

Mode of survival :In infected plant debris

Primary spread :From diseased plant debris

Secondary spread :Through irrigation water, pruning tools

Favourable conditions :High moisture or rainfall

Management :

- Follow crop rotation with crops like soybean , forage legumes and small grains
- Provide proper drainage and Avoid overhead watering .
- Avoid plant injury during weeding
- Spray streptomycin sulphate and tetracycline at 300g / ha + copper oxychloride 1.25 kg / ha

2. Alternaria leaf blight :*Alternariaalternata*

Symptoms :

- Small, water-soaked lesions appear on leaves
- The spots turn brown and then black with yellow border
- Spots grow rapidly and show concentric rings
- Many spots coalesce and cover considerable area of the leaf
- When spots are formed at leaf tip it will lead to tip drying
- Stems show patches of brown spots with concentric rings
- The disease reduces the growth, yield and quality of gel

Mode of survival :As dormant mycelia in infected plant debris

Primary spread :From infected plant debris

Secondary spread :Through wind-borne conidia

Management :

- Collect and destroy diseased leaves

- Spray mancozeb or chlorothalonil 0.2% or copper oxychloride 0.25%

3. Basal stem rot :*Fusarium sp.*

Symptoms :

- Rotting of the stem near soil level
- The base of the affected plant turns dark red or black and then quickly begins to rot

Mode of survival :As chlamydospores in infected plant debris.

Primary spread : From infected plant debris left in field (soil-borne).

Secondary spread :Through irrigation water

Favourable conditions :Damp conditions, prolonged exposure of the stems near the soil to excessively wet condition

Management :

- Monitor the soil conditions and avoid overwatering to prevent basal stem rot
- Plant aloes only in areas receiving better air circulation and at least 10 h of sunlight per day
- Remove and destroy affected plants
- Treat the soil with fungicides to prevent further spread

4. Rust :*Phakopsora pachyrhizi*

Symptoms :

- Disease usually appears on the lowermost leaves and slowly progresses upwards.
- Small, pale yellow spots on the upper surfaces of the succulent leaves.
- The lesions on the undersides of the leaves are orange-yellow to red-orange in colour.
- The spots enlarge and centre of the spot dies and turns brown.

Survival :In infected crop debris and in other crop hosts

Primary spread :From infected crop debris

Secondary spread :Through wind-borne spores or by rain splashes

Favourable conditions :Frequent rain, drizzling, dew with cool temperature and high humidity, Sowing poor quality seeds and poor field sanitation

Management :

- Follow crop rotation.
- Spray mancozeb 0.2%.

Root rot: *Rhizoctonia bataticola*

Symptom

- Discolouration and rotting of roots are the prominent symptoms.

Management

- Dipping stem cuttings in *Pseudomonas fluorescens* @ 2 g/lit of water for 20 minutes followed by drenching with *P. fluorescens* @ 2 g/lit on 30 days after planting.(or) Dipping stem cuttings in carbendazim (0.1%) followed by drenching with carbendazim (0.1%) on 30 days after planting.

LECTURE 31 MUSHROOM CULTIVATION: *AGARICUS BISPORUS*

Compost Preparation:

The substrate for cultivation of button mushroom is a specially prepared compost. The mushroom houses should have the facilities for temperature control and pasteurization. Buildings are constructed of wood or hollow cement bricks or double walls. The shed is partitioned into small compartments and provided with trays. Environmental conditions like temperature, relative humidity and ventilation are controlled inside the shed by installing suitable equipment.

Compost is the substrate in which the mushroom mycelium grows and on which it produces fruiting bodies. It is the product of a fermentation process brought out by a number of mesophilic and thermophilic microorganisms that decompose plant residues and other organic and inorganic matters. The quality of compost influences the yield of mushroom. Compost prepared out of horse manure and wheat straw is ideal one. Since these materials are not easily available, many substitutes are suggested and are in use. There are two methods of composting viz., long method and short method. The difference is based on the time taken for composting. The long method needs three to four weeks, while the short method requires only 12 –15 days, since the composting process is hastened by pasteurization. In the long method of composting, pasteurization is avoided, which will make the compost poor in quality and often gives varying yields.

1. Long method :

The composting is done on a cement floor. It can be done in the open or under a roof, but sides are to be kept open. Many compositions are available and the ingredients vary according to the locality and availability of materials. A widely used composition in India is given below:

Wheat straw (chopped to 8-2- cm): 250 g

Wheat bran: 25 kg

Ammonium sulphate or Calcium ammonium nitrate: 4 kg

Urea: 3 kg

Gypsum: 20 kg

Chopped wheat straw is spread over the floor and water is sprinkled thoroughly to wet the straw. Mix all the ingredients except gypsum. Finally the mixture stacked to a height of one metre and compacted using wooden boards. This mixture is turned periodically on 5th, 10th, 14th, 18th, 22nd and 26th day. The gypsum is added in two equal splits on the 14th day and 18th day. It is advisable

to add nematicides like nemagon on the 22nd day @ 40-50 ml per tonne of substrate. In mushroom houses where insect pests are also a problem, 10-15 ml of Malathion is also added during the final turning and sufficient quantity of water is also added on the heap.

2. Short method:

The short-term compost involves two phases of operation i.e., outdoors composting and steam pasteurization. The commonly used composition is given below:

Chopped wheat straw	: 100 kg
Chicken manure	: 400 kg
Barley	: 72 kg
Urea	: 14.5 kg
Gypsum	: 30 kg

Phase: I Outdoor composting

Barley and chicken manure are added to wheat straw and stacked after adding sufficient water to completely wet the same. The stack can be of 3.3 x 2.5 x 1 m size. Turnings are given on the 2, 4, 6 and 8th days. The pH is adjusted to 8.5 and the compost filled into trays for pasteurization. Phase: II Steam pasteurization

Steam or dry heat is introduced to establish an aerobic fermentation and the temperature inside the compost is maintained between 52-60°C. Usually it is done in a well insulated room where the trays are properly kept and after this all ventilators are closed and steam is introduced to raise the temperature to 52-54°C for 2 or 4 days. After that the temperature of compost is further raised to 58-62°C for four hours and afterwards fresh air is introduced and steam supply is cut off.

BUTTON MUSHROOM – SPAWNING

a) Tray system of cultivation: When the compost is ready, it is taken in trays leaving about 5 cm from the top.

b) Bag system of cultivation: In this method polythene covers of size: 35"x24" with 150 gauge thickness are used. The spawn is mixed with the compost @ 500- 750 g/ 100 kg compost. Then mixed compost is filled in polythene bags @ 15-20 kg / bag. Finally, the beds are covered with newspaper.

CASING AND CROPPING: Casing is nothing but application of a thin layer of soil so as to induce buttoning. There are different materials used for casing and some of the commonly used ones are given below:

Casing materials:

1. Spent compost : sand : lime 4:1:1
2. Spent compost : FYM : clay loam 2:1:1

3. FYM : Clay Loam soils 1:1

4. Loam Soil : sand 1:1

Casing soil should have 80% water holding capacity, with a pH of 6.7 – 8.2 (Best: 7.7). In addition it should have high porosity to get good aerobic condition. Casing material needs to be sterilized before use.

Procedure for casing:

- Remove newspaper and apply casing soil to a thickness of 3-4 cm and gently press it.
- Keep the temperature around 24°C and relative humidity of 100 for one week.
- Reduce the temperature to 15-18°C and relative humidity to 85-90% after one week. (Pinheads appear 12- 15 days after casing and cropping continues for 6-8 weeks. Mushroom will be ready for harvest in another 10 days and appear at weekly intervals).
- Normally 4 kg of mushroom can be harvested from 20 kg compost in Polybag method. In the case of tray system, the yield varies from 6-8 kg/ Sq. m.

Questions

1. Give a detailed note on Button mushroom cultivation ?
2. Write the nutritive value of *Agaricus*.

LECTURE 32 PLEUROTUS AND CALOCYBE

PLEUROTUS - OYSTER MUSHROOM CULTIVATION

Oyster mushroom (*Pleurotus* spp) is shell, fan or spatula-shaped. It forms clusters of caps one above the other. They are with shades of white, cream, grey, pink or light brown depending upon the species. Pink mushrooms become slightly white at maturity. The stipe is strongly eccentric to lateral. The flesh has a mild taste. Oyster mushroom is edible and can be cultivated throughout the year in Tamil Nadu, Karnataka, Kerala, Andra Pradesh, parts of Orissa, etc. Different varieties of oyster mushrooms grown in Tamil Nadu are compared in table 4&5. They are grown indoor and require a mushroom house (shed).

Table. 4. Comparison of important varieties of oyster mushrooms (*Pleurotus* spp.)

Sl. No	Characters	Co 1 (White oyster)	M2 (Grey oyster)	APK 1 (Pink oyster)	MDU 1	Ooty 1	Co (OM) 2
1	Species	<i>P.citrino-pileatus</i>	<i>P.sajor-caju</i>	<i>P.eous</i>	<i>P.djamor</i>	<i>P.ostreatus</i>	<i>Hypsizygus Ulmarius</i>
2	Year of release	1986	1975	1995	1997	1998	2004
3	Colour	White	Grey	Deep	Bright	Bright white	Bluish grey

				rose buds & white at maturity	hite		buds fad to white at maturity
4	Texture	Fleshy	Fleshy	Fleshy and tough	Fleshy	Fleshy	Fleshy
5	Spawn run (days)	15	20	7-12	12-16	33	20
6	Crop cycle (days)	35-40	40-45	35-40	35	55-60	45-50
7	Yield (g/bed of 500 g)	395	328	910	538	531	635
8	Bio-efficiency (%)	79.0	65.6	182	122.8	116	127
9	Shelf life (hrs)	48	48	72	24	36	72

Table. 5. Characteristic features of important varieties of oyster mushrooms.

Sl. No.	Variety	Year of release	Scientific Name	Colour
1.	M 2	1975	Pleurotus sajor-caju	Ashy / grayish white
2.	Co 1	1986	<i>Pleurotus citrinopileatus</i>	Pure white
3.	APK 1	1995	<i>Pleurotus eous</i>	Pink
4.	MDU 1	1997	<i>Pleurotus djamor</i>	White
5.	Ooty 1	1998	<i>Pleurotus ostreatus</i>	Grey / ashy white
6.	MDU 2	2000	<i>Pleurotus flabellatus</i>	White
7.	Florida	Introduced variety	<i>Pleurotus florida</i>	White

8.	Co (OM) 2	2004	<i>Hypsizygus ulmarius</i>	Bluish white
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The requirements and the procedure for cultivation of oyster mushroom are detailed below:

Mushroom house

Thatched shed is more preferable for mushroom growing. Sheds are built in east west direction to avoid direct effect of sun and to reduce the temperature inside the house. On the top covering with chicken mesh prevents entry of rats, squirrels, snakes etc. The sides are covered with coconut thatches. The floor of the shed is filled with sand to a uniform height of 15 cm. Racks are built to accommodate mushroom beds. Instead of racks, nylon ropes can be provided to accommodate the beds in hanging rope method. Inner side of the shed is covered with jute gunny bags. Water is sprinkled twice in a day on the floor and gunny bags to maintain the required temperature and relative humidity.

- a. **Spawn running room:** Spawn running room is one where the beds are kept for running of spawn. Temperature in the room should be maintained between 25 to 28°C. No light is required. But ventilation is needed.
- b. **Cropping room:** Cropping room is one where the opened mushroom beds after completion of spawn running are kept. The temperature should be maintained between 23 and 25°C and relative humidity should be above 80% with diffused light and aeration.

If there is no provision of two separate rooms for spawn running and cropping a single room is enough for growing mushroom

Spawn

Suitable substrates for spawn are Cholan, Maize, Wheat grains. To prepare spawn, half cook the grains, air dry in hessian cloth, with calcium carbonate at 2% level (20g/kg of seed), fill the grains in empty glucose drip bottles to $\frac{3}{4}$ th capacity, plug with non-absorbent cotton and sterilize in a autoclave at 15 psi. for 30 min. Inoculate with pure culture of the fungus and incubate at room temperature for 15 – 20 days. Use 15 - 18 day old spawn for spawning.

Substrate

Paddy straw is cheap, easily available and is used as substrate. Hand thrashed and fresh paddy straw is cut into 3 to 5 cm length. Most cellulosic farm wastes like cereal straw, corn cobs, bagasse, banana leaves and pseudostems, leaf-litter of various kinds, waste paper, cotton wastes, etc. can also be used.

Pasteurization of substrate: Paddy straw bits are soaked in potable water for about 6 hours. Pre-soaked bits are boiled in water for 45 - 60 minutes and removed and air-dried in hessian cloth (which was sterilized with carbendazim solution 0.1% if necessary) to 65 per cent moisture. No water should drip when the bits are squeezed between fingers.

Preparation of mushroom bed (cylindrical bed method) and maintenance

Spawning: For preparation of bed (spawning) use 60 x 30 cm polythene bags. Tie one end of bag and turn inside out. Put the processed straw in the bottom of the bag to height of 5 cm, sprinkle 25 g of spawn. Place the straw to 10 cm height. Repeat the process to get four layers of spawn and 5 layers of straw. The last (upper) layer of straw is of 5 cm height. Tie the mouth with twine and put 10 to 15 holes in a cylindrical bed to ensure aeration inside the bed.

Maintenance in spawn running room: After spawning, the cylindrical beds are taken to spawn running room and kept in racks / hanging ropes. Sprinkle regularly the water on the floor and on the gunny bags to ensure sufficient relative humidity (above 85 %) and temperature (25°C – 28°C) inside the spawn running room. Maintain the beds up to 10 to 15 days till the entire cylindrical beds are completely covered with whitish mushroom fungal mycelium.

Maintenance in cropping room: After the complete coverage of beds with mycelium, these beds are to be transferred to cropping room where the temperature is maintained between 20 and 30°C and relative humidity at above 85 %. If the beds are maintained in tiers, after 10-15 days of spawn running period, cut and remove the polythene bag and transfer the beds to cropping room. Maintain cropping conditions. Keep the beds moist by periodical spraying with water.

Management of pests and diseases

- a. Weed moulds: *Trichoderma*, *Penicillium*, *Aspergillus* and *Sclerotium* are common weed moulds appearing on beds. Use good quality spawn and straw, pasteurize the straw properly and maintain optimum moisture (65%) and high level of cleanliness.
- b. Phorid flies: Provide 35 mm mesh to windows to maintain cleanliness in and around mushroom house.
- c. Bacterial rot: Avoid excess spraying of beds with water. Use chlorinated water to control rotting of mushrooms (2 g of stable bleaching powder in 10 lit of water).

Harvest and yield

Mushroom pinheads appear on 3rd or 4th day of opening of beds (18 – 24 days after spawning). Matured mushrooms can be seen 3-4 days after pinhead formation (21 – 28 days after spawning). Harvesting should be done when the cap begins to fold and has attained a diameter of 8-10 cm. Harvest matured mushrooms before spraying water. Picking is to be done by twisting the mushroom gently so that it is pulled out without leaving any stub and also the surrounding fruit bodies are not disturbed. The base of the stipe, deep within the straw, should be removed by cutting off with a sharp knife. Second and third harvest can be obtained after scraping the surface of beds to 1 to 2 cm deep after first or second harvest or making additional holes in the bed after every harvest. The entire cropping will be over in 40 - 45 days. It is possible to get 800 g to a kg of fresh mushroom from one kg of the dry substrate.

CALOCYBE- MILKY MUSHROOM CULTIVATION

Milky mushroom, *Calocybe indica* P. & C. is an edible mushroom. It is also known as white milky mushroom or white summer mushroom. It is also known as *dudh chatta* because of its milky white sporophore, large sized fruit bodies and delicious flavour. It is popular in West Bengal and adjoining states in India. It is collected from natural habitats and sold in the local markets. The sporophore is milky white, umbrella shaped robust and attractive and on an average a mushroom weighs 55 to 60 g (maximum 472

g). Milky mushroom can be grown at temperatures between 25°C and 35 °C and relative humidity above 80 per cent. It can be cultivated throughout the year in Tamil Nadu. A variety **APK 2** was released in 1998 from Regional Research Station, Aruppukkottai by Tamil Nadu Agricultural University.

Its sporophore or fruiting body has long shelf-life. The major advantage is that it is best suited to relay cropping when no other mushroom can be grown at higher temperature. It has a very good scope for further cultivation and it can replace other tropical mushroom like *Pleurotus* spp. and *Volvariella* spp. Nutritive value of milky mushroom is comparable with other edible mushrooms. It contains 4.65 % of protein, 5.92 % of fibre, 1.28 % of crude ash, 1.42 % of carbohydrates, 0.1 % of fat, 0.14 % of sodium, 0.65 % of potassium, 0.12 % of phosphorus and other nutrients like iron, calcium in traces. Due to its alkaline ash and high fibre content it is highly suited for people with hyperacidity and constipation (Doshi *et al.*, 1988). This mushroom contains increased fibre content and is useful to patients suffering from peptic ulcer, constipation and heart ailments. It has bio-efficiency of 143 per cent. The spent substrata can be used for biogas production or as manure.

Spawn

Grain spawn is used for its cultivation. Half-cooked sorghum grains or paddy chaff are mixed with 2 per cent calcium carbonate and filled in empty glucose bottles or in polypropylene bags. They are autoclaved at 1.1 kg / cm² pressure for 30 min. Then these bottles/bags are aseptically inoculated with pure cultures of mushroom fungus maintained in PDA medium and incubated at room temperature. The spawn run will be completed in 10 to 15 days and these serve as mother cultures. From each bottle of mother culture 30–40 additional (planting or commercial) spawn bottles can be prepared.

Substrate

Milky mushroom can be cultivated on a wide range of cellulosic substrates *viz.*, paddy straw, wheat straw, maize stalks, sorghum stalks, pearl millet stalks, palmarosa grass, vetiver grass, sugarcane bagasse, soybean hay, groundnut haulms, etc. These basal substrates should be properly dried, stored in proper conditions and free from disease and contaminants.

Cultivation Method

Cultivation chamber

Beds after preparation may be kept under normal room temperature (25- 35°C) for spawn run similar to that of oyster mushroom cultivation. After completion of spawn run and after casing, the beds are to be incubated over the racks in a partially sunken chamber lined with blue coloured, high density polythene or silpauline sheet as roofing material. Inside the chamber the temperature should be around 30-35°C and the relative humidity more than 85%. Light intensity of about 1600-3200 lux is essential in the cropping room. Proper ventilation for gaseous exchange is also essential in this chamber.

Mushroom bed preparation

Polythene bags of 60 cm x 30 cm size are used for mushroom bed preparation. Chaffed paddy straw bits of 3 to 5 cm in length are soaked in cold water, kept in a drum for 4-6 hours. After draining the excess water, the straw bits are boiled for 45 - 60 min in a separate drum. Sometimes, steam treatment of substrate for 1 h or chemical sterilization with carbendazim 75 ppm + formalin 500 ppm (soaked for 16 h) may be followed.

Comparatively hot water or steam treatment is safe and best. After substrate treatment they are shade dried to remove excess moisture and used for bed preparation. At the time of bed preparation the substrate should contain around 60% moisture (can be tested by squeeze method). Sorghum grains or paddy chaff spawn may be used and cylindrical beds are prepared following layer method of spawning as done in case of oyster mushroom. With each bottle of spawn 2 cylindrical beds can be prepared. The beds are then incubated for spawn run under semi-dark conditions in a clean room under normal room temperature (25-35°C). Spawn run will be completed in 10 to 12 days.

Casing

Unlike in oyster mushroom cultivation, milky mushroom production involves an additional process called casing for fruit body initiation. After the completion of spawn run, the cylindrical beds are cut horizontally into two equal halves. This mushroom needs casing for fruit body initiation. Over each half-bed, casing soil is applied to a height of 1 to 2.5 cm (Trivedi *et al.*, 1991; Joshi *et al.*, 1993). For casing, steamed (for 1 h) garden soil or clay loam (pH around 8.0) is useful. In some cases, red soil mixed with sand and calcium carbonate (2%) or any other porous medium with good water holding capacity, moderate cation exchange capacity and low electrical conductivity can also be used.

Cropping

Beds after casing are kept in cultivation chambers and sprayed regularly with water to maintain 50 to 60 per cent moisture level in the casing medium. Pinheads appear in 8 to 10 days after casing (18 – 22 days after spawning) and the first harvest can be made in 6 to 8 days after pinhead formation (24 – 30 days after spawning). After obtaining the first harvest the casing medium is gently scraped and sprayed regularly with water. Second and third harvest may be obtained within 45 to 50 days of bed preparation. Then the beds are removed and fresh beds may be kept for cropping.

Harvesting

The right stage for picking can be judged by the size of fruit body. Fruit bodies should be harvested before spore release by twisting so that the stubs are not left on the substrate. It is better to pick all the mushrooms in the bag at a time and then moisten them.

YIELD

Mean yield is 356 g per bed (contains 250 g of paddy straw on dry weight basis), which accounts to 143 per cent bio-efficiency. On an average single mushroom weighs 55 - 60 g. A maximum of 472 g mushroom has been recorded.

Questions

3. Give a detailed note on Oyster mushroom cultivation ?
4. Write the nutritive value of *Calocybe*.

LECTURE 33 VOLVARIELLA

VOLVARIELLA-PADDY STRAW MUSHROOM CULTIVATION

Paddy straw mushroom or the Straw mushroom or the Chinese mushroom or Tributary mushroom is the most common or popular mushroom in South East Asia. Its cultivation started in China almost 300

years ago. It has been cultivated quite extensively under natural conditions in South Eastern Provinces of China, Philippines, Malaysia, Thailand and Myanmar. Under natural conditions it can be grown only from March to October in tropics, but indoor cultivation can supply fresh mushrooms all through the year. In India cultivation aspect of several species of *Volvariella* (*Volvariella volvacea*, *V. diplasia*, *V. esulenta*, *V. bombycina*) are grown. *V. volvacea* is the widely cultivated species throughout the world. But in India, *V. diplasia* is the major cultivated species. It requires a temperature range of 28 – 36°C and even up to 45 °C with a relative humidity of 75 – 85 %. It does not grow below 25°C. It is distinguishable from *Agaricus* that the ring on the stipe is absent and it possesses a conspicuous cup like structure called **volva** at the base of the stipe. The genus takes its name volva which means a wrapper and which completely envelops the main fruiting body during the young stage. The fruit bodies of this mushroom first appear as dark brown to black buttons resembling a bird's egg. At maturity the buttons enlarge and umbrella-like fruit bodies (cap or pileus) emerge after the rupture of the volva. The fully developed cap is 6.8 cm in dia and grayish white in colour. The gills are white but later change to reddish pink as the spores mature. The stem is central white, attenuated above with a bulbous base and 5-12 mm in thickness. The entire fruit body is 6-12 cm tall and soft in texture. The basidiocarp of this mushroom has four distinct parts namely volva, stipe, pileus and gills.

Spawn

Since the spawn production from the pure culture mycelium is unavailable in many countries, the growers use natural spawn *i.e.*, the viable mycelium in straw. The straw of beds having their peak production is cut into pieces of variable sizes and kept for next cultivation cycle. The pure culture is obtained from the tissues of the cap of a healthy and firm fruiting body with a needle a small portion of tissue from the interior or pileus or stipe is removed and transferred to a solid nutrient medium. The spawn is usually prepared on paddy straw. Paddy straw is chopped into bits of 2.5 cm length, soaked in water for 12 – 16 hours. Water is drained off followed by several changes of fresh water. After draining the excess water it is filled in empty glucose bottles or polypropylene bags and a teaspoon full of redgram powder is added to support initial growth of the fungus. The bottle is plugged with non-absorbent cotton wool and sterilized. After sterilization, the bottle is inoculated with the pure culture of the fungus. A number of substitutes for paddy straw in spawn preparation have been tried of which paddy chaff, compost, rice bran, wheat or barley or sorghum grains are good in increasing mushroom yields. Empty glucose bottle or heat resistant polypropylene bags are filled with previously soaked chaffy grains of paddy or cooked grains of wheat or sorghum. Then the grains are mixed with 2 % calcium carbonate and the bottles are closed and then sterilized at 1.5 kg / cm² pressure for 30 minutes. After inoculation with pure culture, they are incubated at 32 – 37°C for 2 – 3 weeks. In paddy straw cultivation straw spawn is preferable than the grain spawn because the later encourages the growth of competitive moulds at higher temperature.

Substrate

The most common substratum on which the paddy straw mushroom is grown is the paddy straw. The straw of wheat, sorghum or other cereals can be used as well although the produce is inferior and the yields are low. The several plant wastes viz., water hyacinth, oilpalm bunch, sugarcane bagasse, banana leaves, saw dust and cotton waste also been used for cultivation.

1. Conventional bed method- Raised bed method of cultivation

A. Substrate preparation

This mushroom grows best on paddy straw. Old, straw is most suitable for its cultivation. The paddy straw is tied into bundles of 1.2 m long x 25 cm diameter (tie end) size. These bundles are steeped in cool water in a cement tank for 18 – 24 hours. This would soften the straw sufficiently for the mycelium to penetrate. Then the bundles are taken out from the tank and kept in hot water at 80°C for 2 hours. Remove the bundles and allow the excess water to drain off in a shade on a cemented floor.

Bed preparation and spawning

The mushroom beds are prepared on a raised bamboo frame supported on bricks or on a raised brick platform inside a thatched hut. The soaked wet bundles (4 nos) are placed side by side on this platform, all the loose ends being on one side. Then another four bundles are placed with their butt ends on opposite side. An arrangement of this type makes one layer. The loose straw extending the layer is cut with the help of scissors. Small bits of straw spawn are placed 7-10 cm inside the margin leaving a space of 5 cm from each other. If grain spawn is applied it is sprinkle over the top of the first layer (80-100 g). A little quantity of red gram powder (20 g) is also applied along with the spawn about 15 cm away from the outer edge. On the top of the spawned first layer, again a second layer of 4 bundles is placed in a similar fashion with their cut ends at right angles to the previous layer in a criss-cross fashion and another four bundles are placed with their cut ends just opposite. This 8 bundles form second layer which is also spawned similarly as done in first layer. The third layer is again laid on top of the second layer and spawned. The final layer of 8 bundles is placed on the 3rd layer and spawned. Then it is covered with a thin layer of straw. This 32 bundles of straw along with spawn make a single bed which is now gently pressed to make it compact for effective spawn run and to avoid rapid water loss and provide favourable humidity and it is covered with polyethylene sheets or gunny bags. The dry weight of straw / bed is 25 to 32 kg.

Spawn run

The individual beds are watered daily with a rose can once or twice, depending upon the climatic conditions. Mostly no watering is required for the first 3-4 days. A minimum of 18 to 20 lit of water is sprayed per bed to maintain the moisture level of 60 to 70%. It takes 10 to 15 days for complete mycelial growth under optimum conditions of 30 to 35°C temperature with 85 to 90 % RH. Then the polythene sheet is removed.

Cropping

Proper watering and maintaining congenial temperature within the bed are important factors for the maximum spread of mycelium of the paddy straw fungus. The spawn run beds are exposed to fresh air and the mushrooms start appearing as pinheads in about 10 days and are ready for picking (button stage) after 3-5 days. Then they grow into full size.

Harvest and yield

Mushrooms are to be picked at button stage early in the morning by gentle twisting of fruiting body. The fruiting bodies are carefully separated from the adhering straw. The correct stage of picking is when the volva is about to rupture or just ruptured. Mushroom production continues for a period of 2-3 weeks. The total crop period is 30 – 40 days. Each bed of 30 kg paddy straw can produce 4 to 6 kg of fresh mushrooms (i.e., 10-20 per cent bioefficiency). When the mushroom production stops, the straw can be composted to

farm manure. This mushroom is very good to taste and valued for its excellent aroma. It can be cultivated in North-Indian plains from May to September and in peninsular India from March to November.

The paddy straw mushrooms must be consumed immediately after harvest. If preserved at a low temperature (10-15°C) in a refrigerator, they keep well for about 48 hr. If mushrooms are immersed in 10 % brine solution followed by drying of the surface moisture, they keep well up to a week. They can also be dried either in the sun or under controlled temperature (50-55°C) in a drying oven. Since the dehydrated mushrooms are hygroscopic, they should be packed in air-tight containers or sealed in polythene bags.

Mushroom can be canned if it is picked up at a very early button stage. Mushrooms are trimmed, cut to the desired size, washed well in water, blanched for 4-5 minutes in boiling water, cooled rapidly to room temperature and filled in tins with 2 per cent hot brine. Cans are sealed and steam sterilized at 10 lbs pressure for 40 minutes. After sterilization, the cans are cooled in water and kept in cool place.

2. Improved cage-cultivation

A wooden cage is made with a size 1 m x 50 cm x 25 cm. Clean fresh paddy straw is made into 60 bundles of each 25 cm long and 20 cm thick. These bundles are sterilized in hot boiling water for 20-30 minutes and the excess water drained. Ten straw bundles are arranged uniformly in the button layer inside the cage and spawn grains are spread uniformly. Thus six layers are formed. This bed is covered with polythene sheet and bound with a binding thread. After the mycelial run is over, the polythene sheet is removed. Pinheads appear within 10-15 days after spawning. Spraying of water is continued till next flush of mushroom, which appears within a week.

3. Twisted bed method

A raised wooden platform of 1 m x 1 m size is prepared 25 cm above the ground level. Straw is soaked in water for 6 hours and then immersed in hot water for 30 minutes. The straw is removed and allowed to dry in shade to get rid of excess water. It is twisted into ropes of 5-8 inches (12-20 cm) thickness. The ropes are placed in a zig-zag manner in the platform. In the same manner another layer is formed in the opposite direction. This forms the first bed layer. Spawning is done 5 cm away from the margin. Bengal gram powder is sprinkled over the spawn. Similarly the other three layers are prepared. It is pressed with wooden plank and covered with polyethylene sheet. It takes 10 to 15 days for complete mycelial growth and after spawn run mushrooms are produced.

4. Hollow cylindrical bed method

Five kg paddy straw is soaked for 6 – 8 hours in cold water. It is then immersed in hot water for 30 minutes. The straw is removed and allowed to dry in shade. Ropes of 5-8 inches (12-20 cm) thickness are made and are wound round a can with a diameter of 30 cm. Cement pots can also be used. Thus four to six layers are wound round the cylinder or pot and finally the container is removed to make a hollow cylindrical bed. Spawning is done both inner and outer side of the hollow cylindrical bed in each layer. Then it is covered with polythene sheet. It takes 10-15 days for spawn run and after the spawn run mushrooms are produced.

Questions

1. Give a detailed note on Paddy straw mushroom cultivation ?

2. Write the nutritive value of *Volvariella*.

LECTURE 34 BIOTIC AND ABIOTIC STRESSES OF MUSHROOMS

A. Fungal diseases

1. Dry bubble

Dry bubble is also known as *Verticillium* disease or brown spot or *La mole*. It was first reported in India during 1973 (Seth *et al.*, 1973). The disease delays the pinhead formation, reduces the number of sporophores and the yield of white button mushroom. If it is not controlled, it may destroy the crop in two to three weeks. It is more common when the cropping period is extended beyond 60 days.

Symptoms: The symptoms of the disease vary with the time of infection. The fungus produces white mycelial growth on the casing soil which later turns into greyish yellow. If the infection occurs at pinhead stage (before differentiation of cap and stalk) the whole tissue will look like bubbles of 2 to 25 μm in diameter. If the infection occurs at a later stage, the diseased mushrooms become crooked and deformed. Unilateral cracks of stem and bending of deformed fruit bodies are also common. When a part of the cap is affected, hare-lip symptom is seen. The fungus grows on the mature sporophore as grey mould and makes them as unsalable. On fully developed mushrooms it produces light brown and sunken spots on the caps. The spots in the cap coalesce and the caps shrink, turn leathery, dry and show cracking.

Fungus: *Verticillium fungicola* var. *fungicola*

Mode of spread: The major source of contamination is debris and dust on the floor of the mushroom house. It is carried to the mushroom farm by infested casing soil. Conidia are produced in sticky clusters and sticks easily to any contact. It spreads to other growing rooms by spores in air, by phorid and sciarid flies, equipment and hands and clothings of workers. Excess water running off the beds carries the conidia to lower beds or to the floor of the mushroom house. The fungus is soil-borne and conidia survive in moist soil for one year. It also perpetuates as resting mycelium in the infected sporophore and spent compost. High humidity (90-95%), lack of proper air circulation, delayed harvesting and temperature above 15°C favour the development and spread of dry bubble disease.

Management: Use of sterilized casing soil, pasteurized compost and proper disposal of spent compost helps in reducing the incidence of the disease. Affected patches may be sprayed with 2 per cent commercial formalin. Spraying with mancozeb (0.25 per cent) or zineb (0.25 per cent) at 10 days interval controls the disease. Provision of ideal environmental conditions like relative humidity to 80 to 85 per cent and temperature to 14°C helps to reduce the disease incidence.

2. Wet bubble

Wet bubble is also called as *Mycogone* disease or *La mole* or white mould or bubble disease. It was first reported from Jammu and Kashmir in 1978 (Kaul *et al.* 1978). It is a serious disease of white button mushroom when it develops early in the crop.

Symptoms: The symptoms vary with the time of infection. When the young pinheads are infected, the whole mass of mushroom becomes distorted and brown. Due to the formation of chlamydospores it

becomes brown and then decay. Clear brown drops caused by putrefying bacteria exude from the bubble at very high humidity or moisture. If the conditions are dry the destroyed mass becomes dry. When the beds are infected the disease appears in spots. White mycelial patches occur on the surface of casing following infection of a developing mushroom below the casing surface. When the infection occurs at a later stage of mushroom development, brown streaks are formed on the stalk and gills. The affected gill shows white mycelial growth.

Fungus: *Mycogone perniciosa*

Mode of spread: The infection comes from casing soil, air on the surface of the building, crop debris and spent compost. Chlamydospores survive in casing soil up to three years. The fungal conidia produced on the infected mushroom spread by air, water splashes, flies, mites and by pickers. The optimum temperature for the mycelial growth is 25°C and the fungus infects few wild fleshy fungi also.

Management: Adoption of strict hygienic measures reduces the incidence. The casing soil should be sterilized properly before use. Spraying with zineb 0.3 per cent or mancozeb 0.3 per cent at weekly interval controls the disease. Use of benomyl or chlorothalonil or thiabendazole is also recommended. If casing soil is found contaminated treating the soil with one per cent formalin at 25 lit per square metre is effective. Immediately after casing, spraying with 0.8 per cent formalin (2 lit in 100 lit of water for 100 m²) on the casing surface can also be followed. Formalin 0.8 per cent spraying is harmful when it is applied at later stage of mushroom development. Immediately after the spray the mushroom house should be kept closed for 8 to 10 hours. Later, ventilation should be provided to remove the formaldehyde vapour.

3. Green mould

Green mould is also known as *Trichoderma* spot or blotch. It occurs in composts, which were not processed and pasteurized properly. They also occur in casing soil, walls, wooden trays and iron racks. In India, green mould, *Trichoderma viride* was first reported on *Agaricus bisporus* (Thapa and Seth, 1977). Later *T. hamatum* and *T. harzianum* were also reported during 1986-1987. *T. harzianum*, *T. koningii*, *T. lignorum* and *T. viride* have been reported on *Agaricus bisporus*, *A. bitorquis*, *Pleurotus spp.*, *Pholiota nameko* and *Lentinus edodes*.

Symptoms: Species of *Trichoderma* associated with green mould symptoms in compost, on casing soil, in spawn bottles and on grains after spawning. *Trichoderma viride* attacks the spawning tray and reduces the spawn run. It appears as green patches on the spawned and cased trays. When it appears on the casing soil it reduces the pinhead formation of the mushroom. *T. viride* causes reddish brown discolouration of the stipe and sunken lesions on the pileus. *T. koningii* grows as a cottony web of grey mycelium over the casing surface. It also grows and covers the whole surface of the mushroom and causes wet rot. It also produces purple brown spots with a dry cracked surface. Infected caps turn brown. *T. hamatum* grows during spawn run. On young pin heads enlarged spots occur leading to cracking of cap. Later stipe is also infected. Under high humid conditions it causes brown spots on the caps.

Fungi: Different species of *Trichoderma* are responsible for green moulds in composts and casing soil. They are *Trichoderma hamatum*, *T. harzianum*, *T. koningii* and *T. viride*.

Mode of spread: The fungus survives as spores in soil and in spent compost. Addition of unsterilized supplements introduces green moulds. Dead mushroom tissues in the beds and cut stipes help in the infection. Green moulds appear generally in composts rich in carbohydrate and poor in nitrogen. High

relative humidity and low pH of the casing soil favour green moulds. Air-borne dust and mites are main infection routes.

Management: Proper pasteurization and conditioning of compost check the green moulds. Supplements should be sterilized properly before their use. Dead mushrooms and cut stalks should be removed from mushroom house promptly and destroyed. Proper hygienic conditions should be maintained during mushroom growing. Spraying of zineb 0.2 per cent or carbendazim 0.1 per cent or thiabendazole 0.2 per cent or treatment with calcium hypochlorite 15 per cent on the used soil controls the green moulds.

4. Cobweb disease or soft mildew

It is also known as soft decay or soft mildew or *Dactylium* disease or mildew disease. It causes soft rot or decay of fruiting body. It was first reported on white button mushroom by Seth (1977) from Himachal Pradesh. The disease caused 51.7 per cent loss in yield (Sharma, 1992).

Symptoms: Small, circular, white patches of mycelium of the fungus appears on the surface of casing. Later the fungus grows as a fluffy white mould on the mushroom. The diseased mushroom turns brown and rots. The mycelium of the pathogenic fungus turns pink or red.

Fungus: *Cladobotryum dendroides* (*Dactylium dendroides*; Perfect stage *Hypomyces rosellus*).

Mode of spread: The pathogen is soil-borne and is introduced into the crop by soil contamination or by farm workers. It spreads through air.

Management: Sterilize the casing mixture at 50°C for 4 hrs or disinfect the casing soil by benomyl (150g/100m² casing area). Dusting between flushes with zineb or mancozeb at 100 g/100m² or spraying with formalin 0.2 per cent prevents the fungal attack.

5. Competitor moulds/ Indicator moulds/Weed moulds

a. False truffle

It is also known as **calve's brain disease**. False truffle was first reported from Solan by Sohi *et al.* (1965). Its incidence is noticed both in hills and in the plains of North India. Its incidence was reported on *A. bisporus* and *A. bitorquis* (Zaayen *et al.*, 1979; Sharma, 1991, 1992) Severe crop losses occur when the crop is affected before, after and during spawn run. It occurs throughout the cropping period of hot weather mushroom.

Symptoms: The disease appears as small weft of white to cream mycelium on the surface of the compost or under the casing soil. Later it becomes thick and develops into white, solid, wrinkled, round to irregular mass resembling brain or peeled walnut-like structure called ascocarp. Ascocarp appears in masses and raises the casing soil gently. Ascocarps are spherical to irregular, white to cream initially and turn brown at maturity. They finally disintegrate into a powdery mass emitting a chlorine-like smell. The fungus donot allow mushroom mycelium to grow. The infected mycelium turns dull brown. The spawn in affected spots turns soggy and disappears.

Fungus: *Diehliomyces microsporus* Diel. and Lambert (*Pseudobalsamia microspora*).

Mode of spread: Ascospores from casing soil and in wooden trays of previous crops are the sources of infection. Spread of the ascospores occurs in drainage water and on air-borne debris.

Management: Strict hygienic measures should be followed. Filter with 2 mm dia mesh should be installed in peak heat and spawn running areas to prevent the fungus. Compost should be prepared only on concrete floors. Compost temperature during spawn run should not exceed 21 to 24°C. During cropping temperature should be kept below 18°C. Casing soil, which contains ascospores should not be used. Young truffles can be picked and buried or burnt before fruit bodies turn brown. Drying of woodworks and trays help eradication of the fungus. Compost should be cooked out at 70°C for 12 hours or at 80°C for two hours at the end of the crop to kill the ascospores. Initial infection can be checked by treating the affected patches with 2 per cent formalin.

b. Olive green mould

Olive green mould, *Chaetomium olivaceum* was first reported from India during 1975 (Gupta *et al.*, 1975) and *C. globosum* was reported in 1979 (Thapa *et al.*, 1979). It causes yield loss ranging from 10 to 50 per cent in *A. bisporus*.

Symptoms: The fungus appears as greyish white mycelium in the compost soon after spawning. Then olive green to brown and pinhead size perithecia are formed. Spawn growth is delayed and reduced. Compost, which does not support spawn will support the growth of *Chaetomium* spp.

Fungi: *Chaetomium globosum* and *C. olivaceum*.

Mode of spread: Compost and casing soil are the major source of infection. Ascospores are spread by air current, clothes and other materials used in mushroom farm. The fungi are favoured by anaerobic conditions during peak heat, which occur when the compost is too wet, over composted (temperature 62°C) and not adequately aerated during peak heat. These fungi are able to survive at higher levels of ammonia. The growth of *C. olivaceum* is favoured by alkalinity of the compost.

Management: Olive green mould can be prevented by good composting in Phase-I and control of environment during phase II. It is essential to control the peak heat conditions to avoid anaerobiosis. The peak heat room should be ventilated well to save an exchange capacity of about 28 air changes per hour. Spraying with zineb 0.2 per cent controls the spread of the disease.

c. Brown plaster mould

Brown plaster mould caused by *Papulospora byssina* was first reported in India (Munjai and Seth, 1974). It causes 90 to 92 per cent loss in *Agaricus bisporus*.

Symptoms: The fungus appears as white mycelium on the surface of the compost and in casing soil. In course of time the colour changes to light brown to cinnamon brown and to rust colour at the end. In severe cases, the growth of the mushroom mycelium is completely arrested.

Fungus: *Papulospora byssina*

Mode of spread: The fungus spreads through air-borne bulbils in mushroom house. Wet compost and improper pasteurization of compost, higher temperature during spawn run and cropping favour the

development of the fungus. The fungus is commonly seen when gypsum is added to compost lesser than the required quantity.

Management: Composting should be made with addition of recommended level of gypsum. Peak heating should be of sufficient duration and at proper temperature. Compost should not be too wet before or after peak heating. Spraying on the affected patches with 2 to 4 per cent formalin reduces the spread. Spraying with carbendazim 0.1 per cent or benomyl 0.1 per cent or thiophanate methyl 0.1 per cent or carboxin 0.1 per cent is recommended for its control.

d. Yellow moulds

Yellow moulds on white button mushroom have been reported from Jammu and Kashmir (Kaul *et al.*, 1978), Punjab (Garcha *et al.*, 1987), Haryana and Himachal Pradesh in India. Incidence of these fungi from 10 to 70 per cent has been reported.

Symptoms: These fungi form a yellowish brown corky mycelial layer at the interphase of compost and casing. The yellow moulds may develop in a layer below the casing (mat disease), form circular colonies in the compost (*confetti*) or they may be distributed throughout the compost (*vert-de-gris*). It becomes visible when it develops its stroma. They grow as competitors. They reduce the food supply to the mushroom or kill its mycelium by toxic metabolites.

Fungi: *Chrysosporium luteum* (Ces.) Gram, *C. sulphureum* (Cost & Matr.) Corm and *Myceliophthora lutea* Cost.

Mode of spread: The primary infection is through air, chicken manure, spent compost and improperly sterilized wooden trays. The secondary spread is through flies, mites, water splashes, picking and tools used in mushroom growing.

Management: Good farm hygiene, proper pasteurization of compost and casing layer reduces their incidence. Use of air filters checks the fungus. Spraying with benomyl 0.04 to 0.05 per cent or copper oxychloride 0.04 per cent is also recommended. Spraying with calcium hypochlorite solution 15 per cent eradicates the moulds.

e. *Sepedonium* yellow mould

Incidence of yellow mould disease caused by the fungus, *Sepedonium* was reported in India (Thapa *et al.*, 1991) and its incidence ranged from 5 to 20 per cent. Sometimes it caused total failure of the white button mushroom crop.

Symptoms: The mould occurs in the compost as white growth. Later the colour changes to yellow and then to tan. Generally it occurs at the basal layers of compost or at the bottom of the cropping bags. The fungus causes distortion of mushrooms probably due to production of volatile toxins. These toxins also inhibit mycelial growth of the mushroom.

Fungi: *Sepedonium chrysosporium* and *S. maheshwarianum* (*Hypomyces chrysospermum*)

Mode of spread: Primary infection is from spent compost or improperly sterilized wooden trays. Spores spread through air. The fungus survives through thick-walled chlamydospores. Higher nitrogen content in

the form of chicken manure favours the fungus. More wetness leads to its development in the lower layer of compost.

Management: Proper pasteurization of compost and provision of air-filters during spawning and spawn running (to prevent the entry of spores) reduces the incidence. Incorporation of carbendazim 0.5 per cent in the compost effectively controls it.

f. Ink caps or ink weeds

Ink caps (*Coprinus spp.*) appear generally during spawn run in North India on white button mushroom (Kaul *et al.*, 1978; Garcha, 1984). When the peak heating takes place at too low temperature these weedy mushrooms are commonly seen.

Symptoms: Ink caps appear in the compost during spawn run or in newly cased beds. The stipe of these weedy mushrooms is slender with bell shaped caps. Caps are cream coloured at first but later turn to bluish black. Sometimes it occurs in cluster. They decay and form a black shiny mass.

Fungi: *Coprinus atramentarius*, *C. comatus*, *C. fimetarius* and *C. lagopus* occur in white button mushroom beds.

Mode of spread: The primary infection is through improperly pasteurized compost or casing soil. Normally ink caps are seen when the compost has excess nitrogen in the ammoniacal form, and when insufficient quantities of gypsum are added to the compost. They may also occur when the compost is wet and poor in feature.

Management: Proper pasteurization of compost and casing soil, avoiding excessive watering and rouging out the weedy mushrooms from the beds immediately after the emergence are the important measures of control. Before filling the trays the compost should be freed from ammonia. If the fruiting bodies of the weedy fungus are formed in large numbers in spawned trays then the compost should be re-pasteurized at 60°C for two hours and then re-cased.

g. White plaster mould

Occurrence of white plaster mould has been reported from different parts of India (Bhardwaj *et al.*, 1989) and it causes about 35 per cent loss in white button mushroom yield.

Symptoms: The fungus appears as white dense patches on the compost or casing soil. The patches may be small to more than 50 cm in diameter. After a week, the white growth changes to light pink. Due to its attack spawn run is affected.

Fungus: *Scopulariopsis fimicola* (Cost. & Matr.) (*Oospora fimicola*)

Mode of spread: Improper fermentation of manures and chilling of the beds cause occurrence of this fungus. The fungus is favoured by over-composted compost, which retains ammonia smell and has a pH of 8.2. Excessive moisture and inadequate ventilation favour the fungus.

Management: Proper composting and addition of optimum quantities of gypsum and water reduce the incidence. Removal of the fungal plaster and spraying with benomyl 0.1 per cent or spot application of formalin four per cent solution reduces the incidence.

h. Cinnamon mould

It is also known as Cinnamon brown mould or brown mould and it has been reported to occur in Punjab (Garcha *et al.*, 1987), Himachal Pradesh (Sohi, 1988) and Jammu and Kashmir (Kaul *et al.*, 1978).

Symptoms: The fungus appears as large circular patches of white aerial mycelium on the compost or casing. The colour changes to light yellow or to light golden brown. When the spores mature colour changes to cinnamon brown. The fungus produces many cup-like fleshy fruit bodies on the beds. The fungus inhibits the mycelium of the mushroom, depletes the nutrients in the compost and disfigure the fruiting bodies resulting in delay cropping and reduction in yield.

Fungi: *Peziza ostracoderma* (*Chromatosporium fulvum*)

Mode of spread: Primary infection is through casing soil and damp wood. The ascospores spread through air. The disease is favoured by over-pasteurized compost, high moisture content and by presence of excess ammonia in the compost.

Management: Casing soil should be sterilized and moisture content should be maintained properly. Newly cased beds can be protected by spraying with zineb. Spraying the trays and surrounding areas with sodium pentachlorophenol (3 to 5 lbs/450 litres of water) also give protection against cinnamon mould.

i. Lipstick mould

It is also called as red lipstick mould. In India it has been reported from Punjab (Garcha *et al.*, 1987) and Himachal Pradesh (Sohi, 1988). In white button mushroom it usually occurs in crops previously attacked by virus disease.

Symptoms: The mould appears as fine, cottony white mycelial growth in the cracks or crevices of casing soil or in the sides of compost trays. As the spores of the fungus matures the colour changes to cherry red and finally to dull orange or buff. The fungus inhibits mycelial growth of the mushroom.

Fungus: *Sporendonema purpurascens* (Ben.) Mason & Hughes.

Mode of spread: Spent compost and casing soil are important sources of primary infection. The chicken manure is suspected to carry this fungus. The fungus spreads by pickers and water splashes.

Management: Cropping bed temperature exceeding 21°C should be avoided. It can be controlled by heating the compost with steam at 62°C for 90 minutes or by dusting with calcium hypochlorite or by using benomyl or zineb. Drenching the casing with zineb (1lbs/450 litres of water at 4.5 litres/100 sq. ft of bed) is also effective against lipstick mould.

j. Lilliputia mould

In India, incidence of *Lilliputia refula* (*Gliocladium prolificum* Bainer) has been reported from Delhi and Himachal Pradesh. It restricts the spawn spread in the compost.

Mode of spread: Chicken manure and horse manure are the sources of infection. Mycelium is viable for three months at 10°C whereas cleistothecia are viable for nine months.

Management: Spraying with zineb 0.02 per cent controls the mould.

k. Pink mould / White mould

In India, pink mould has been reported from Himachal Pradesh (Seth and Munjal, 1981) and Jammu and Kashmir. During white button mushroom cultivation it appears first as white growth on the casing soil and later it turns pink.

Fungus: *Cephalothecum roseum*.

Mode of spread: The conidia spread through air.

Management: Spraying of captan or thiram at 0.04 per cent on the casing soil twice at 9 to 10 days interval is effective.

l. Oedocephalum mould

In India, the incidence of *Oedocephalum* up to 60 per cent has been reported from Solan (Sharma, 1991). Its occurrence indicates the presence of ammonia in the compost used for cultivation of white button mushroom.

Symptoms: The mould appears as irregular, silvery grey patches on the compost during cool down before spawning. After spawning the mould is light grey. It changes to dark tan or light brown when conidia mature. Similar type of growth is observed in casing layer also.

Fungus: *Oedocephalum fimetarium*.

Management: Spraying or local swabbing with formalin 2 % controls the fungus.

m. Other moulds

i. Brown plaster or mould: *Arthrobotrys spp.* appear as brown plaster on the casing surface at the end of the crop. Its occurrence is common when there is low temperature of compost in phase II and high nematode population. They are parasites of nematodes and their presence indicates nematode infestation in compost/casing layer.

ii. Black whisker mould: The fungus, *Doratomyces stemonitis* produces dark grey to black whisker like bristles on the casing. It appears due to poor composting in the initial stage of Phase I. The bristles are about 2 mm in length and bear spores in them. The spores are allergic to pickers. Proper fermentation, peak heating and adoption of strict hygienic measures control the mould.

iii. Fire mould: Fire mould, *Neurospora crassa* appears in the compost or casing after the cook out. It produces white mycelium, which later turn orange. Large wefts of mycelium hang down like cobwebs. It is very difficult to eradicate it once become established in the farm.

iv. *Aphanoascus* mould: The mould, *Aphanoascus composites* occurs in the compost when chicken manure is used without proper mixing and fermentation during composting. Its occurrence leads to formation of thick and compact layer of compost where exchanges of gases are not proper.

v. *Mortierella* mould A competitor mould of Zygomycotina, *Mortierella reticulata* appears on the surface of the compost during spawn run. It occurs severely when spent compost is used and where compost was not covered with plastic sheet during spawn run.

vi. *Aspergillus* spp: Twenty species of *Aspergillus* including *A. flavus*, *A. niger* and *A. fumigatus* have been found on the compost of white button mushroom and in *Pleurotus* cultivation and cause reduction in yield.

vii. *Rhizopus* spp: *Rhizopus* spp. is common in the beds of *Agaricus*, *Pleurotus* and *Volvariella*. *R. oryzae* was found as contaminant in *Pleurotus* beds whereas it was found appearing in the synthetic compost prepared for *Pleurotus* cultivation.

viii. Black compost: Fungi like *Pythium hydnosporum* (Syn. *P. ortotrogus*) and *P. oligandrum* causes black patches in uncolonized compost in the beds at the end of spawn run. These patches are few cm to one metre in diameter and are found below the compost surface. The mushroom mycelium is inhibited more when the fungus enters the compost before spawning or with the spawn. Avoiding wet conditions of the compost helps in its control.

ix. Smoky moulds: *Penicillium* spp. were found associated with the cultivation of white button mushroom, oyster mushroom and paddy straw mushrooms. They are normally found growing on trays or sides of shelves or pieces of fruiting bodies left on the bed. They are also found on grain medium when there was improper sterilization during spawn preparation. Affected beds smell mouldy. The fungus produces smoky spores in the air. Provision of air filters in Phase-II, strict hygienic measures and spraying with formalin solution controls the smoky moulds.

Competitor moulds in oyster mushroom: There are very few competitor moulds or weed moulds in oyster mushroom cultivation. The type of mould depends on the substrate, method of bed preparation and conditions prevailing and mushroom cultivation. The list of competitor moulds is given below.

Competitor moulds in oyster mushrooms

<i>Alternaria alternata</i>	<i>Fusarium moniliforme</i> var. <i>subglutinans</i>
<i>Arthobotrys</i> sp.	<i>Momniella echinata</i>
<i>Aspergillus flavus</i>	<i>Mucor</i> sp.
<i>A. fumigatus</i>	<i>Oedocephalum globerulosum</i>
<i>Aspergillus niger</i>	<i>O. lineatum</i>
<i>Cephalosporium asperum</i>	<i>Penicillium lineatum</i> sp.
<i>Cephalosporium acremonium</i>	<i>Phialospora</i> sp.
<i>Chaetomium globosum</i>	<i>Rhizopus stolonifer</i>
<i>Cladosporium cladosporoides</i>	<i>Sclerotium rolfsii</i>
<i>Cochibiololus specifer</i>	<i>Sordaria fimicola</i>
<i>Coprinus retirugis</i>	<i>Stachybotrys chartarum</i>
<i>Coprinus sterquilinus</i>	<i>Stilbum nanum</i>

<i>Drechslera bicolor</i>	<i>Stysanus medius</i>
<i>Fusarium moniliforme</i>	<i>Trichoderma viride</i>
<i>Fusarium moniliforme</i> var. <i>ferbiglutinans</i>	<i>Trichothecium roseum</i>
<i>Fusarium graminearum</i>	<i>Trichurus terrophilus</i>

These moulds occur in substrates and compete with the mycelium of the mushroom for space, water and nutrition. They can be controlled by the spraying benomyl (50 ppm) or carbendazim (100 ppm) + copper oxychloride (100 ppm) or thiram (100 ppm).

Competitor moulds in paddy straw mushroom, giant mushroom, black ear and white milky mushroom: In paddy straw mushroom cultivation, *Alternaria* sp., *Chaetomium* spp. and *Sordaria* sp. are commonly observed as contaminants in wheat, maize, barley and sorghum straw beds. *Coprinus* sp., *Penicillium* sp., *Aspergillus* sp., *Rhizopus* sp. and *Sclerotium* sp. have been reported as competitor moulds from the substrates. Spraying on beds with captan 0.2 per cent or thiram controls them. Button-rot disease of paddy straw mushroom caused by *Sclerotium* sp. has been reported from Tamil Nadu.

Mycogone rosea parasitizes giant mushroom (*Stropharia rugoso-annulata*) under natural conditions. The fungus produces cottony white growth on the gills and light brown spots on the stipe. Diseased sporophores are deformed.

Cladobotryum verticillatum produces white fluffy growth on the substrate for black ear (*Auricularia polytricha*) cultivation and reduced 9 to 96 per cent in mushroom yield. Spraying carbendazim 50 ppm solution effectively controls the disease. *Aspergillus* sp., *Fusarium* sp. and *Trichoderma* sp. are found to be competitors. *Aspergillus* sp., *Coprinus* sp., *Fusarium* sp., *Mucor* sp., *Rhizopus* sp., *Sclerotium* sp. and *Trichoderma* sp., were the competitors in the substrate for cultivation of white milky mushroom (*Calocybe indica*). From the casing mixture *Cladobotryum* sp. and *Oedocephalum* sp. have been reported.

B. Bacterial diseases

1. Bacterial blotch or brown blotch

It is otherwise known as bacterial spot. *Pseudomonas fluorescens* has been reported on white button mushroom (Tolaas, 1915) from many countries including India. It was reported in 1915 from America and 1976 from India. The disease is common in mushroom farms where there is no satisfactory crops and poor ventilation system. In farm where growers used to close the air fans for fear of lowering down the temperature in the cropping room bacterial blotch is common. Use of farmyard manure is used as one of the components in casing mixture often leads to bacterial blotch incidence. It is a dreaded disease and may cause total loss of the crop when it occurs severely.

Symptoms: The pathogen produces 2 to 3 mm deep pale yellow on the mushroom. Later the colour changes to golden yellow or chocolate brown. Its occurrence is noticed from early buttons stage onwards. It is also seen even on stored mushrooms. When pinheads are attacked they turn completely brown and do not develop into nature mushroom. Under favourable moisture conditions spots enlarge and coalesce covering the entire mushroom cap. Stipe will also show the symptom. Affected mushroom become sticky. Severely diseased mushrooms are distorted. Splitting at the blotched area is also noticed.

Bacterium: *Pseudomonas fluorescens* biotype G. (Syn. *P. tolaasii*, *Phytomonas tolaasii* and *Bacterium tolaasii*).

Mode of spread: Casing and air-borne dust are the primary sources of infection. It is present in the casing soil even after pasteurization. Bacteria on the mushroom cap will reproduce easily when moisture or free water persists for more than three hours after watering. High relative humidity and low temperature of 8 to 18°C favour the infection. The bacterium survives between crops on the mushroom spores, surfaces in debris, peat, chalk and on tools used in mushroom production. Secondary spread is through hands of pickers, tools, ladder, implements, debris, sciarid flies and mites.

Management: Casing materials before and after mixing should be stored in areas free from the pathogen. Diseased mushrooms should be removed and destroyed. Preventive measures should be taken to check spread through picker's hand and watering. Adequate hygienic measures reducing the humidity (relative humidity should not exceed 85 per cent) in the room by minimizing the number and volume of water sprays, introduction of sufficient fresh air into cropping room followed by spraying with chlorinated water (100-150 ppm, 0.5 lit/m²) at three or four days interval starting before the disease appearance control the disease. Spraying of streptomycin 200 ppm or oxytetracycline 300 ppm is also effective in checking the disease.

2. Others

a. Bacterial rot: The bacterium, *Pseudomonas alcaligenes* is the incitant of bacterial rot in *Pleurotus sajor-caju*. The symptoms include water-soaked spots and yellowish brown discolouration of young sporophores and rotting of matured sporophores. Rotting starts from the centre of the sporophore towards periphery. The gills on the lower surface turn yellow. The caps become crinkled and rolls upward and inward.

b. Brown spot: *Pseudomonas stutzeri* is reported as competitive bacterium on paddy straw substrate used for the cultivation of *Pleurotus sajor-caju*. It induced brown spots in the substrate and caused 27 to 61 per cent yield reduction. Dipping in streptocycline solution (more than 100 ppm) or formalin (25 ppm) controlled this bacterium.

c. Yellow blotch: Yellow blotch on *P. sajor-caju* is caused by *Pseudomonas agarici* and it caused complete crop failure in Solan, Himachal Pradesh. The disease appears as blotches of varying sizes on pileus. The blotches are depressed, yellow and hazel-brown or orange in colour. If the disease is noticed during primordial stage the entire crop will be lost. The infected fruit bodies rot, become shiny and emit bad odour at higher temperature and humid conditions. Spraying with oxytetracycline 400 ppm or streptocycline 400 ppm or sodium hypochlorite 400 ppm effectively controls the bacterium.

C. Virus diseases

In 1948, a serious infectious disease of button mushroom was observed in the USA and it was known as *La France* disease (Sinden and Hanster, 1950). Hollings (1962) and Gandy and Hollings (1962) demonstrated the association of three types of viruses in mushroom having die-back symptoms. In India, virus-like diseases were reported in white button mushroom and oyster mushroom. In 1967 in Netherlands, 4.5 per cent or about 790,000 kg of mushroom was lost due to virus disease.

Symptoms: The symptom expression of virus diseases depends on the concentration of the virus, strain of the mushroom spawn used and environmental conditions given during cultivation. Due to virus infection the

mycelium disappears after the normal spread. Pinheads development is slow and they are also small. Pinheads appear late and below the surface of the casing layer. Sporophores have off-white caps and mature early. Caps may be small and flat. The stipes are slightly bent and elongated or watery in nature. Diseased mushrooms are loosely attached to substrate. The gills become hard. Sometimes diseased mushroom give out musty smell.

Viruses: Spherical virus particles of 24 to 26 nm dia have been reported in *Pleurotus ostreatus*, *P. sapidus*, *P. columbinus* and *P. florida* and flexuous rods of 40-600 nm long. A polyhedral virus measuring 34 nm in dia has been reported on *Volvariella volvacea*. Rod and spherical viruses have been reported on *Lentinus edodes*.

Mode of spread: The viruses spread through mycelium, spores and germ tubes of mushrooms and through vectors. Phorid flies (*Megaselia halterata*) and mites help in introduction of virus particles to trays free from virus infection.

Management: *Agaricus bitorquis* has been reported to be immune to all viruses affecting *A. bisporus*.

ABIOTIC DISORDERS OR ABNORMALITIES

Mushroom production requires proper management of cultivation practices. Deviation in the environment leads to abiotic disorders. In white button mushroom stroma, weepers, flock, hollow core and brown pith, purple stem, rose comb, scales and crocodile skin, long stem and brown discolouration are important abiotic disorders. In oyster mushrooms poor ventilation and low light exposure cause long stipes and small pileus.

1. Stroma: Stroma is the aggregations of mushroom mycelium on the surface of spawned compost or casing which hinder the formation of pinheads and fruiting bodies. Stroma can be easily peeled off from the surface of compost/casing. Spawn showing the dense patches of mycelium should not be used for spawning the compost and the portion showing compact mass may be re-cased with pasteurized casing soil. This condition can also be avoided by lowering bed temperature and fresh air supply as soon as the cottony growth appears.

2. Weepers: Mushrooms are called weepers when the cap exudes water. Water collects on the casing surface below a weeper and the area emits putrid smell. Low moisture compost coupled with high moisture casing leads to formation of weepers.

3. Flock: Flock is malformation of mushroom cap and gills. It is physiologically induced. Premature opening of cap and poorly developed or very small gills with poor pigmentation are often noticed. It normally appears in first flush but disappears during subsequent flushes. Flocks are produced due to genetic or environmental conditions or due to brown plaster mould or false truffle.

4. Hollow core and brown pith: The cut-end portions of the stipe after harvest may be hollow extending to the whole length and become brown. This seems to be due to watering and water stress.

5. Rose comb: Severe malformation of the caps and gills resembling a rooster's comb is a common abnormality when two frequent pesticide sprays given. Such mushrooms may burst, split or turn brown.

Rose comb condition may be due to use of polluted casing soil. Smoke and oil from coal, kerosene oil or some coal tar products cause the above abnormality when fumes come in contact with the fruit bodies.

6. Scales and crocodile skin: Scales arise through the surface tissue and the mushroom fails to grow. Too much drying out of beds or use of air with more velocities are the main causes. Strong vapour of formaldehyde causes tearing off of outer layer of the skin of half-grown mushrooms. The crocodile skin is formed due to bursting of skin of mushroom.

7. Long stemmed mushroom: Mushrooms with long stem appear in the beds when CO₂ concentration is too high or with poor ventilation. With the improvement of aeration such conditions can be avoided.

8. Browning: Browning of small pinheads and half grown mushrooms occur during high temperature conditions. It may also occur when formalin solution is sprayed on mushrooms. Sprinkling water at high pressure (maximum pressure is 0.4 atm) and chlorinating with high chlorine rate (maximum rate is 500 ml/100 lit of water for 100m² area) also cause browning of mushrooms.

9. Open veil: Veil and gills are either not formed at all or formation is very weak. High temperature and less ventilation are more often the cause for this abnormality.

10. Cracked mushrooms: High temperature followed by less humidity or dry atmosphere inside the cropping rooms cause cracking of the mushrooms surface. Humidity in the cropping room should be maintained between 85 and 95 per cent to overcome this problem.

11. Hard gilled mushrooms: Frequent fluctuation in temperature and humidity inside the cropping rooms result in formation of hard gilled mushrooms in which veils and gills are not formed.

12. Early opening of mushrooms: High bed temperature (above 22°C) and dry compost below the casing layer (in the case of white button mushroom) are the predisposing factors for mushrooms which open up at premature stage.

PEST PROBLEMS IN MUSHROOM CULTIVATION

Insect pests:

Many insect pests attack the mushrooms. Small larvae of flies, beetles, springtails are very commonly noticed, in addition to mites and nematodes. Absolute cleanliness is a must to prevent the infestation of the insect pests in mushroom sheds.

a) Flies:

i) Phorid fly: *Megaselia halterata* and *M. tamilnadolensis*

ii) Sciarid fly *Lycoriella mali*

Phorid Sciarid

Life cycle 20- 38 days 20 – 33 days

Damage: The larvae feed on the mycelium and show rotting patches

The larvae feed on the mycelium and show rotting patches in the beds. Young buds are also eaten by the larvae. They also tunnel into grown up mushroom and cause rotting of the mushrooms. The flies spread the disease from one bed to others.

Favorable conditions

Temperature of 16-24 is highly favorable and moisture contents of 70 % and above show more incidences. More severe in button mushroom cultivation, when compared to oyster and milky mushrooms.

b) Beetles:

Black beetle: *Sacphisoma nigrofaceatum*

Brown beetle : *S. pictummotschulsky* – golden lines seen on the body of the insect.

Both feed on young buds and grown up mushrooms by scrapping the tissues. They mainly transmit the bacterial blotch disease from one bed to other.

c) Spring tails / Columboles:

Tiny insects with stout antennae feed on the mycelium and buds. *Lepidocyrtus cyaneus* and *Isotoma simplex*.

d) Nematodes:

Nematode infestation is more severe in button mushrooms. The following two nematodes are very commonly noticed: *Ditylenchus mycelophagus* and *Aphelenchoides compositicola*.

e) Mites:

In addition to insect pests, two mites are very severely feed on the mushroom spawn as well as on mushroom buttons. They are i) Tarsonemid mite- *Tarsonemus myceliophagus* and *T. floriculus* feed on mycelium and transmit the diseases.

ii) Tryoglyphid mite- *Tyrophagus lintneri*, and *T. longior*

Integrated Pest Management:

- Bed moisture content should be around 60- 65%
- Fix insect proof nets in the windows.
- In button mushroom , newspaper should be treated with 0.1 % formalin

- Fix white insect trap to attract the flies. Spray malathion @ 1 ml./ lit. or dichlorvas 0.5 ml/lit. in the floor and sides to kill the flies and beetles, never spray on the mushroom beds and buttons. Weeds: Weeds, moulds and Diseases: i) Ink Cap:

Coprinus comatus is a common weed on mushroom beds. It is favoured by high moisture content of the beds, more compaction of beds and poor ventilation with more of ammonia in side the cropping room.

It produces dark blue to violet coloured buds with a long white thin stalk , with opens in a few days and disintegrate as black mass of tissues, covering the entire bed , thus arresting the growth of spawn, development of young buds. The entire bed becomes black in color show rotting of the spawn.

- Remove and destroy the infected beds immediately
- Avoid chemical method of sterilization as this process lead to more weed growth.

Questions

1. Milky mushroom variety released in 1998 from RRS Aruppukkottai is
 A) **APK2** B) APK1
 C) M2 D) CO3
2.are major pest of mushroom throughout the world
 A) Aphids B) **Sciarids**
 C) White fly D) hoppers
3. Inky caps appear if the compost contains too much of
 A) **Nitrogen** B) Potash
 C) Phosphorus D) iron
4. Bacterial blotch of mushroom is caused by
 A) *Xanthomonas axonopodis* B) *Erwinia carotovora*
 C) ***Pseudomonas tolaasii*** D) *Bacillus subtilis*

Questions

1. Give a detailed note on Oyster mushroom cultivation ?
2. Write the nutritive value of *Calocybe*.