

**DEPARTMENT OF PLANT PATHOLOGY
UNDER GRADUATE EDUCATION**

PAT 301 DISEASES OF FIELD CROPS (1+1)

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THEORY

Etiology, symptoms, mode of spread, survival, epidemiology and management of diseases of the following crops. **Cereals:** Rice, Wheat, Sorghum, Pearl millet, Finger millet, Foxtail millet, **Pulses:** Redgram, Blackgram, green gram, chickpea, soybean cowpea, lablab **Oilseeds** : Groundnut, gingelly, castor, sunflower, **Cash crops:** Cotton, Sugarcane Tobacco, mulberry – Fungal spoilage of grains during storage and their management.

PRACTICAL

Study of symptoms and host-parasite relationship of important diseases of Cereals, Pulses, Oilseeds and Cash crops. Study tour to hot spot areas and submission of fifty important preserved diseased specimens.

LECTURE SCHEDULE - THEORY

Etiology, symptoms, mode of spread, survival, epidemiology and management of

1. Fungal diseases of rice – blast, brown spot, sheath rot and sheath blight.
2. Fungal diseases of rice – other minor diseases.
3. Bacterial, viral and Phytoplasma diseases of rice.
4. Diseases of wheat
5. Sorghum diseases – Downy mildew, sugary disease, charcoal rot and other foliar diseases.
6. Sorghum diseases – Rust, smut.
7. Disease of Maize and Pearl millet.
8. Diseases of Ragi (finger millet) Tenai (Foxtail millet) and pulses (Red gram and Chickpea)
9. Mid Semester examination.
10. Diseases of pulses - black gram, green gram, cowpea, lablab and soybean.
11. Diseases of groundnut
12. Diseases of gingelly
13. Diseases of castor and sunflower
14. Diseases of cotton
15. Diseases of sugarcane
16. Diseases of tobacco and mulberry
17. Fungal spoilage of grains during storage and management.

PRACTICAL

Study of symptoms and host-parasite relationship of

1. Rice diseases – blast, brown spot, sheath rot, sheath blight and other fungal diseases.
2. Bacterial, viral and phytoplasma diseases of rice.
3. Diseases of wheat
4. Diseases of Sorghum
5. Diseases of maize and pearl millet
6. Diseases of ragi and minor millet
7. Field visit
8. Diseases of red gram and chickpea
9. Diseases of green gram, black gram, cowpea, soybean and lablab
10. Diseases of groundnut
11. Diseases of gingelly, castor and sunflower
12. Field visit
13. Diseases of cotton
14. Diseases of sugarcane
15. Field visit
16. Diseases of tobacco and mulberry, fungal spoilage of food grains and its management.
17. Practical examination

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RICE (*Oryza sativa*)

Blast

Pyricularia oryzae (Syn : *P. grisea*)
(Sexual stage : *Magnaporthe grisea*)

Symptoms

The fungus attacks the crop at all stages from seedlings in nursery to heading in main field. The typical symptoms appear on leaves, leaf sheath, rachis, nodes and even the glumes are also attacked. On the leaves, the lesions start as small water soaked bluish green flecks, soon enlarge and form characteristic spindle shaped spots with grey centre and dark brown margin (**Leaf blast**). The spots join together as the disease progresses and large areas of the leaves dry up and wither. Similar spots are also formed on the sheath. Severely infected nursery and field show a burnt appearance.

In infected nodes, irregular black areas encircle the nodes can be noticed. The affected nodes may break up and all the plant parts above the infected nodes may die (**Node blast**). At the flower emergence, the fungus attacks the peduncle which is engirdled, and the lesion turns to brownish-black. This stage of infection is commonly referred to as rotten neck/neck rot/neck blast/panicle blast. In early neck infection, grain filling does not occur and the panicle remains erect like a dead heart caused by a stem borer. In the late infection, partial grain filling occurs. Small brown to black spots also may be observed on glumes of the heavily infected panicles. The pathogen caused by yield losses ranged from 30-61 per cent depending upon the stages of infection.

Pathogen

Mycelium of the fungus, is hyaline to olivaceous, septate and highly branched. Conidia are produced in clusters on long septate, olivaceous slender conidiophores. Conidia are obpyriform to ellipsoid, attached at the broader base by a hilum. Conidia are hyaline to pale olive green, usually 3 celled. The perfect state of the fungus is *M. grisea*. It produces perithecia. The ascospores are hyaline, fusiform, 4 celled and slightly curved.

Favourable Conditions

Application of excessive doses of nitrogenous fertilizers, intermittent drizzles, cloudy weather, high relative humidity (93-99 per cent), low night temperature (between 15-20°C or less than 26°C), more number of rainy days, longer duration of dew, cloudy weather, slow wind movement and availability of collateral hosts.

Mode of Spread and Survival

The disease spreads primarily through airborne conidia since spores of the fungus present throughout the year. Mycelium and conidia in the infected straw and seeds are important sources of inoculum. Irrigation water may carry the conidia to different fields. The fungus also survives on collateral hosts viz., *Panicum repens*, *Digitaria maggrinata*, *Brachiaria mutica*, *Leersia hexandra*, *Dinebra retroflea*, *Echinochloa crusgalli* and *Stenotaphrum secundatum*.

Fore casting

Forecasting blast of rice can be made on the basis of minimum night temperature range of 20-26°C in association with a high relative humidity range of 90 per cent and above lasting for a period of a week or more during any of the three susceptible phases of crop growth, viz., seedling stage, post transplanting tillering stage and neck emergence stage. In

Japan, the first leaf blast model was developed and named as BLAST. Later based on different field experiments various models were developed namely, PYRICULARIA, PYRIVIEW, BLASTAM, EPIBLA and P BLAST.

Management

Grow resistant varieties like Ponmani, ADT40, Co25 in Samba and Co37, Co43, IR20, Co44, ADT36 and ADT39 in Thaladi seasons. The varieties viz. Co45, ADT37, Vikas, Jaya, IR62, IR64 and ASD 18 also showed moderate resistance to blast. Avoid cultivation of highly susceptible varieties viz., IR50 and TKM6 and susceptible varieties viz., Ponni, White Ponni and IR36 in disease favourable season. Remove and destroy the weed hosts in the field bunds and channels. Treat the seeds with Captan or Thiram or Carbendazim or Carboxin or Tricyclazole at 2 g/kg. Seed treatment with biocontrol agent *Trichoderma viride* @ 4g/kg or *Pseudomonas fluorescens* @ 10g/kg of seed. Avoid close spacing of seedlings in the main field. Spray the nursery with Carbendazim 25 g or Edifenphos 25 ml for 8 cent nursery. Spray the main field with Edifenphos 250 ml or Iprobenphos 500 ml or Carbendazim 250 g or Tricyclazole 400 g or Thiophanate Methyl 500 g or Pyroquilon 500 g/ha.

Brown Spot or Sesame leaf spot

Helminthosporium oryzae
(Syn : Drechslera oryzae)
(Sexual stage : *Cochliobolus miyabeanus*)

Symptoms

The fungus attacks the crop from seedling in nursery to milk stage in main field. Symptoms appear as lesions (spots) on the coleoptile, leaf blade, leaf sheath, and glume, being most prominent on the leaf blade and glumes. The disease appears first as minute brown dots, later becoming cylindrical or oval to circular. The several spots coalesce and the leaf dries up. The seedlings die and affected nurseries can be often recognised from a distance by their brownish scorched appearance. Dark brown or black spots also appear on glumes which contain large number of conidiophores and conidia of the fungus. It causes failure of seed germination, seedling mortality and reduces the grain quality and weight.

Pathogen

H. oryzae produces greyish-brown to dark brown septate mycelium. Conidiophores may arise singly or in small groups. They are straight, sometime geniculate, pale to brown in colour. Conidia are usually curved with a bulge in the centre and tapering towards the ends occasionally almost straight, pale olive green to golden brown colour and are 6-14 septate. The perfect stage of the fungus is *C. miyabeanus*. It produces perithecia with asci containing 6-15 septate, filamentous or long cylindrical, hyaline to pale olive green ascospores. It produces C25 terpenoid phytotoxins called ophiobolin A, (or Cochliobolin A), ophiobolin B (or cochliobolin B) and ophiobolin I. Ophiobolin A is most toxic. These breakdown the protein fragment of cell wall resulting in partial disruption of integrity of cell.

Favourable Conditions

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

Mode of Spread and Survival

The infected seeds are the most common source of primary infection. The conidia present on infected grain and mycelium in the infected tissue may be viable for 2 to 3 years. The fungus may survive in the soil for 28 months at 30°C and 5 months at 35°C. Airborne conidia infect the plants both in nursery and in main field. Maximum flight of conidia takes

place at a wind velocity of 4.0 - 8.8 hr. Minimum temperature of 27 -28°C, Relative humidity of 90-99% and rainfall of 0.4 -14.4 mm favoured the dispersal of the conidia to maximum extent. The fungus also survives on collateral hosts like *Leersia hexandra*, *Arundo donax*, and *Echinochloa colonum*.

Management

Field sanitation-removal of collateral hosts and infected debris in the field. Crop rotation, adjustment of planting time and proper fertilization are suggested. Use of slow release nitrogenous fertilizers is advisable. Grow disease tolerant varieties viz., Co44, Cauvery, Bala Bhavani. Use disease free seeds. Treat the seeds with Thiram or Captan at 4 g/kg. Spray the nursery with Edifenphos 40 ml or Mancozeb 80 g or Captafol 40 g for 8 cents nursery. Spray the crop in the main field with Edifenphos 500 ml or Mancozeb 1 kg or Captafol 625 g/ha.

Narrow brown leaf spot

Cercospora janseana

(Sexual stage : *Sphaerulina oryzina*)

Symptoms

The fungus produces short, linear brown spots mostly on leaves and also on sheaths, pedicels and glumes. The spots appear in large numbers during later stages of crop growth.

Pathogen

Conidiophores are produced in small groups and brown in colour. Conidia are hyaline or sub hyaline, cylindrical and 3-5 septate.

Management

Spray Carbendazim 250 g or Mancozeb 1 kg/ha.

Sheath rot

Sarocladium oryzae

(Syn : *Acrocyndrium oryzae*)

Symptoms

Initial symptoms are noticed only on the upper most leaf sheath enclosing young panicles. The flag leaf sheath show oblong or irregular greyish brown spots. They enlarge and develop grey centre and brown margins covering major portions of the leaf sheath. The young panicles may remain within the sheath or emerge partially. The panicles rot and abundant whitish powdery fungal growth is formed inside the leaf sheath.

Pathogen

The fungus produces whitish, sparsely branched and septate mycelium. Conidiophore is slightly thicker than the vegetative hyphae. Conidia are hyaline, smooth, single celled and cylindrical in shape.

Favourable Conditions

Closer planting, high doses of nitrogen, high humidity and temperature around 25-30°C. Injuries made by leaf folder, brown plant hopper and mites increase infection.

Mode of Spread and Survival

Mainly through air-borne conidia and also seed-borne.

Management

Apply recommended doses of fertilizers. Adopt optimum spacing. Spray Carbendazim 250g or Edifenphos 1 lit or mancozeb 1 kg or Chlorothalonil 1 kg/ha at boot leaf stage and 15 days later. Soil application of gypsum in 2 equal splits (500 kg/ha) reduce the sheath rot incidence.

Sheath blight

Rhizoctonia solani

(Sexual stage : *Thanetophorus cucumeris*)

Symptoms

The fungus affects the crop from tillering to heading stage. Initial symptoms are noticed on leaf sheaths near water level. On the leaf sheath oval or elliptical or irregular greenish grey spots are formed. As the spots enlarge, the centre becomes greyish white with an irregular blackish brown or purple brown border. Lesions on the upper parts of plants extend rapidly coalescing with each other to cover entire tillers from the water line to the flag leaf. The presence of several large lesions on a leaf sheath usually causes death of the whole leaf, and in severe cases all the leaves of a plant may be blighted in this way. The infection extends to the inner sheaths resulting in death of the entire plant. Older plants are highly susceptible. Five to six week old leaf sheaths are highly susceptible. Plants heavily infected in the early heading and grain filling growth stages produce poorly filled grain, especially in the lower part of the panicle.

Pathogen

The fungus produces usually long cells of septate mycelium which are hyaline when young, yellowish brown when old. It produces large number of globose sclerotia, which are initially white, later turn to brown or purplish brown.

Favourable Conditions

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

Mode of Spread and Survival

The pathogen can survive as sclerotia or mycelium in dry soil for about 20 months but for 5-8 months in moist soil. It infects more than 188 crop species in 32 families. Sclerotia spread through irrigation water.

Management

Avoid excess doses of fertilizers. Adopt optimum spacing. Eliminate weed hosts. Apply organic amendments. Avoid flow of irrigation water from infected fields to healthy fields. Deep ploughing in summer and burning of stubbles. Spray Carbendazim 250 g or Chlorothalonil 1 kg or Edifenphos 1 lit/ha. Seed treatment with *Pseudomonas fluorescens* @ of 10g/kg of seed followed by seedling dip @ of 2.5 kg or products/ha dissolved in 100 litres and dipping for 30 minutes. Soil application of *P.fluorescens* @ of 2.5 kg/ha after 30 days of transplanting (This product should be mixed with 50 kg of FYM/Sand and then

applied. Foliar spray at 0.2% concentration commencing from 45 days after transplanting at 10 days interval for 3 times depending upon the intensity of disease.

Grain discolouration

Drechslera oryzae, *D. rostratum*, *D. tetramera*, *Curvularia lunata*, *Trichoconis padwickii*, *Sarocladium oryzae*, *Alternaria tenuis*, *Fusarium moniliforme*, *Cladosporium herbarum*, *Epicoccum purpurascens*, *Cephalosporium sp.*, *Phoma sp.*, *Nigrospora sp.*

Symptoms

The grains may be infected by various organisms before or after harvesting causing discolouration, the extent of which varies according to season and locality. The infection may be external or internal causing discoloration of the glumes or kernels or both. Dark brown or black spots appear on the grains. The discolouration may be red, yellow, orange, pink or black, depending upon the organism involved and the degree of infection. This disease is responsible for quantitative and qualitative losses of grains.

Favourable Conditions

High humidity and cloudy weather during heading stage.

Mode of Spread and Survival

The disease spreads mainly through air-borne conidia and the fungus survives as parasite and saprophyte in the infected grains, plant debris and also on other crop debris.

Management

Pre and post-harvest measures should be taken into account for prevention of grain discolouration. Spray the crop at bootleaf stage with Mancozeb 1 kg or Iprobenphos 500 ml or Carbendazim 250 g/ha. Store the grains with 13.5-14% moisture content.

False smut

Ustilaginoidea virens

(Syn : *Claviceps oryzae - sativa*)

Symptoms

The fungus transforms individual grains into greenish spore balls of velvety appearance. Due to the development of the fructification of the pathogen, the ovaries are transformed into large velvety green masses. Usually only a few spikelets in a panicle are affected.

Pathogen

Chlamydospores are formed on the sporeballs, they are spherical to elliptical, waxy and olivaceous.

Favourable conditions

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

Udbatta disease

Ephelis oryzae

(Sexual stage : *Balansia oryzae-sativa*)

Symptoms

The symptoms are evident at the time of panicle emergence. The infected panicle inside the sheath is matted together by the mycelium. The entire ear head is converted into a straight compact cylindrical dark spike like structure. The spikelets are cemented to the central rachis and the size is remarkably reduced. No grain is formed. The entire spike is covered by greyish stroma and convex pycnidia are immersed in the stroma.

Pathogen

Pycnidiospores are hyaline, needle shaped and 4-5 celled.

Management

Hot water seed treatment at 45°C for 10 min. effectively controls the disease. Removal of collateral hosts like *Isachne elegans*, *Eragrostis tenuifolia* and *Cynodon dactylon*.

Stackburn disease

Trichoconis padwickii
(Syn : *Alternaria padwickii*)

Symptoms

Leaves and ripening grains are affected. In the leaves, circular to oval spots with dark brown margins are formed. The central portion of the spot turns to light brown or almost white and has numerous minute dots. On the glumes reddish brown or pale brown spots appear. The kernels may shrivel and become brittle when severe spotting occurs.

Pathogen

Conidia are elongately fusoid, long beak at the tip, 3 to 5 septate, thick walled and constricted at the septa.

Management

Treat the seeds with Thiram or Captan or Mancozeb at g/kg. Hot water treatment at 54°C for 15 minutes is also effective. Burn the stubbles and straw in the field.

Bunt or Kernel Smut or black smut

Tilletia barclayana

Minute black pustules or streaks are produced in the grains which burst open at the time of ripening. The grains may be partially or entirely replaced by the fungal spores. The sorus pushes the glumes apart exposing the black mass of spores. Only a few flowers are infected in an inflorescence. The fungus survives as chlamydospores for one or more years under normal condition and 3 years in stored grains.

Stem rot

Sclerotium oryzae
(Sexual stage : *Magnaporthe salvinii*)

Symptoms

Small black lesions are formed on the outer leaf sheath and they enlarge and reach the inner leaf sheath also. The affected tissues rot and abundant sclerotia are seen in the rotting tissues. The culm collapses and plants lodge. If the diseased tiller is opened, profuse

mycelial growth and large number of sclerotia can be seen. The sclerotia may be seen in the stubbles after harvest.

Pathogen

White to greyish hyphae produce smooth, spherical black and shiny sclerotia, visible to naked eyes as black masses.

Favourable Conditions

Infestation of leaf hoppers and stem borer and high doses of nitrogenous fertilizers.

Mode of Spread of Survival

The sclerotia survive in stubbles and straw and are carried through irrigation water.

Management

Use of recommended doses of fertilizer. Deep ploughing in summer and burning of stubbles. Avoid flow of irrigation water from infected fields to healthy fields.

Foot rot or Bakanae disease
Fusarium moniliforme
(Sexual stage : *Gibberella fujikuroi*)

Symptoms

The infected seedlings in nursery are lean and lanky, much taller than healthy seedlings and die after some time. In the main field, the affected plants have tall lanky tillers and have longer internodes and aerial adventitious roots from the nodes above ground level. The root system is fibrous and bushy. The plants are killed before earhead formation or they produce only sterile spikelets. When the culm is split open white mycelial growth can be seen.

Pathogen

Fungus produces both macro and micro conidia. Micro conidia are hyaline, single celled and oval in shape. Macro conidia are slightly sickle shaped, narrow at both ends and two to five celled. The fungus produces phytotoxin called fusaric acid, which is non-host specific.

Mode of Spread and Survival

The fungus is externally seed-borne.

Management

Treat the seeds with Thiram or Captan or Carbendazim at 2 g/kg.

Bacterial leaf blight
Xanthomonas oryzae p.v. oryzae

Symptoms

The disease is usually noticed at the time of heading but in severe cases occur earlier also. Seedlings in the nursery show circular, yellow spots in the margin, later enlarge, coalesce and cause drying of foliage. “**Kresek**” symptom is seen in seedlings, 1-2 weeks

after transplanting. The bacterium enters through the cut wounds in the leaf tips, becomes systemic and cause death of entire seedling.

In grown up plants water soaked, translucent lesions appear usually near the leaf margin. The lesions enlarge both in length and width with a wavy margin and turn straw yellow within a few days, covering the entire leaf. As the disease progresses, the lesions cover the entire leaf blade which may turn white or straw coloured. Lesions may also be seen on leaf sheaths in susceptible varieties. Milky or opaque dew drops containing bacterial masses are formed on young lesions in the early morning. They dry up on the surface leaving a white encrustation. The affected grains have discoloured spots surrounded by water soaked areas. If the cut end of leaf is dipped in water, bacterial ooze makes the water turbid.

Pathogen

The bacterium is strict aerobe, gram negative, non spore forming, rod shaped with size ranging from 1-2 x 0.8-1.0µm with monotrichous polar flagellum of 6-8 µm. The bacterial cells are capsulated and are joined to form an aggregate mass. Colonies are circular, convex with entire margins, whitish yellow to straw yellow later and opaque.

Favourable Conditions

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

Mode of Spread and Survival

The infected seeds as a source of inoculum may not be important since the bacteria decrease rapidly and die in the course of seed soaking. The pathogen survives in soil and in the infected stubbles and on collateral hosts like *Leersia spp.*, *Plantago major*, *Paspalum dictum*, and *Cyanodon dactylon*. The pathogen spreads through irrigation water in dry season and also through typhoons and rain storms.

Management

Burn the stubbles. Use optimum dose of fertilizers. Avoid clipping of tip of seedling at the time of transplanting. Avoid flooded conditions. Remove weed hosts. Grow resistant cultivars like IR 20 and TKM 6. Spray Streptomycin sulphate and tetracycline combination 300 g + Copper oxychloride 1.25 g/ha.

Bacterial leaf streak

Xanthomonas campestris p.v. oryzae

Symptoms

Fine translucent streaks are formed on the veins and the lesions enlarge lengthwise and infect larger veins and turn brown. On the surface of the lesions, bacteria ooze out and form small yellow band-like exudates under humid conditions. In severe cases the leaves may dry up.

Management

Similar to bacterial leaf blight.

Tungro disease

Virus

Symptoms

Infection occurs both in the nursery and in the main field. Plants are markedly stunted. Leaves show yellow to orange discoloration and interveinal chlorosis. Yellow discoloration is commonly seen in “Japonica” varieties, while “Indica” varieties show orange discoloration. Young leaves are often mottled with pale green to whitish interveinal stripes. The plants may be killed if infected early. Tillering is reduced with poor root system. The infected plants have few spikelets and panicles are small with discoloured grains.

Tungro infected plants can be chemically identified by **Iodine Test**. Ten cm long leaf tip is cut in the early morning before 6 A.M. and dipped in a solution containing 2 g Iodine and 6 g Potassium Iodide in 100 ml of water for 30 minutes. Tungro infected leaves show dark blue streaks.

Pathogen

It is a composite disease caused by two morphologically unrelated viruses : rice tungro bacilliform virus (RTBV) and rice tungro spherical virus (RTSV). RTBV has a bacilliform capsid 130 x 30 nm made up of a single species of coat protein of MW 36 K and a single molecule of circular double - stranded DNA of 8.3 KbP. RTSV has a isometric capsid, 30 nm in diameter comprising two to three polypeptide species and a single species of polyadenylated single - stranded RNA of about 10 KbP.

Mode of Spread and Survival

Two types of virus particles are associated with the disease. Bacilliform particles cause majority of the symptoms of the disease. Spherical particles help in the transmission of bacilliform virus by the green leaf-hoppers. If the bacilliform virus particles are alone present in the rice plant they will not be transmitted by the leafhopper vector. The leafhoppers viz, *Nephotettix virescens*, *N. nigropictus*, *N. parvus*, *N. malayanus* and *Recilia dorsalis* transmit the virus in a non-persistent manner. There is no latent period in the vector and infectivity is retained for a maximum period of 6 days after acquisition of the virus.

Management

Summer deep ploughing and burning of stubbles. Destroy weed hosts of the virus and vectors. Grow disease tolerant cultivars like IR50 and Co45. Control the vectors in the nursery by application of carbofuran 170 g/cent, 10 days after sowing. Spray Phosphamidan 500 ml or Fenthion 500 ml or Monocrotophos 1 lit/ha or Neem oil 3 per cent in the main field 15 and 30 days after transplanting to control leaf hoppers.

Grassy stunt Virus

The infected plants are markedly stunted and have excessive tillering and has an erect growth habit. The leaves become short, narrow, pale green or pale yellow and have numerous small dark brown spots. On older leaves these spots spreading give a bronze colour to the plants. The plants may produce a few small panicles which bear dark brown and unfilled grains.

Mode of Spread and Survival

The virus is transmitted in a persistent manner by the brown planthopper, *Nilaparvata lugens*. It has a latent period of 5 to 28 days in the vector.

Rice dwarf

Virus

Symptoms

The virus infected plants show marked stunted growth with chlorotic or whitish specks on the leaves. The size of specks varies often and form interrupted streaks along the veins and distal part of infected leaves show diffuse yellowing. The number of tillers may be reduced with retarded growth. The diseased plants may survive until harvest time, remaining more or less green. Plants which are infected at early stage produce no earheads, if produced, may have small unfilled grains.

Pathogen

The partially purified virus particle have a hexagonal outline and are 70 nm in diameter with a surrounding envelope. The virus particle contains double stranded RNA or of double helical in nature.

Favourable Conditions

High population of *Nephotettix cincticeps*, *Reclia dorsalis* and *N. nigropictus*. The presence of gramineous weeds like *Echinochloa crusgalli*, *Glyceria acutifolia* and *Panicum miliaceum*.

Mode of Spread and Survival

The virus is found to survive in the gramineous weeds. The virus is transmitted through the egg masses of leafhoppers from one generation to another. (Trans ovarian transmission).

Management

Destroy the weed host which harbour the virus and the vectors. Spray Phosphamidon or Fenthion 500 ml or Monocrotophos 1 lit/ha.

Ragged stunt Virus

Symptoms

Formation of ragged leaves with irregularly edged portions, stunting of plants, vein swelling, delay in flowering, production of nodal branches and incomplete emergence of panicles are the main diagnostic symptoms.

Mode of Spread and Survival

The virus is transmitted in a persistent manner by the brown planthopper, *Nilaparvata lugens* but not through seed. It has a latent period of 3 to 35 days in the vector.

Rice yellow dwarf Mycoplasma Like Organism (MLO)

Symptoms

The infected plants are stunted and have yellowish green to whitish green leaves. There is excessive tillering and leaves became soft and droop slightly. Plants are usually

sterile but some may produce small panicles with unfilled grains. If plants are infected early they usually die before maturity, and even if they do survive no panicles are produced or only a small number with no grains. With later infection there may be little sign that the plant is diseased, but regrowth from stubble will show typical chlorosis.

Mode of Spread and Survival

The MLO is transmitted by *Nephotettix virescens* and *N. nigropictus* with a latent period of 25-30 days. It survives on several grass weeds.

Management

Deep ploughing during summer and burning of stubbles. Rice varieties like IR62 and IR64 are resistant to the disease. The management practices followed for Rice Tungro disease may be adopted for this disease also.

SORGHUM (*Sorghum bicolor*)

Downy Mildew

Peronosclerospora sorghi

Symptoms

The fungus, *Peronosclerospora sorghi* is the cause of a systemic downy mildew of sorghum. It invades the growing points of young plants, either through oospore or conidial infection and as the leaves unfold they show various types of symptoms. The first few leaves that show symptoms are only partially infected with green or yellow colouration of the infected portion. Abundant downy white growth is produced on the lower surface of the leaves, consists of conidiophores and conidia. Normally three or four leaves develop the chlorotic downy growth type of symptoms. Subsequent leaves show progressively more of a complete bleaching of the leaf tissue, sometimes in streaks or stripes. As the infected bleached leaves mature they become necrotic and the interveinal tissues disintegrate, releasing the resting spores (oospores) and leaving the vascular bundles loosely connected to give the typical shredded leaf symptom.

Pathogen

P. sorghi is systemic in young host plant in the form of intercellular, non-septate mycelium. It is an obligate parasite. Conidiophores emerge through the stomata in single or in clusters which are stout and dichotomously branched. Conidia are single celled, hyaline, globose and thinwalled. Oospores are typically produced abundantly in parallel bands between fibro vascular strands of the shredded leaf tissue which are more or less round, thickwalled and deep brown in colour.

Favourable Conditions

Maximum sporulation takes place at 100 per cent relative humidity. Optimum temperature for sporulation is 21-23°C. Light drizzling accompanied by cool weather is highly favourable.

Mode of Spread and Survival

The primary infection is by means of oospores present in the soil which germinate and initiate the systemic infection. The oospores persist in the soil for several years.

Secondary spread is by means of air-borne conidia. Presence of mycelium of the fungus in the seeds of systemically infected plants is also a source of infection.

Management

Crop rotation with other crops like pulses and oilseeds. Avoid the secondary spread of the disease by roguing out the affected plants since the wind plays an important role in the secondary spread of the disease from the infected plants. Grow moderately resistant varieties like Co25 and Co26. Seed treatment with Metalaxyl (Apron 35 SD) at 6 g/kg of seed. Spray Metalaxyl 500 g or Mancozeb 1 kg or Ziram 1 kg or Zineb 1 kg/ha.

Leaf blight

Exerohilum turcicum

(Syn : *Helminthosporium turcicum*)

Symptoms

The leaf blight pathogen also causes seed rot and seedling blight of sorghum. The disease appears in the form of small narrow elongated spots in the initial stage. But in due course they extend along with the length of the leaf becoming bigger. On older plants, the typical symptoms are long elliptical necrotic lesions, straw coloured in the centre with dark margins. The straw coloured centre become darker during sporulation. The lesions can be several centimeters long and wide. Many lesions may develop and coalesce on the leaves, destroying large areas of leaf tissue, giving the crop a distinctly burnt or blasted appearance.

Pathogen

The mycelium is localised in the infected lesion. Conidiophore emerges through stomata and are simple, olivaceous, septate and geniculate type. Conidia are olivaceous brown, 3-8 septate and thick walled.

Favourable Conditions

Cool moist weather, high humidity (90 per cent) and high rainfall.

Mode of Spread and Survival

The fungus is found to persist in the infected plant debris. Seed borne conidia are responsible for seedling infection. The secondary spread of the disease is through wind-borne conidia.

Management

Use disease free seeds. Treat the seeds with Captan or Thiram at 4 g/kg. Spray Mancozeb 1.25 kg or Captafol 1 kg/ha.

Rectangular Leaf spot

Cercospora sorghi

Symptoms

The symptoms appear as small leaf spots which enlarge to become rectangular lesions (which can be 5-15 mm long by 2 to 5 mm wide) on the leaf and leaf sheath. Usually the lower leaves are first attacked. The lesions are typical dark red to purplish with some what lighter centres. The lesions are mostly isolated and limited by veins. Severe spotting results

in premature drying of leaves. The colour of the spots vary from red, purple, brown or dark depending upon the variety.

Pathogen

Mycelium of the fungus is hyaline and septate. Conidiophores emerge in clusters through stomata, which are brown and simple, rarely branched. Conidia are hyaline, thin walled, 2-13 celled and long obclavate.

Favourable Conditions

Cool moist weather, high humidity (90 per cent) and high rainfall.

Mode of Spread and Survival

The conidia survive upto 5 months. The disease spreads through air-borne and seed-borne conidia.

Management

Use disease free seeds. Treat the seed with Captan or Thiram at 4 g/kg. Spray Mancozeb 1.25 kg or Captafol 1kg/ha.

Anthracnose and red rot *Colletotrichum graminicolum*

Symptoms

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

Pathogen

The mycelium of the fungus is localised in the spot. Acervuli with setae arise through epidermis. Conidia are hyaline, single celled, vacuolate and falcate in shape.

Favourable Conditions

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

Mode of Spread and Survival

The disease spread by means of seed-borne and air-borne conidia and also through the infected plant debris.

Management

Treat the seeds with Captan or Thiram at 4 g/kg. Spray the crop with Mancozeb 1.25 kg/ha.

Rust
Puccinia purpurea

Symptoms

The fungus affects the crop at all stages of growth. The first symptoms are small flecks on the lower leaves (purple, tan or red depending upon the cultivar). Pustules (uredosori) appear on both surfaces of leaf as purplish spots which rupture to release reddish powdery masses of uredospores. The pustules are elliptical and lie between and parallel with the leaf veins. In highly susceptible cultivars, the pustules occur so densely that almost the entire leaf is destroyed. Teliopores develop later sometimes in the old uredosori or in telisori, which are darker and longer than the uredosori. The pustules may also occur on the leaf sheaths and on the stalks of inflorescence.

Pathogen

The uredospores are pedicellate, elliptical or oval, thin walled, echinulated and dark brown in colour. The teliospores are reddish or brown in colour and two celled, rounded at the apex with one germ pore in each cell. The teliospores germinate and produce promycelium and basidiospores. Basidiospores infect *Oxalis corniculata* (alternate host) where pycnial and aecial stages arise after infection.

Favourable Conditions

Low temperature of 10 to 12°C favours teliospore germination and a spell of rainy weather favours the onset of the disease.

Mode of Spread and Survival

The uredospores survive for a short time in soil and infected debris. Presence of alternate host helps in perpetuation of the fungus.

Management

Remove the alternate host *Oxalis corniculata*. Spray the crop with Mancozeb at 1.25 kg/ha.

Grain smut/Kernel smut / Covered smut / Short smut
Sphacelotheca sorghi

Symptoms

The individual grains are replaced by smut sori which can be localized at a particular part of the head or occur over the entire inflorescence. The sori are oval or cylindrical and are covered with a tough white cream to light brown skin (peridium) which often persists unbroken upto threshing. The size, colour and degree of breakage of the sori varies considerably with race of the fungus and the sorghum cultivar. Ratoon crops exhibit higher incidence of disease.

Loose smut/Loose kernel smut
Sphacelotheca cruenta

Symptoms

The affected plants can be detected before the ears come out. They are shorter about a foot than the healthy plants with thinner stalks and marked tillering. The ears come out much earlier than the healthy. The glumes are hypertrophied and the earhead gives a

loose appearance than healthy. The sorus is covered by a thin membrane which ruptures very early, exposing the spores even as the head emerges from the sheath. The size of the sorus varies with the variety of the host.

Long smut

Tolyposporium ehrenbergii

Symptoms

The presence of long smut can be discovered only by a close examination of the ears in the field. This disease is normally restricted to a relatively small proportion of the florets which are scattered on a head. The sori are long, more or less cylindrical, elongated, slightly curved with a relatively thick creamy-brown covering membrane (peridium). The peridium splits at the apex to release black mass of spores among which are found several darkbrown filaments which represent the vascular bundles of the infected ovary.

Head smut

Sphacelotheca reiliana

Symptoms

The head is completely replaced by a large gall (sorus). The galls are at first covered by a whitish grey membrane of fungal tissue, which ruptures, often before the head emerges from the boot leaf, to expose a mass of brown-black powder (smutspores) along which are embedded long, thin, darkcoloured filaments which are the vascular bundles of the infected head. Sometimes smaller sori develop on the leaves and lower part of the peduncle.

Management for all smuts

Treat the seed with Captan or Thiram at 4 g/kg. Use disease free seeds. Follow crop rotation. Collect the smutted ear heads in cloth bags and dip in boiling water.

Ergot or Sugary disease

Sphacelia sorghi

Symptoms

The disease is confined to individual spikelets. The first symptom is the secretion of honey dew (creamy sticky liquid) from infected florets. Under favourable conditions, long, straight or curved, cream to light brown, hard sclerotia develop. At the base of the affected plants white spots can be seen on the soil surface, denoting the drops of honey dew which had fallen on the soil. Often the honey dew is colonised by *Crerebella sorghivulgaris* which gives the head a blackened appearance.

Pathogen

The fungus produces septate mycelium. The honey dew is a concentrated suspension of conidia, which are single celled, hyaline, elliptic or oblong in shape and slightly constricted in the middle.

Favourable Conditions

A period of high rainfall and high humidity during flowering season. Cool night temperature and cloudy weather aggravate the disease.

Mode of Spread and Survival

The primary source of infection is through the germination of sclerotia which produce ascospores, which infect the ovary. The secondary spread takes place through air and insect-borne conidia. Rain splashes also help in spreading the disease.

Management

Adjust the date of sowing so that the crop does not flower during September-October when high rainfall and high humidity favour the disease. Spray any one of the following fungicides at emergence of earhead (5-10 per cent flowering stage) followed by a spray at 50 per cent flowering and repeat the spray after a week, if necessary. Ziram (or) Zineb (or) Mancozeb (or) Carbendazim at 1 kg/ha.

Head mould/Grain mould/Head blight

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

Symptoms

If rains occur during the flowering and grain filling stages, severe grain moulding can occur. Fungi from many genera have been isolated from the infected sorghum grains and the most frequently occurring genera are *Fusarium*, *Curvularia*, *Alternaria*, *Aspergillus* and *Phoma*. *Fusarium semitectum* and *F.moniliforme* develop a fluffy white or pinkish colouration. *C. lunata* colours the grain black. Symptom varies depending upon the organism involved and the degree of infection.

Favourable Conditions

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

Mode of Spread and Survival

The fungi mainly spread through air-borne conidia. The fungi survive as parasites as well as saprophytes in the infected plant debris.

Management

Adjust the sowing time. Spray any one of the following fungicides in case of intermittent rainfall during earhead emergence, a week later and during milky stage. Mancozeb 1 kg/ha. or Captan 1 kg + Aureofungin-sol 100 g/ha.

Phanerogamic parasite

Witch Weed

Striga asiatica and *Striga densiflora*

It is a partial root parasite and occurs mainly in the rainfed sorghum. It is a small plant with bright green leaves, grows upto a height of 15-30 cm. It always occurs in clusters of 10-20/host plant. *S. asiatica* produces red to pink flowers while. *S. densiflora* produces white flowers. Each fruit contains minute seeds in abundance which survive in the soil for several years.

The root exudates of sorghum stimulate the seeds of the parasite to germinate. The parasite then slowly attach to the root of the host by haustoria and grow below the soil surface and produce underground stems and roots for about 1-2 months. The parasite grows faster and appears at the base of the plant. Severe infestation causes yellowing and wilting of the host leaves. The infected plants are stunted in growth and may die prior to seed setting.

Management

Regular weeding and interculture operation during early stages of parasite growth. Spray Fernoxone (sodium salt of 2, 4-D) at 450g/500 litre of water.

CUMBU (*Pennisetum americanum*)

Downy mildew

Sclerospora graminicola

Symptoms

Infection is mainly systemic and symptoms appear on the leaves and the inflorescences. The first symptoms can appear in seedlings at three to four leaf stage. The affected leaves show patches of light green to light yellow colour on the upper surface of leaves and the corresponding lower surface bears white downy growth of the fungus. The yellow discolouration often turns to streaks along veins. The downy growth seen on infected leaves consists of sporangiophores and sporangia. As a result of infection young plants dry and die ultimately. Symptoms may appear first on the upper leaves of the main shoot or the main shoot may be symptom free and symptoms appear on tillers or on the lateral shoots.

The inflorescences of infected plants can be completely or partially malformed with florets converted into leafy structures, the ear head gives the typical symptom of green ear.

Infected leaves and inflorescences produce sporangia over a considerable period of time under humid conditions and necrosis begins. The dry necrotic tissues from infected plant contain masses of oospores.

Pathogen

The mycelium is systemic, nonseptate, intercellular in the parenchymatous tissues. Short, stout, hyaline sporangiophores arise through stomata and branch irregularly, ends with characteristic stalks bearing the sporangia. Sporangia are hyaline, thin walled and elliptical, bear prominent papilla. Oospores are round in shape, surrounded by a smooth, thick and yellowish brown wall.

Favourable Conditions

Very high humidity (90 per cent), presence of water on the leaves and low temperature of 15-25°C favour the formation of sporangiophore and sporangia. Under such conditions, 35,000 sporangia are liberated from one sq. inch of leaf area.

Mode of Spread and Survival

The oospores remain viable in soil for 5 years or longer giving rise to the primary infection on the host seedling. Secondary spread is through sporangia which are produced during rainy season. It is also believed that the dormant mycelium is present in embryo of infected seeds.

Management

Deep ploughing so as to bury the oospore deeply. Rogue out infected plants. Adopt crop rotation. Use excess seed rate. Grow resistant varieties like X5, WCC-75 and Co7. Treat the seeds with Metalaxyl (Apron 35SD) at 6g/kg. Spray Mancozeb 1kg or Metalaxyl+Mancozeb (Ridomil MZ) at 2kg/ha on 20th day after sowing in the field.

Smut

Tolyposporium penicillariae

Symptoms

The pathogen infects few florets and transforms them into plump sacs (sori) containing black powder (smut spores). In the early stage, the sori are larger and greener than normal healthy grains and when the sori mature they become dark brown and are easily broken and release millions of black smut spore balls.

Pathogen

The fungus mostly confined to the sorus. The sori contains spores which are usually in balls and are not easy to separate. Each spore is angular or round and light brown coloured.

Favourable Conditions

High humidity and successive cropping with cumbu.

Mode of Spread and Survival

It survives spore balls in the soil and serve as primary source of inoculum. The secondary spread is by air-borne conidia.

Management

The damage caused by the fungus is negligible. However, removal and destruction of affected earhead will help in controlling the disease.

Rust

Puccinia penniseti

Symptoms

Symptoms first appear mostly on the distal half of the lamina. The leaf soon becomes covered by uredosori which appear more on the upper surface. Sometimes, the necrotic spots appear around the group of pustules. The pustules may be formed on leaf sheath, stem and even on peduncles. Later, telial formation takes place on leaf blade, leaf sheath and stem. While brownish uredinia get exposed at maturity, the black telia remain covered by the epidermis for a longer duration.

Pathogen

Uredospores are oval, elliptic or pyriform with four germ pores, sparsely echinulated and pedicellate. Teliospores are dark brown in colour, 2 celled, cylindrical to club shaped, apex flattered, broad at top and tapering towards base. The fungus has a long life cycle producing uredial and telial stages on cumbu and aecial and pycnial stages on brinjal. (*Solanum melongena*)

Favourable Conditions

Closer spacing. Presence of abundant brinjal plants and other species of *Solanum* viz., *S. torvum*, *S. xanthocarpum* and *S. pubescens*.

Mode of Spread and Survival

Air-borne uredospores are the primary sources. The uredial stages also occur on several species of *Pennisetum*.

Management

Spray with Wettable Sulphur 2.5 kg or Captafol 1 kg or Mancozeb 1.25 kg/ha.

Ergot or Sugary disease

Claviceps fusiformis

Symptoms

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

Pathogen

The pathogen produces septate mycelium which produce conidiophores and are closely arranged. Conidia are hyaline and one celled. The sclerotia are small and dark grey but white inside. Sclerotia are 3-8 mm long and 0.3-15 mm broad.

Mode of Spread and Survival

Sclerotia are viable in soil for 6-8 months. The primary infection takes place by germinating sclerotia present in the soil. Secondary spread is by insects or air-borne conidia. The role of collateral hosts like *Cenchrus ciliaris* and *C. setigerus* in perpetuation of fungus is significant. The fungus also infects other species of *Pennisetum*.

Management

Adjust the sowing date so that the crop does not flower during September when high rainfall and high relative humidity favour the disease spread. Immerse the seeds in 10 per cent common salt solution and remove the floating sclerotia. Remove collateral hosts. Spray with Carbendazim 500g or Mancozeb 1.25 kg or Ziram 1kg/ha when 5-10 per cent flowers have opened and again at 50 per cent flowering stage.

Minor diseases

Grain mould *Fusarium* and *Curvularia* spp. Complex of several fungi.
Grains covered with white, pink or black moulds.

Blast *Pyricularia setariae*. Diamond shaped to circular
lesions with dark brown margins and chlorotic haloes.

Zonate leaf spot *Gloeocercospora* sp. Rough circular lesions with
alternating concentric bands of straw and brown
colour, often coalescing over the leaf surface.

Banded leaf and Sheath blight *Rhizoctonia* spp. Patch work of light and dark
discoloured areas often bearing fluffy to light
brown fungal mats.

MAIZE (*Zea mays*)

Downy mildew/Crazy top

Peronosclerospora sorghi

Symptoms

The most characteristic symptom is the development of chlorotic streaks appear on the leaves and the plants exhibit a stunted and bushy appearance due to the shortening of the internodes. White downy growth can be seen not only on the lower surface of leaf but also on the chlorotic streaks. The downy growth also occurs on bracts of green unopened male flowers in the tassel. Sometimes miniature to large leaves has been noticed in the tassel. These leaves bear well defined downy growth. Proliferation of auxillary buds on the stalk of tassel as well as the cobs is very common (**Crazy top**).

Pathogen

The fungus grows as white downy growth on both surface of the leaves, consist of sporangiophores and sporangia. Sporangiohophores are quite short and stout, branch profusely into series of pointed sterigmata which bear hyaline, oblong or ovoid sporangia (conidia). Sporangia germinate directly and infect the plants. In advanced stages, oospores are formed which are spherical, thick walled and deep brown.

Favourable Conditions

Low temperature (21-33OC), high relative humidity, (90 per cent), water logging condition and light drizzling. Young plants are highly susceptible.

Mode of Spread and Survival

The primary source of infection is through the oospores present in the soil and also the dormant mycelium present in the infected maize seeds. Secondary spread is through air-borne conidia. The oospores survive in the soil as well as in the infected plant debris.

Management

Deep ploughing. Crop rotation with pulses. Adjust the time of sowing. Rogue out infected plants. Treat the seeds with Metalaxyl compound (Apron 35SD) at 6g/kg. Spray the crop with Metalaxyl + Mancozeb 2kg or Mancozeb 1.25 kg/ha on 20th day after sowing. Grow resistant varieties and hybrids viz. Co1, CoH₁ and CoH₂.

Leaf blight

Helminthosporium maydis
(Syn : *H. turcicum*)

Symptoms

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

Pathogen

Conidiophores are in group, geniculate, mid dark brown, pale near the apex and smooth. Conidia are distinctly curved, fusiform, pale to mid dark golden brown with 5-11 pseudosepta.

Favourable Conditions

Optimum temperature for the germination of conidia is 8 to 27OC provided with free water on the leaf. Infection takes place early in the wet season.

Mode of Spread and Survival

It is a seed-borne fungus. It also infects sorghum, wheat, barely, oats, sugarcane and spores of the fungus are also found to associate with seeds of green gram, black gram, cowpea, varagu, Sudan grass, Johnson grass and Teosinte.

Management

Treat the seeds with Captan or Thiram at 4 g/kg. Spray Mancozeb 1.25 kg or Captan 1 kg/ha.

Rust *Puccinia sorghi*

Symptoms

Circular to oval, elongated cinnamon-brown powdery pustules are scattered over both surface of the leaves. As the plant matures, the pustules become brown to black owing to the replacement of red uredospores by black teliospores.

Pathogen

Uredospores are globose or elliptical finely echinulate, yellowish brown with 4 germ pores. Teliospores are brownish black, or dark brown, oblong to ellipsoidal, rounded to flattened at the apex. They are two celled and slightly constricted at the septum and the spore wall is thickened at the apex.

Favourable Conditions

Cool temperature and high relative humidity.

Mode of Spread and Survival

Presence of alternate hosts viz., *Oxalis corniculata* and *Euchlaena mexicana*.

Management

Remove the alternate hosts. Spray Mancozeb at 1.25 kg/ha.

Head smut *Sphacelotheca reiliana*

Symptoms

Symptoms are usually noticed on the cob and tassel. Large smut sori replace the tassel and the ear. Sometimes the tassel is partially or wholly converted into smut sorus. Under such conditions the individual spikelets on tassels may form shoot like growths, or the entire tassel may develop into leaf like structures. The smutted plants are stunted in growth, produce little yield and remain greener than that of the rest of the plants.

Pathogen

Smut spores (chlamydospores) are produced in large numbers which are reddish brown to black, thick walled, finely spined, spherical or slightly irregular.

Favourable Conditions

Low temperature favours more infection and this fungus also infects the sorghum crop and *vice versa*.

Mode of Spread and Survival

The smut spores retains its viability for two years. The fungus is externally seed-borne and soil-borne. The major source of infection is through soil-borne chlamydospores.

Management

Field sanitation. Crop rotation with pulses. Treat the seeds with Captan or Thiram at 4 g/kg.

Charcoal rot

Macrophomina phaseolina
(*Rhizoctonia bataticola*)

Symptoms

The fungus attacks roots of seedlings and young plants. The affected plants first exhibit the wilting symptoms. The stalk of the infected plants can be recognized by grayish streaks and become weak. The pith become shredded and grayish black minute sclerotia develop abundantly on the vascular bundles. Shredding of the interior of the stalk often causes stalks to break in the region of the crown. The crown region of the infected plant become dark in colour. Shredding of root bark and disintegration of root system are the common features.

Pathogen

The fungus produces large number of sclerotia which are round and black in colour. Sometimes, it produces pycnidia on the stems or stalks.

Favourable Conditions

High temperature and low soil moisture (drought)

Mode of Spread and Survival

The fungus has a wide host range, attacking sorghum, cumbu, ragi and pulses. It survives for more than 16 years in the infected plant debris. The primary source of infection is through soil-borne sclerotia.

Management

Long crop rotation with crops that are not natural host of the fungus. Irrigate the crops at the time of earhead emergence to maturity. Treat the seeds with Carbendazim or Captan at 2 g/kg. Grow disease tolerant varieties viz., SN-65, SWS-8029, Diva and Zenit.

Minor diseases

Brown spot	<i>Physoderma maydis</i> . Water soaked lesions, which are oval, later turn into light green and finally brown.
Stalk rot	<i>Erwinia dissolvens</i> . Dark brown lesion and rotting of stalk at crown level about 6"-12" from ground level. Lodging of plants.
Mosaic	Virus. Formation of mosaic symptoms. Plants produce smaller ear head and immature

seeds.

WHEAT (*Triticum aestivum*)

Black or stem rust	:	<i>Puccinia graminis tritici</i>
Leaf, brown or orange rust	:	<i>Puccinia recondita</i>
Yellow or stripe rust	:	<i>Puccinia striiformis</i>
Loose smut	:	<i>Ustilago tritici</i> (= <i>U. nuda tritici</i>)
Flag smut	:	<i>Urocystis tritici</i>
Rough spored bunt or		
Stinking smut	:	<i>Tilletia caries</i>
Smooth spored bunt	:	<i>Tilletia foetida</i>
Karnal bunt	:	<i>Neovassia indica</i>
Foor rot	:	<i>Pythium graminicolum</i> and <i>P. arrhenomanes</i>
Powdery mildew	:	<i>Erysiphe graminis</i> var. <i>tritici</i>

Foot rot

Pythium graminicolum and *P. arrhenomanes*

Symptoms

The disease mainly occur in seedlings and roots and rootlets become brown in colour. Seedlings become pale green and have stunted growth. Fungus produce sporangia and zoospores and oospores.

Favourable Conditions

Wet weather and high rainfall.

Mode of Spread and Survival

Through soil and irrigation water.

Management

Follow crop rotation. Treat the seeds with Carboxin or Carbendazim at 2g/kg.

Powdery mildew

Erysiphe graminis var. *tritici*

Symptoms

Greyish white powdery growth appears on the leaf, sheath, stem and floral parts. Powdery growth later become black lesion and cause drying of leaves and other parts.

Pathogen

Fungus produces septate, superficial, hyaline mycelium on leaf surface with short conidiophores. The conidia are elliptical, hyaline, single celled, thin walled and produced in chains. Dark globose cleistothecia containing 9-30 asci develop with oblong, hyaline and thin walled ascospores.

Mode of Spread and Survival

Fungus remains in infected plant debris as dormant mycelium and asci. Primary spread is by the ascospores and secondary spread through airborne conidia.

Favourable Conditions

Temperature of 20-21°C.

Management

Dust sulphur at 40 kg/ha. Spray 1% thiosulphate.

Leaf blight

Alternaria triticina

Symptoms

Reddish brown oval spots appear on young seedlings with bright yellow margin. In severe cases, several spots coalesce to cause drying of leaves. Fungus produces light brown coloured multicellular conidia singly or in chain.

Mode of Spread and Survival

Primary spread is by externally and internally seed-borne conidia. Secondary spread by air-borne conidia.

Favourable Conditions

Temperature of 25°C and high relative humidity.

Management

Soak the seeds in water for 4 hrs followed by 10 min. dip in hot water at 52°C. Grow resistant varieties like Arnautka, E6160 and K7340. Spray the crop with Mancozeb or Zineb at 1.5 kg/ha.

Minor diseases

Septoria leaf blotch	Septoria tritici
Helminthosporium leaf spot	Helminthosporium spp.
Tundu or yellow ear rot	Combination of Anguina tritici and Corynebacterium tritici
Take all disease	Ophiobolus graminis
Seedling blight	Rhizoctonia solani and Fusarium sp
Sclerotinia rot	Sclerotinia sclerotiorum
Leaf blight	Cladosporium herbarum
Blackchaff	Xanthomonas translucens var. undulosum
Dilophora leaf spot	Dilophora alopecuri
Molya disease (Nematode)	Heterodera avenae

RAGI (*Eleusine coracana*)

Blast

Pyricularia grisea

Symptoms

The pathogen attacks the crop from seedling stage to the time of grain formation. The lesions are spindle shaped and are of different size. In the beginning, the spots have yellow margin with grayish green centre. Under humid conditions, an olive grey overgrowth of fungus can be seen on the centre of the spot. Later the centre become whitish grey and disintegrate. The lesions on the seedlings are about 0.3 to 0.5 cm in breadth and 1-2 cm in length. Stem infection causes blackening of the nodal region. Maximum damage is caused by the neck infection. The neck region turns black and shrink. Infection may also occur at the basal portions of the panicle branches including the fingers. The affected portions turn brown and ears become chaffy and only few shrivelled grains are formed.

Pathogen

Young hyphae are hyaline and septate and turns to brown when become old. Numerous conidiophores and conidia are formed in the middle portion of the lesions. Conidiophores are slender, thin walled, emerging singly or in groups, unbranched, geniculate and pale brown in colour. Conidia are thin walled, sub-pyriform, hyaline 1-2 septate, mostly 3 celled with a prominent hilum.

Favourable Conditions

Optimum temperature is 25-30°C. High relative humidity (92-95 per cent) and continuous drizzles. Presence of collateral hosts like Tenai, bajra, wheat, barley and oats.

Mode of Spread and Survival

The fungus is seed-borne and the primary infection takes place through the seed-borne conidia and also the other crops serve as source of inoculum. The secondary spread is through air-borne conidia.

Management

Treat the seeds with Captan or Thiram at 4g or Carbendazim at 2 g/kg. Grow moderately resistant varieties like Co10, Co11, Co12, Co13, PR202 and HR374. Spray with Iprobenphos (IBP) or Edifenphos 500 ml or Carbendazim 250 g/ha, first spray immediately after noticing the symptoms and second spray at flowering stage.

Seedling blight or Leaf blight
Helminthosporium nodulosum
(Sexual stage : *Cochliobolus nodulosum*)

Symptoms

The pathogen attacks all the parts of the plants including roots, base of the plants, culms, leaf sheath, leaf blade, neck of the panicle and the fingers. Both pre-and post-emergence rot may be seen. On young leaves the disease appears as minute, light brown oval spots. The affected leaves wither prematurely and seedlings may be killed. The fungus affect the base of the plants and cause root rot and foot rot. In grown up plants, spots are oblong and dark brown. The spots on the leaf sheath and culms are irregular and are generally found on the junction of blade and sheath. Infection on the neck causes discoloration and sooty growth in the inflorescences.

Pathogen

Hypha of the fungus is light brown coloured and septate. Conidiophores are long, septate, dark brown in colour, often branched and geniculate. Conidia are straight ovoid, pale to dark golden brown, 5-7 pseudoseptate. *C. nodulosum* produces spherical perithecia and asci contain 1 to 8 ascospores.

Favourable Conditions

Optimum temperature for infection is 30-32°C and 80-90% relative humidity. Rains during earhead emergence is favourable.

Mode of Spread and Survival

The pathogen readily infects *Setaria italica*, *Eleusine indica*, *Echinochloa sp*, *Panicum miliaceum*, *Pennisetum typhoides*, *Sorghum bicolor* and *Zea mays*. Primary spread is through seed-borne inoculum and the secondary spread by air-borne conidia.

Management

Treat the seeds with Captan or Thiram at 4 g/kg. Spray with Mancozeb at 1.25 kg/ha.

Wilt

Sclerotium rolfsii

(Sexual stage : *Corticium rolfsii*)

Symptoms

The infected plants become pale, chlorotic and stunted. The fungus attacks basal stem portion and later the leaf sheath and culm. The infected portion becomes soft and dark brown in colour. A whitish mycelial mass can be seen on the basal stem and on the nodal portions. On the surface of the lesions, small spherical, dark coloured sclerotia are formed.

Pathogen

The mycelium of the fungus is septate and white to tan coloured. Sclerotia are minute, mustard seed like structures and black in colour.

Favourable Conditions

High soil moisture and high temperature (more than 30°C)

Mode of Spread and Survival

The fungus survives in the soil as sclerotia and spreads through irrigation water and implements.

Management

Spot drench with Copper oxychloride at 0.25 per cent. Crop rotation with non host plants.

Mottle streak and streak Virus

Symptoms

The virus affected plants are stunted and pale green in colour. Chlorotic streaks are formed on the leaves and it is continuous in the case of streak and it is discontinuous in mottle streak. Early infection leads to reduction of tillers and grain formation.

Favourable Conditions

The disease is high in April-May sown crops due to high population of vectors viz., *Cicadulina bipunctella* and *C. cinai*.

Management

Rogue out the infected plants. Spray Monocrotophos or Methyl demeton 500 ml/ha. Spray first on noticing symptoms and repeat twice at 20 days interval.

Minor diseases

Downy mildew	<i>Sclerospora macrospora</i> Green ear symptom. Proliferation of spikeles.
Smut	<i>Melanopsicum eleusinis</i> Grains are converted into enlarged greenish to dirty black sori
Bacterial disease	<i>Xanthomonas eleusineae</i> Minute red leaf spots. Stunted growth and ears are not formed.
Phanerogamic parasite	<i>Striga asiatica</i>

TENAI (*Setaria italica*)

Blast

Pyricularia setariae

Symptoms

The spots are seen on the leaf blade. They are circular with light centre and are surrounded by a dark brown margin. The spots are small and scattered. When the disease appears in severe form the leaves wither and dry up. Neck infection is very rare.

Pathogen

The conidiophores emerge through epidermal cells or through stomata. Several conidia are formed one after another from each conidiophore. They are sub-hyaline, three celled and obpyriform. Thickwalled, olivebrown and globose chlamydospores are also developed at the tips of the germ tube.

Favourable Conditions

The optimum temperature is 30°C. High relative humidity (90 per cent), low night temperature and cloudy weather.

Mode of Spread and Survival

The primary source of infection is through seed-borne conidia and to some extent soil-borne. The secondary spread is through air-borne conidia which are produced on ragi, bajra, wheat and *Dectyloctenium aegyptium*.

Management

Treat the seeds with Captan or Thiram 4 g Carbendazim 2 g/kg. Spray the crop with Iprobenphos (IBP) or Edifenphos 500 ml/ha.

Leaf spot or Leaf blotch
Helminthosporium setariae
(Sexual stage : *Cochliobolus setariae*)

Symptoms

Leaf spots are brown in colour and small. Some times lesions also appear as blotches and the rotting of the secondary roots may also occur.

Pathogen

The conidiophores are simple, erect, cylindrical, brown, slightly swollen at the base and geniculate at the apex. Conidia are ellipsoid, straight or slightly curved and pale to moderately dark brown.

Favourable Conditions

Optimum temperature for growth and sporulation is 30°C

Mode of Spread and Survival

Externally seed borne.

Management

Treat the seeds with Captan or Thiram at 4 g/kg.

Smut
Ustilago crameri

Symptoms

The fungus grows systemically inside the host and express the symptom at the time of flowering. The sori are seen in the flowers and the basal parts of the palea. The fungus affects most of the grains in an ear but sometimes the terminal portion of ear may escape. The sori are pale grey in colour and measures 2 to 4 mm in diameter. When the crop matures the sori rupture and liberate dark powdery mass of spores.

Pathogen

The chlamydospores are dark brown in mass but lighter singly, irregular or angular in shape and smooth walled. The chlamydospores are inter calary in hyphal strands.

Mode of Spread and Survival

The fungus is externally seed-borne and secondary spread by air-borne chlamydospores.

Management

Treat the seeds with Captan or Thiram at 4 g/kg.

Rust
Uromyces setariae italicae

Symptoms

Numerous minute, brown uredosori appear on both surface of the leaf and are covered by the epidermis for very long time. The pustules are small, oblong and cinnamon brown in colour. The telia are smaller but covered by epidermis for quite a longer period and are grayish black in colour. Severe incidence of disease reduces the yield.

Pathogen

The uredospores are round, spiny, yellowish brown with 3 or 4 germ pores. The teliospores are one celled, smooth, oblong globose and thick walled especially at the apex.

Mode of Spread and Survival

The fungus can also attack other species of *Setaria viz., S. glauca, S. viridis* and *S. verticillata*. The air-borne uredospores cause primary infection.

Management

No control measure is generally taken against this disease.

Downy mildew or Green ear *Sclerospora graminicola*

Symptoms

Primary infection causes chlorosis of the plant and the leaves turn whitish. The terminal spindle fails to unroll, becomes chlorotic and later turn brown and get shredded. Whitish bloom of sporangiophores and sporangia develop on the surface of the affected leaves under humid conditions. The affected plants rarely comes to flowering. If the infection is mild, the plants may develop ears but the floral parts are proliferated into green leafy structures called green ear.

Pathogen

The sporangiophores are quite and branch heavily. The sporangia are hyaline, broadly fusiform or ovate in shape. Oospores are also produced in the infected host tissue. They are spherical with smooth wall and dark brown in colour.

Mode of Spread and Survival

Primary infection is mainly from soil-borne oospores or from oospores on the grains. The oospores are able to survive upto 8-10 years.

Favourable Conditions

Rainy weather, low temperature (15-25°C), high humidity (90 per cent) and high soil moisture.

Management

Treat the seeds with Captan or Thiram at 4 g/kg.

Minor diseases

Root rot	Periconia circinata	Browning of roots and death of plants
	Pythium spp	
	Helminthosporium	
	sativum	

Damping off	Pythium graminicola P. aristosporum	Damping off symptoms
Bacterial blight	Pseudomonas alboprecipitans	Greyish green spots with brown margin
Bacterial stripe	Pseudomonas setariae	Long narrow dark brown streaks with foetid smell
Virus diseases	Cocks foot mild mosaic virus and Maize mosaic virus	Mosaic mottling symptoms

KUTHIRAI VALI (*Echinochloa frumentacea*)

Smut

Ustilago crus-galli

Symptoms

The infected ear heads are completely destroyed. The fungus also produces gall-like swellings on the stem, the nodes of young shoots and in the axils of older leaves. The gall-like swellings are covered by a hairy tough membrane of host tissue.

Pathogen

The smut spores are mikado-brown, spherical and echinulated.

Mode of Spread

Externally seed-borne.

Management

Treat the seeds with Captan or Thiram at 4 g/kg.

Minor diseases

Smut	Ustilago paradoxa	Ovary is transformed into hairy, grey and round sorus. The sorus resembles normal grain in size.
Smut	Ustilago panici frumentacei	The affected ovary is three times bigger than normal grain. The spores escape through an opening at the tip.
Leaf stripe	Helminthosporium frumentacei	Small, yellow spots increase in number parallel to the vein, coalesce and form long stripes.
Leaf blight	Helminthosporium monoceros	Spots are isolated and and brown in colour, coalesce and become grey leading to blight.
Virus diseases	Wheat streak mosaic and Sugarcane mosaic	Mosaic mottling symptoms

VARUGU (*Paspalum scrobiculatum*)

Head smut

Sorosporium paspali-thunbergii

Symptoms

The entire panicle is transformed into a long sorus and cream coloured thin membrane covers the sorus. In some cases it is enclosed in the flag leaf and may not emerge fully. The membrane bursts open and exposes the black mass of spores.

Pathogen

Spores are globose to angular and dark brown with a thick smooth episore.

Mode of Spread and Survival

Mainly seed-borne. The spores stick to surface of the grains and infect the next crop.

Management

Treat the seeds with Thiram or Captan at 4 g/kg.

Minor diseases

Rust	<i>Puccinia substriata</i>	Form uredia on upper surface and telia on lower surface of the leaf.
Sugary or ergot	<i>Claviceps paspali</i>	Honey dew ooze out and disease form reddish brown crust on lemma and palea. Dark grey sclerotia are formed.

PANIVARAGU (*Panicum miliare*)

Rust

Uromyces linearis

Symptoms

Numerous, narrow, minute, brown pustules arranged in linear rows appear on the upper surface of the leaves.

Pathogen

Uredia are erumpent and brown in colour. The fungus also attacks the other hosts like *Panicum ripens* and *P. antidotale*. The fungus is spread through air-borne uredospores.

Leaf spot

Helminthosporium oryzae

The fungus which attacks the rice also attacks this crop and produce brown rectangular spots.

SAMAI (*Panicum miliaceum*)

Smut

Sphacelotheca destruens

Symptoms

The entire inflorescence is converted into a sorus containing spores (Chlamydospores) and fibrous vascular bundles. The sorus is covered by a white or grey membrane. Abnormal development of hairs is evident on the leaf sheaths of infected plants. The smut spores are round or angular and yellowish brown.

Mode of Spread and Survival

Externally seed-borne and survive for more than 8 years.

Minor diseases

Rust	Uredo sp	Uredial stage alone noticed
Downy mildew	Sclerospora graminicola	Yellow stripes on the leaf, whitish growth on the leaves and shredding of leaf.
Blast	Pyricularia grisea	Spindle shaped brown lesions.
Seed rot	Melanomma paniclemiliaci	White to purplish violet colour on the ungerminated seeds.

RED GRAM (*Cajanus cajan*)

Wilt

Fusarium oxysporum f. sp. udum

Symptoms

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

Pathogen

The fungus produces hyaline, septate mycelium. Microconidia are hyaline, small, elliptical or curved, single celled or two celled. Macroconidia are also hyaline, thin walled, linear, curved or fusoid, pointed at both ends with 3-4 septa. The fungus also produce thick walled, spherical or oval, terminal or intercalary chlamydospores singly or in chains of 2 to 3.

Favourable Conditions

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

Mode of Spread and Survival

The fungus survives in the infected stubbles in the field. The primary spread is by soil-borne chlamydospores and also by seed contaminant. Chlamydospores remain viable in soil for 8-20 years. The secondary spread in the field is through irrigation water and implements.

Management

Treat the seeds with *Trichoderma viride* at 4 g/kg. Avoid successive cultivation of redgram in the same field. Follow long crop rotation with tobacco. Adopt mixed cropping of sorghum in the field. Grow resistant lines like ICP 8862, ICPL 88046, ICPL 227, BWR 254, DPPA 85-14, DPPA 85-15 and GPS 52.

Dry root rot

Macrophomina phaseolina
(Sclerotial stage : *Rhizoctonia bataticola*)

Symptoms

The disease occurs both in young seedlings and grown up plants. Infected seedlings can show reddish brown discoloration at collar region. The lower leaves show yellowing, drooping and premature defoliation. The discolored area later turns to black and sudden death of the plants occur in patches. The bark near the collar region shows shredding. The plant can be easily pulled off leaving dark rotten root in the ground. Minute dark sclerotia are seen in the shredded bark and root tissues. The fungus also produce dark discoloration of sub-epidermal tissue in lower part stem. Large number of brown dots seen on the stem portion represent the pycnidial stage of the fungus.

Pathogen

The fungus produces dark, brown, filamentous hyphae and constrictions are seen in hyphal branches at the junction with main hyphae. Sclerotia are jet black, smooth, hard, minute, globose and 110-130µ in diameter. The pycnidia are dark brown and ostiolated. Conidiophores (phialides) are hyaline, short, obpyriform to cylindrical, develop from the inner walls of the pycnidium. The conidia (Pycnidiospores) are hyaline, single celled and ellipsoid to ovoid.

Favourable Conditions

Prolonged drought followed by irrigation. High temperature of 28-35°C.

Mode of Spread and Survival

The primary spread of the disease is by seed borne sclerotia. Secondary spread is by soil-borne sclerotia and air-borne conidia. The pathogen survives as sclerotia in the soil as facultative parasite and in dead host debris.

Management

Treat the seeds with Carbendazim or Thiram at 4 g/kg or pellet the seeds with *Trichoderma viride* at 4 g/kg. Apply heavy doses of farm yard manure or green leaf manure like *Gliricidia maculata* at 10 t/ha or Apply Neemcake at 250 kg/ha. Grow resistant varieties like Co4.

Powdery mildew

Leveillula taurica

Symptoms

White powdery growth of the fungus can be seen on the lower surface of leaves. The corresponding areas in upper surface show pale yellow discoloration. The white powdery mass consists conidiophores and conidia of the fungus. In severe cases, the white growth can be seen on the upper surface also. The severe infection of the fungus leads to premature shedding of leaves and plant remains barren.

Pathogen

The fungus is intercellular and absorbs nutrition through haustoria. The conidiophores, which arise through stomata, are hyaline, long, non septate, slender and rarely branched and bear single conidium at the tip. The conidia are hyaline, single celled and elliptical or clavate. The fungus also produce black, globose cleistothecia with simple myceloid appendages. They contain 9-20 cylindrical asci. Each ascus contains 3-5 ascospores which are also hyaline and unicellular.

Favourable Conditions

Dry humid weather following rain fall.

Mode of Spread and Survival

The fungus survives in the soil as cleistothecia and ascospores from asci infect the first lower most leaves near the soil level. Secondary spread is by air-borne conidia.

Management

Spray Carbendazim 500g or Wettable sulphur 1.5 kg/ha at the initiation of the disease and repeat after 15 days.

Stem blight

Phytophthora drechsleri f. sp. *cajani*

Symptoms

Initially purple to dark brown necrotic lesions girdle the basal portion of the stem and later may occur on aerial parts of the seedlings. Initially lesions are small and smooth, later enlarging and slightly depressed. Infected tissue become soft and whole plant wilts. In the adult plants, infection is mostly confined to basal portions of the stem. The infected bark become brown and the tissue softening causing the plant to collapse. The infected branches may break off in wind. The upper portions of the infected twigs eventually wilt and dry. In leaf, localized yellowing starts from the tip and margin and gradually extends towards the mid-rib. The centre of the spots later turn brown and hard. The spots increase in size and cover a major portion of the lamina, leading to drying.

Pathogen

Fungus produces hyaline, coenocytic mycelium. The sporangiophores are hypha-like with a swelling on the tip bearing hyaline, ovate or pyriform, non-papillate sporangia. Each sporangium produces 8-20 zoospores. Oospores are globose, light brown, smooth and thick walled.

Favourable Conditions

Soils with poor drainage, low lying areas, heavy rain during the months of July-September and high temperature (28-30°C).

Mode of Spread and Survival

The fungus survives in the soil and plant debris in the form of oospores. Primary infection is from oospores and secondary spread by zoospores from sporangia. Rain splash and irrigation water help for the movement of zoospores.

Management

Treat the seeds with Metalaxyl at 7 g/kg. Spray Metalaxyl at 500 g/ha. Adjust the sowing time so that crop growth should not coincide with heavy rainfall.

Leaf spot *Cercospora indica*

Symptoms

Small, light brown coloured spots appear on leaves. The spots later become dark brown and the infected portions drop off leaving shot hole symptoms. When several spots join together, irregular necrotic blotches develop and premature defoliation occurs. In severe cases, black lesions develop on petioles and stem.

Pathogen

The fungus produces large number of whip-like, hyaline, 7-9 septate conidia in groups on the conidiophores which are light to dark brown in colour.

Mode of Spread and Survival

The fungus survives in the infected plant tissues. The disease is spread by air-borne conidia.

Management

Remove the infected plant debris and destroy. Spray Mancozeb 1 kg or Carbendazim 500 g/ha soon after the appearance of symptom and repeat after a fortnight.

Sterility Mosaic **Virus**

Symptoms

The disease attack can be seen in all stages of crop growth. Leaves show typical mosaic mottling symptoms. Yellow patches intermingle with green colour of leaf. The green portions exhibit puckering symptom. In severe cases, leaves become smaller and cluster near tip because of shortened internodes and stimulation of axillary buds. The plants are generally stunted and do not produce pod. Plants infected at early stages (upto 45 days) of crop growth show near complete sterility and yield loss upto 95 per cent. As plants become older (after 45 days), their susceptibility to the disease decreases and such plants show partial sterility. If pods develop, the seeds may be small, shrivelled and immature. Because the infected plants show sterility and the leaves show the 'mosaic' symptom, the name of the disease is sterility mosaic.

Mode of Spread and Survival

The disease is transmitted by an Eriophyid mite *Aceria cajani*. The self-sown redgram plants and perennial types of redgram serve as sources of infection.

Management

Rogue out infected plants upto 40 days after sowing. Spray Monocrotophos at 500 ml/ha soon after appearance of the disease and if necessary, repeat after 15 days. Grow resistant genotypes/cultivars like ICP 7035, VR3, Purple 1, DA11, DA32, ICP 6997, Bahar, BSMR 235, ICP 7198, PR 5149, ICP 8861 and Bhavanisagar 1.

Yellow Mosaic Virus

Symptoms

Small yellow patches or spots appear on young leaves. The area of yellow discoloration slowly increases and newly formed leaves may completely turn yellow. Infected plants are stunted and mature later and produce very few flowers and pods. The pods are small and distorted. The early infection of virus leads to heavy yield loss.

Mode of Spread and Survival

The virus survives in weed hosts and perennial redgram plants. The disease is transmitted by white flies (*Bemisia tabaci*).

Management

Rogue out the diseased plants upto 45 days after sowing. Remove weed hosts periodically. Spray Monocrotophos or Methyldemeton at 500 ml/ha immediately on noticing the disease and repeat after 15 days, if necessary.

Minor diseases

Seedling blight	Sclerotium rolfsii	Small brown water soaked dots appear near collar region, expands to irregular necrotic spots leading to girdling of stem and death of seedling.
Brown blotch	Colletotrichum capsici	Purple brown discolouration occurs mainly on pods but also on petioles, leaf veins, stems and peduncles. Pods become distorted and have black fruiting bodies.
Anthrachnose	Colletotrichum lindemuthianum (Glomerella cingulata)	Black lesions develop on stem which spreads to leaf petiole and leaves. Black sunken lesions also develop on pod.
Stem rot	Pythium aphanidermatum	Seedlings of 2-3 weeks old are severely attacked at collar region and

		death occurs immediately. Greyish green water soaked lesions develop on adult plants, leading to girdling of stem.
Leaf spot	<i>Alternaria alternata</i>	Water soaked, circular to irregular spots occur on margins of leaves. The centre of the spot is straw coloured with raised reddish brown margins.
Rust	<i>Uredo cajani</i> and <i>Uromyces dolichi</i>	Dark brown pustules (Uredia) occur on older leaves. Telia production is absent in <i>U. cajani</i> .
Halo blight	<i>Pseudomonas phaseolicola</i>	Small brown spots appear on leaves and develop a chlorotic halo. The spots extend and form dried brown zone. Brown elongated streaks appear on petioles, stem and pods.

BENGAL GRAM (*Cicer arietinum*)

Root rot

Rhizoctonia solani

(Sexual stage : *Thanatephorus cucumeris*)

Symptoms

The disease occur severely in the seedling stage. A dark brown lesion develop on the stem near ground level. The infected seedling slowly turn yellow and petioles and leaflets show drooping, leads to complete drying of the plant. The stem near the collar region and below show rotting symptom. The black dead tissues contain pinkish mycelial growth and sclerotia.

Pathogen

The hyphae of the fungus are dark brown, filamentous and septate with constrictions in hyphal branches at the junction with main hypha. The sclerotia are brown and irregular in shape. The fungus has its sexual stage, *T. cucumeris*, which produces 2-4 basidiopores in terminal clusters on a celled hypha.

Favourable Conditions

Heavy soils with poor drainage and warm humid weather.

Mode of Spread and Survival

The pathogen survives in the soil in infected host debris as sclerotia for several years. The secondary spread is through farm implements, irrigation water and rain splash.

Management

Treat the seeds with Carbendazim or Thiram at 2 g/kg or seed pelleting with *Trichoderma viride* at 4 g/kg or *Pseudomonas fluorescens* @ 10g/kg of seed. Apply farmyard manure at 10 t/ha. Grow resistant genotypes like ICC 32, ICC 42, ICC 12223, ICC 11322 and H82-2.

Wilt

Fusarium oxysporum f.sp. ciceri

Symptoms

The disease occurs at two stages of crop growth, seedling stage and flowering stage or adult stage. The chief symptoms in seedlings are yellowing and drying of leaves from base upward, drooping of petioles and rachis, improper branching, withering of plants. In the case of adult plants, drooping of leaves is observed initially in upper part of plant, quickly notices in entire plant. The lower leaves dry but are not shed at maturity. Dark brown or black discoloration is noticed below and above collar region and in advanced stages cause complete drying of the plant. Vascular browning is conspicuously seen as black streaks on the stem and root portion below the bark.

Pathogen

The fungus produces hyaline to light brown, septate and profusely branched hyphae. Microconidia are oval to cylindrical, hyaline, single celled, normally arise on short conidiophores. Macroconidia which borne on branched conidiophores, are thin walled, 3 to 5 septate, fusoid and pointed at both ends. Chlamydospores are roughwalled or smooth, terminal or intercalary, may be formed singly or in pairs in chains.

Favourable Conditions

High soil temperature (Above 25°C), high soil moisture and presence of weed hosts like *Cyperus rotundus*, *Tribulus terrestris* and *Convolvulus arvensis*.

Mode of Spread and Survival

The fungus may be seed-borne and survives in infected plant debris in soil. The primary infection is through chlamydospores in soil, which remain viable upto next crop season. The weed hosts also serve as a source of inoculum. The secondary spread is through irrigation water, cultural operations and implements.

Management

Treat the seeds with Carbendazim or Thiram at 2 g/kg or Carbendazim 1 g+Thiram 1g/kg or treat the seeds with *Trichoderma viride* at 4 g/kg *Pseudomonas fluorescens* @ 10g/kg of seed. Apply heavy doses of organic manure or green manure. Grow resistant cultures like ICC 42, H82-2, ICC 12223, ICC 11322, ICC 12408, P 621 and DA1.

Ascochyta blight

Ascochyta rabiei

Symptoms

All above ground parts of the plant are attacked. On leaflets, the lesions are round or elongated, bearing irregularly depressed brown spots, and are surrounded by a brownish red margin. Similar spots may appear on the stem and pods. The spots on the stem and pods have pycnidia arranged in concentric circles as minute black dots. When the lesions girdle the stem, the portion above the point of attack rapidly dies. If the main stem is girdled at the collar region, the whole plant dies.

Pathogen

The fungus produces hyaline to brown and septate mycelium. Pycnidia are spherical to sub-globose with a prominent ostiole. Pycnidiospores (conidia) are formed from hyaline, amoulliform phialides from the inner cells of the pycnidium. They are hyaline, oval to oblong, straight or slightly curved and single celled, occasionally bicelled.

Favourable Conditions

High rainfall during flowering, temperature of 20-25°C and relative humidity of 60 per cent.

Mode of Spread and Survival

The fungus survives in the infected plant debris as pycnidia. The pathogen is also externally and internally seed-borne. The primary spread is from seed-borne pycnidia and plant debris in the soil. The secondary spreads is mainly through air-borne pycnidiospores (conidia). Rain splash also helps in the spread of the disease.

Management

Remove and destroy the infected plant debris in the field. Treat the seeds with Thiram 2g or Carbendazim 2 g or Thiram + Carbendazim at 2 g/kg. Exposure of seed at 40-50°C reduced the survival of *A. rabiei* by about 40-70 per cent. Spray with Carbendazim at 500 g/ha. Follow crop rotation with cereals.

Rust

Uromyces ciceris-arietini

Symptoms

The infection appears as small oval, brown, powdery lesions on both the surface, especially more on lower surface or leaf. The lesions, which are uredosori, cover the entire leaf surface. Late in the season dark teliosori appear on the leaves. The rust pustules may appear on petioles, stems and pods. It is a heteroecious rust, but the pycnial and aecial stages are unknown.

Pathogen

The uredospores are spherical, brownish yellow in colour, loosey echinulated with 4-8 germ pores. Teliospores are round to oval, brown, single celled with unthickened apex and the walls are rough, brown and warty.

Mode of Spread and Survival

The fungus survives as uredospores in the legume weed *Trigonella polycerata* during summer months and serve as primary source of infection. The spread is through wind-borne uredospores.

Management

Destroy weed host. Dust Sulphur at 20 kg/ha. Spray Wettable sulphur 1 kg or Carbendazim 500 g/ha.

Stunt disease Virus

Symptoms

Affected plants are stunted and bushy with short internodes. The leaflets are smaller with yellow, orange or brown discoloration. Stem also shows brown discoloration. The plants dry prematurely. If survive, a very few small pods are formed. Phloem growing in the collar region is the most characteristic symptom of the stunt, leaving xylem normal.

Mode of Spread and Survival

The virus is transmitted by *Aphis craccivora*.

Management

Rogue out the infected plants. Spray Monocrotophos at 500 ml/ha.

Minor diseases

Foot rot	<i>Operculella Padwickii</i>	Rotting is evident from collar region onwards. Internal brown discoloration appears above the rotten portion (only on bark portion)
Cottony rot or stem rot	<i>Sclerotinia sclerotiorum</i>	The disease appears mostly on adult plants as water soaked lesion on upper parts of stem. The affected portion is covered with white cottony growth and black sclerotial bodies.
Collar rot	<i>Sclerotium rolfsii</i>	The water soaked black lesions develop near collar region in seedling upto 6 weeks, leading to yellowing and death. Older seedlings may dry without collapsing.
Leaf blight	<i>Stemphylium Sarciniforme</i>	The pathogen produces ovoid necrotic spots on leaves, pods and stems. The spots have ashy borders.
Bacterial leaf blight	<i>Xanthomonas campestris p.v. cassiae</i>	Small water soaked lesions develop later turn to dark brown spots on leaves with chlorotic haloes. Post emergence seedling rot is also common.
Bean Common Mosaic	Virus	Stunted, bushy appearance of plant with mosaic mottling. Vector : <i>Aphis gossypii</i> and <i>A. craccivora</i>
Alfalfa mosaic	Virus	Twisting of terminal bud followed by necrosis and initiation of secondary branches. The new branches are stiff, erect and have small leaves with mild mottling. Vector : <i>A. craccivora</i> and <i>A.gossypii</i>

BLACK GRAM (*Vigna mungo*)
and
GREEN GRAM (*Vigna radiata*)
Powdery mildew
Erysiphe polygoni

Symptoms

Small, irregular powdery spots appear on the upper surface of the leaves, sometimes on both the surfaces. The disease becomes severe during flowering and pod development stage. The white powdery spots completely cover the leaves, petioles, stem and even the pods. The plant assumes greyish white appearance, leaves turn yellow and finally shed. Often pods are malformed and small with few ill-filled seeds.

Pathogen

The fungus is ectophytic, spreading on the surface of the leaf, sending haustoria into the epidermal cells. Conidiophores arise vertically from the leaf surface, bearing conidia in short chains. Conidia are hyaline, thinwalled, elliptical or barrel shaped or cylindrical and single celled. Later in the season, cleistothecia appear as minute, black, globose structures with myceloid appendages. Each cleistothecium contains 4-8 asci and each ascus contains 3-8 ascospores which are elliptical, hyaline and single celled.

Favourable Conditions

Warm humid weather. The disease is severe generally during late kharif and rabi seasons.

Mode of Spread and Survival

The fungus is an obligate parasite and survives as cleistothecia in the infected plant debris. Primary infection is usually from ascospores from perennating cleistothecia. The secondary spread is carried out by the air-borne conidia. Rain splash also helps in the spread of the disease.

Management

Remove and destroy infected plant debris. Spray Carbendazim 500g or Wettable sulphur 1.5 kg or Tridemorph 500 ml/ha at the initiation of disease and repeat 15 days later. Grow resistant varieties like LBG17, PDU10, ICI12/2 and PLU 322.

Anthraxnose
Colletotrichum lindemuthianum
(Sexual stage : *Glomerella lindemuthianum*)

Symptoms

The symptom can be observed in all aerial parts of the plants and at any stage of crop growth. The fungus produces dark brown to black sunken lesions on the hypocotyl area and cause death of the seedlings. Small angular brown lesions appear on leaves, mostly adjacent to veins, which later become greyish white centre with dark brown or reddish margin. The lesions may be seen on the petioles and stem. The prominent symptom is seen on the pods. Minute water soaked lesion appears on the pods initially and becomes brown and enlarges to form circular, depressed spot with dark centre with bright red

or yellow margin. Several spots join to cause necrotic areas with black dots (Acervuli). The infected pods have discolored seeds.

Pathogen

The fungus mycelium is septate, hyaline and branched. Conidia are produced in acervuli, arise from the stroma beneath the epidermis and later rupture to become erumpent. A few dark coloured, septate setae are seen in the acervulus. The conidiophores are hyaline and short and bear oblong or cylindrical, hyaline, thinwalled, single celled conidia with oil globules. The perfect stage of the fungus produces perithecia with limited number of asci, which contain typically 8 ascospores which are one or two celled with a central oil globule.

Favourable Conditions

High relative humidity (Above 90 per cent), low temperature (15-20°C) and cool rainy days.

Mode of Spread and Survival

The fungus is seed-borne and cause primary infection. It also lives in the infected plant tissues in soil. The secondary spread by air borne conidia produced on infected plant parts. Rain splash also helps in dissemination.

Management

Remove and destroy infected plant debris in soil. Treat the seeds with Carbendazim at 2 g/kg. Spray Carbendazim 500g or Mancozeb 1 kg/ha soon after the appearance of disease and repeat after 15 days.

Leaf spot

Cercospora canescens

Symptoms

Small, circular spots develop on the leaves with grey centre and brown margin. The several spots coalesce to form brown irregular lesions. In severe cases defoliation occurs. The brown lesions may be seen on petioles and stem in severe cases. Powdery growth of the fungus may be seen on the centre of the spots.

Pathogen

The fungus produces clusters of dark brown septate conidiophores. The conidia are linear, hyaline, thin walled and 5-6 septate.

Favourable Conditions

Humid weather and dense plant population.

Mode of Spread and Survival

The fungus survives on diseased plant debris and on seeds. The secondary spread by air-borne conidia.

Management

Remove and burn infected plant debris. Spray Mancozeb at 1 kg/ha or Carbendazim 250 g/ha.

Rust

Uromyces phaseoli typica
(Syn: *U.appendiculatus*)

Symptoms

The disease is mostly seen on leaves, rarely on petioles, stem and pods. The fungus produces small, round, reddish brown uredosori mostly on lower surface. They may appear in groups and several sori coalesce to cover a large area of the lamina. In the late season, teliosori appear on the leaves which are linear and dark brown in colour. Intense pustule formation causes drying and shedding of leaves.

Pathogen

It is an autoecious, long cycle rust and all the spore stages occur on the same host. The uredospores are unicellular, globose or ellipsoid, yellowish brown with echinulations. The teliospores are globose or elliptical, unicellular, pedicellate, chestnut brown in colour with warty papillae at the top. Yellow coloured pycnia appear on the upper surface of leaves. Orange coloured cupulate aecia develop later on the lower surface of leaves. The aeciospores are unicellular and elliptical.

Favourable Conditions

Cloudy humid weather, temperature of 21-26°C and nights with heavy dews.

Mode of Spread and Survival

The pathogen survives in the soil as teliospores and as uredospores in crop debris. Primary infection is by the sporidia developed from teliospores. Secondary spread is by wind-borne uredospores. The fungus also survives on other legume hosts.

Management

Remove the infected plant debris and destroy. Spray Mancozeb 1 kg or Carbendazim 500 g or Wettable sulfur 1 kg/ha, immediately on the set of disease and repeat after 15 days.

Dry root rot

Rhizoctonia bataticola
(Pycnidial stage : *Macrophomina phaseolina*)

Symptoms

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

Pathogen

The fungus produces dark brown, septate mycelium with constrictions at hyphal branches. Minute, dark, round sclerotia of size 110-130µ are produced in abundance. The fungus also produces dark brown, globose ostiolated pycnidia on the host tissues. They pycnidiospores (conidia) are thin walled, hyaline, single celled, elliptical and measure 10-42X6-10µ.

Favourable Conditions

Day temperature of 30°C and above and prolonged dry season followed by irrigation.

Mode of Spread and Survival

The fungus survives in the infected debris and also as facultative parasite in soil. The primary spread is through seed-borne and soil-borne sclerotia. The secondary spread is through seed-borne and soil-borne sclerotia. The secondary spread is through pycnidiospores which are air-borne.

Management

Treat the seeds with Carbendazim or Thiram at 4 g/kg or pellet the seeds with *Trichoderma viride* at 4 g/kg or *Pseudomonas fluorescens* @ 10g/kg of seed. Apply farm yard manure or green leaf manure (*Gliricidia maculate*) at 10 t/ha or neemcake at 250 kg/ha.

Yellow mosaic Virus

Symptoms

Initially small yellow patches or spots appear on green lamina. The young leaves are the first to show the symptoms. The yellow discoloration slowly increases and newly formed leaves may completely turn yellow. The infected plants normally mature later and bear a very few flowers and pods. The pods are small and distorted. The early infection causes death of the plant before seed set.

Favourable Conditions

Summer sown crops are highly susceptible. The presence of weed hosts viz., *Croton sparsiflorus*, *Acalypha indica*, *Eclipta alba* and *Cosmos pinnatus* and legume hosts.

Mode of Spread and Survival

The virus survives in the weed hosts and other legume crops. The disease spreads through wind-borne viruliferous white fly, *Bemisia tabaci*.

Management

Rogue out the diseased plants upto 40 days after sowing. Remove the weed hosts periodically. Increase the seed rate (25 kg/ha). Grow resistant black gram variety like VBN-1, PDU 10, IC12/2 and PLU 322. Cultivate the crop during rabi season. Follow mixed cropping by growing two rows of maize (60 x 30 cm) or sorghum (45 x 15 cm) or cumbu (45 x 15 cm) for every 15 rows of black gram or green gram.

Leaf crinkle Virus

Symptoms

The symptom appears initially in young leaves. The enlargement of 4th or 5th leaf is seen four or five weeks after sowing. Later crinkling and curling of the tips of leaflets are seen. The petioles as well as internodes are shortened. The infected plant gives a stunted and bushy appearance. Flowering is delayed, inflorescence, if formed, are malformed with small size flower buds and fail to open. The age of the plant is prolonged with dark green leaves till harvest.

Favourable Conditions

The presence of weed hosts like *Aristolochia bracteata* and *Digera arvensis*. Closs planting. Kharif season crop is highly susceptible. Continuous cropping of other legumes which also harbour the virus.

Mode of Spread and Survival

The virus is seed-borne and primary infection occurs through infected seeds. White fly, *Bemisia tabaci*, is the vector, helps in the secondary spread. The virus is also transmissible.

Management

Use increased seed rate (25 kg/ha). Rogue out the diseased plants at weekly interval upto 45 days after sowing. Cultivate seed crop during rabi season. Remove weed hosts periodically. Spray Monocrotophos or Methyl demeton on 30 and 40 days after sowing at 500 ml/ha.

Leaf curl (Tomato Spotted Wilt Virus)

Symptoms

The infection starts as chlorosis of lateral veins near the leaf margins and margins slowly curl downwards. The infected leaves are brittle and sometimes show vein necrosis on the under surface of the leaves, extends to the petiole. Plants affected in the early stages of growth develop top necrosis and die. The plant may produce a few small and malformed pods.

Favourable Conditions

Rainy days during kharif season show high incidence of disease. The presence of the weed hosts viz., *Acanthospermum hispidum*, *Ageratum conyzoides*, *Amaranthus viridis*, *Calotropis gigantea*, *Lagasca mollis*, *Trianthema portulacastrum*, *Cassia tora*, *Cleome gynandra*, *Solanum nigrum* and *Datura metal* and other legume hosts.

Mode of Spread and Survival

The virus is transmitted by thrips viz., *Frankliniella schultzei*, *Thrips tabaci* and *Scirtothrips dorsalis*. The virus survives in weed hosts, tomato, petunia and Chilli.

Management

Rogue out infected plants upto 30 days after sowing. Remove the weed hosts which harbour virus and thrips. Spray Monocrotophos or Methyl demeton at 500 ml/ha on 30 and 45 days after sowing.

Minor diseases

Ascochyta leaf spot	<i>Ascochyta phaseolorum</i>	Small irregular spot with grey to brown centre and yellow border. They rapidly enlarge to produce very large brown lesions with concentric markings.
Bacterial blight	<i>Xanthomonas Phaseoli</i>	Circular, reddish brown spots appear on leaves, enlarge to form irregular

brown lesions. Water soaked, sunken spots with red border occur on pods.

Seedling blight	<i>Sclerotium rolfsii</i>	Refer Redgram
Stem rot	<i>Pythium aphanidermatum</i>	Refer Redgram

COWPEA (*Vigna unguiculata*)

Wilt

Fusarium oxysporum f. sp. tracheiphilum

Symptoms

Symptoms do not appear until the plants are about six weeks old. Initially a few plants are noticed with pale green flaccid leaves which soon turn yellow. Growth is stunted, Chlorosis, drooping, premature shedding or withering of leaves with veinal necrosis often occurs and finally plant dies within 5 days. Brownish, purple discoloration of the cortical area is seen, often extends throughout the plant.

The fungus produces falcate shaped macroconidia which are 4-5 septate, thin walled and hyaline. The microconidia are single celled, hyaline and oblong or oval. The chlamydospores are also produced in abundance.

Favourable Conditions

Temperature of 20-25°C and moist humid weather.

Mode of Spread and Survival

The fungus survives in the infected stubbles in the field. The primary spread is through chlamydospores and seed contamination. The secondary spread is through conidia by irrigation water.

Management

Treat the seeds with Carbendazim or Thiram at 2 g/kg or treat the seeds with *Trichoderma viride* at 4 g/kg. Spot drench with Carbendazim at 0.5 g/litre.

Bacterial leaf spot

Xanthomonas vignicola

Symptoms

The disease attacks at any stage of plant growth. The seedling infection starts as red lesion at cotyledon leads to withering. In adult plants yellow circular spots appear on leaves, enlarge and become angular and encircled by a yellow halo. The infection can be seen on the petiole, stem and pods as brown linear lesions. The affected twigs show twig blight and infected pods contain shrivelled seeds.

Favourable Conditions

Heavy rainfall, high relative humidity (above 80 per cent) and temperature of 20-25°C.

Mode of Spread and Survival

The bacterium is seed-borne and cause primary infection in the field. The wind, rain splash and insects help in the secondary spread.

Management

Collect the seeds from healthy plants and use disease free seeds.

Aphid-borne mosaic Virus

Symptoms

The affected plants are stunted and the leaves show variable amounts of dark green vein banding, leaf distortion and blistering. The affected leaves are leathery. The infected plants produce a few pods which are small and distorted.

Favourable Conditions

The presence of weed hosts and other legume hosts.

Mode of Spread and Survival

The virus is transmitted aphid vectors viz., *Aphis craccivora*, *A. fabae*, *A. gossypii*, *Macrosphum euphorbiae* and *Myzus persicae*. The virus survives in weed hosts and other legume crops.

Management

Remove the infected plants upto 30 days after sowing. Rogue out the weed hosts periodically. Grow resistant varieties like Co.6. Spray thrice with Monocrotophos or Methyl demeton at 500 ml/ha at 15 days intervals.

Minor diseases

Bacterial blight	<i>Xanthomonas phaseoli</i>	Refer Black gram
Seedling blight	<i>Sclerotium rolfsii</i>	Refer Red gram
Stem rot	<i>Pythium aphanidermatum</i>	Refer Red gram
Cottony rot	<i>Sclerotinia sclerotiorum</i>	Refer Bengal gram
Stem rot	<i>Phytophthora cactorum</i>	Dark brown or black brown sunken lesions appear at the base of stem or branches, extending several centimeters. The leaves are light green with upward rolling and rapid wilting occurs.

Red leaf spot	<i>Septoria vignae</i>	Dark red, circular or irregular spots appear on both the surfaces of leaves.
Brown leaf spot	<i>Myrothecium roridum</i>	Small brown spots with pinkish margin appear on leaves. Lesions may also occur on petiole, stem and pod.

GARDEN LABLAB (*Lablab purpureus* var. *typicus*)
and
FIELD LABLAB (*L. purpureus* var. *lignosus*)

Rust	<i>Uromyces phaseoli typica</i>	Refer Black gram
Podery mildew	<i>Erysiphe polygoni</i>	Refer Black gram
Anthrachnose	<i>Colletotrichum lindemuthianum</i>	Refer Black gram
Bacterial blight	<i>Xanthomonas phaseoli</i>	Refer Black gram
Yellow mosaic	Virus	Refer Black gram
Common Bean mosaic	Virus	Refer Black gram
Leaf spot	<i>Cercospora cruenta</i>	Small brown or reddish spots appear on young and old leaves. When spot matures, the centre of spot turns grey and falls off, leaving a shot-hole symptom. Brown lesions may develop on the stem.

SOYA BEAN (*Glycine max*)

Dry root rot	<i>Macrophomina phaseolina</i>	Refer Black gram
Yellow mosaic	Virus	Refer Black gram
Wilt	<i>Fusarium oxysporum</i>	Refer Cowpea
Leaf spot	<i>Cercospora sojiana</i>	Well defined spots often bound by veins

		with purple border and grey centre. The spots may develop on pods also.
Bacterial leaf spot	<i>Xanthomonas phaseoli sojense</i>	Circular reddish spots appear on leaves with yellow halo. Sunken black spots with brown border appear on pods.

HORSE GRAM (*Macrotyloma uniform*)

Dry root rot	<i>Macrophomina phaseolina</i>	Refer Black gram
Anthrachnose	<i>Colletotrichum lindemuthianum</i>	Refer Black gram
Rust	<i>Uromyces phaseoli typica</i>	Refer Black gram
Yellow mosaic	Virus	Refer Black gram
Leaf spot	<i>Cercospora cruenta</i>	Refer Black gram
Cottony stem rot	<i>Sclerotinia sclerotiorum</i>	Refer Bengal gram

GROUND NUT (*Arachis hypogaea*)

Tikka leaf spots

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

Late leaf spot : *Phaeoisariopsis personata*
Syn : *cercospora personata*
(Sexual stage) : *Mycosphaerella berkeleyii*)

Symptoms

The disease occurs on all above ground parts of the plant, more severely on the leaves. The leaf symptoms produced by the two pathogens can be easily distinguished by the following characters.

Both the fungi produce lesions also on petiole, stem and pegs. The lesions caused by both species coalesce as infection develops and severely spotted leaves shed prematurely. The quality and yield of nuts are drastically reduced in severe infections.

Pathogen

C. arachidicola (Sexual stage : *M. arachidis*)

The fungus is intercellular and do not produce haustoria and become intracellular when host cells die. The fungus produces abundant sporulation on the upper surface of the leaves. Conidiophores are olivaceous brown or yellowish brown in colour, short, 1 or 2 septate, unbranched and geniculate and arise in clusters. Conidia are sub hyaline or pale yellow, obclavate, often curved 3-12 septate, 35-110 x 2.5 - 5.4 um in size with rounded to distinctly truncate base and sub-acute tip. The perfect stage of the fungus produces perithecia as ascostromata. They are globose with papillate ostiole. Asci are cylindrical to clavate and contain 8 ascospores. Ascospores are hyaline, slightly curved and two celled, apical cell larger than the lower cell.

P. personata (*C. personata*) (Sexual stage : *M. berkeleyii*)

The fungus produces internal and intercellular mycelium with the production of haustoria. The conidiophores are long, continuous, 1-2 septate, geniculate, arise in clusters and olive brown in colour. The conidia are cylindrical or obclavate, short, measure 18-60 x 6-10um, hyaline to olive brown, usually straight or curved slightly with 1-9 septa, not constricted but mostly 3-4 septate. The fungus in its perfect stage produces perithecia as ascostromata which are globose or broadly ovate with papillate ostiole. Asci are cylindrical to ovate, contain 8 ascospores. Ascospores are 2 celled and constricted at septum and hyaline.

Favourable Conditions

Prolonged high relative humidity for 3 days, low temperature (20°C) with dew on leaf surface, heavy doses of nitrogen and phosphorus fertilizers and deficiency of magnesium in soil.

Mode of Spread and Survival

The fungi survives for a long period in the infected plant debris as conidia, dormant mycelium and perithecia in soil. The volunteer groundnut plants also harbour the pathogens. The fungi also survives on contaminated pods and seeds. The primary infection is by ascospores or conidia liberated from infected plant debris. The secondary spread is by wind blown conidia. Rain splash also helps in the spread of conidia.

Management

Remove and destroy the infected plant debris. Eradicate the volunteer groundnut plants. Keep weeds under control. Treat the seeds with Carbendazim or Thiram at 2g/kg. Spray Carbendazim 250g or Mancozeb 1 kg or Chlorothalonil 1 kg/ha and if necessary, repeat after 15 days. Grow moderately resistant varieties like ALR.1.

Rust

Puccinia arachidis

Symptoms

The disease attacks all aerial parts of the plant. The disease is usually found when the plants are about 6 weeks old. Small brown to chestnut dusty pustules (uredosori) appear on the lower surface of leaves. The epidermis rupture and exposes a powdery mass of uredospores. Corresponding to the sori, small, necrotic, brown spots appear on the upper

surface of leaves. The rust pustules may be seen on petioles and stem. Late in the season, brown teliosori, as dark pustules, appear among the necrotic patches. In severe infection lower leaves dry and drop prematurely. The severe infection leads to production of small and shriveled seeds.

Pathogen

The fungus produces both uredial and telial stages. Uredial stages are produced abundant in groundnut and production of telia is limited. Uredospores are pedicellate, unicellular, yellow, oval or round and echinulated with 2 or 3 germ pores. Teliospores are dark brown with two cells. Pycnial and aecial stages have not been recorded and there is no information available about the role of alternate host.

Favourable Conditions

High relative humidity (above 85 per cent), heavy rainfall and low temperature (20-25°C).

Mode of Spread and Survival

The pathogen survives as uredospores on volunteer groundnut plants. The fungus also survives in infected plant debris in soil. The spread is mainly through wind-borne inoculum of uredospores. The uredospores also spread as contamination of seeds and pods. Rainsplash and implements also help in dissemination. The fungus also survives on the collateral hosts like *Arachis marginata*, *A. nambyquarae* and *A. prostrate*.

Management

Avoid monoculturing of groundnut. Remove volunteer groundnut plants and reservoir hosts. Spray Mancozeb 1 kg or Wettable sulphur 2.5 kg or Tridemorph 500 ml or Chlorothalonil 1 kg/ha. Grow moderately resistant varieties like ALR.1

Collar rot or seedling blight or crown rot

Aspergillus niger and *A. pulverulentum*

Symptoms

The fungus is both seed-borne and soil-borne and so the infection can be seen at any stage from sowing onwards. The disease usually appears in three phases.

i. Pre-emergence rot : Seeds are attacked by soil-borne conidia and rotten of seeds prevents the seeds to germinate. The seed are covered with black masses of spores and internal tissues of seed become soft and watery.

ii. Post-emergence rot : The pathogen attacks the emerging young seedling and cause circular brown spots on the cotyledons. The symptom spreads later to the hypocotyl and stem. Brown discoloured spots appear on collar region. The affected portion become soft and rotten, resulting in the collapse of the seedling. The collar region is covered by profuse growth of fungus and conidia and affected stem also show shredding symptom.

iii. Crown rot : The infection when occurs in adult plants show crown rot symptoms. Large lesions develop on the stem below the soil and spread upwards along the branches causing drooping of leaves and wilting of plant.

Pathogen

The mycelium of the fungus is hyaline to sub-hyaline. Conidiophores arise directly from the substrate and are septate, thick walled, hyaline or olive brown in colour. The vesicles are mostly globose and have two rows of hyaline phialides viz., primary and secondary phialides. The conidial head are dark brown to black. The conidia are globose, dark brown in colour and produce in long chains.

Favourable Conditions

Deep sowing of seeds, high soil temperature (30-35°C) and low soil moisture.

Mode of Spread and Survival

The pathogen survive in plant debris in the soil, not necessarily from a groundnut crop. Soil-borne conidia cause disease carry over from season to season. The other primary source is the contaminated seeds. The fungi are carried on the seed surface or under the testa.

Management

Select good quality seeds. Treat the seeds with Carbendazim 2 g or Thiram 4g/kg. Avoid deep sowing of seeds. Destroy the crop debris by burning.

Root rot

Macrophomina phaseolina

Symptoms

In the early stages of infection, reddish brown lesion appears on the stem just above the soil level. The leaves and branches show drooping, leading to death of the whole plant. The decaying stems are covered by whitish mycelial growth. The death of the plant results in shredding of bark. The rotten tissues contain large number of black or dark brown, thick walled sclerotia. When infection spreads to underground roots, the sclerotia are formed externally as well as internally in the rotten tissue. Pod infection leads to blackening of the shells and sclerotia can be seen inside the shells.

Pathogen

The fungus produces hyaline to dull brown mycelium. The sclerotia are thick walled and dark brown in colour.

Favourable Conditions

Prolonged rainy season at seedling stage and low lying areas.

Mode of Spread and Survival

The fungus remains dormant as sclerotia for a long period in the soil and in infected plant debris. The primary infection is through soil-borne and seed-borne sclerotia. The secondary spread of sclerotia is aided by irrigation water, human agency, implements, cattle etc.

Management

Treat the seeds with Thiram 4g or Carbendazim 2g/kg or treat the seeds with *Trichoderma viride* at 4g/kg. Spot drench with Carbendazim at 0.5 g/lit.

Rossetts Virus

Symptoms

The affected plants are characterized by the appearance of dense clump or dwarf shoots with tuft of small leaves forming in a rosette fashion. The plant exhibits chlorosis and mosaic mottling. The infected plants remain stunted and produce flowers, but only a few of the pegs may develop further to nuts but none bear seeds.

Mode of Spread and Survival

The virus can survive on the volunteer plants of groundnut and other hosts. The virus is transmitted by *Aphis craccivora* in a persistent manner.

Management

Use heavy seed rate and rogue out periodically the infected plants. Spray Monocrotophos or Methyl demeton at 500 ml/ha.

Peanut spotted wilt or bud necrosis or groundnut ring mosaic Tomato spotted wilt virus (TSWV)

Symptoms

First symptoms are visible 2-6 weeks after infection as ring spots on leaves. The newly emerging leaves are small, rounded or pinched inwards and rugose with varying patterns of mottling and minute ring spots. Necrotic spots and irregularly shaped lesions develop on leaves and petioles. Stem also exhibits necrotic streaks. As the plant matures, it becomes generally stunted with short internodes and short auxillary shoots. Leaflets formed on these auxillary shoots show a wide range of symptoms including reduction in size, distortion of the lamina, mosaic mottling and general chlorosis. In advanced conditions, the necrosis of buds occurs. Drastic reduction in flowering is noticed and seeds produced are abnormally small and wrinkled with the dark black lesions on the testa

Mode of Spread and Survival

The virus perpetuates in the weed hosts viz., *Bidens pilosa*, *Erigeron bonariensis*, *Tagetes minuta* and *Trifolium subterraneum*. The virus is transmitted by thrips viz., *Thrips tabaci* and *Frankliniella* sp..

Management

Adopt spacing of 15x15 cm. Remove and destroy infected plants upto 6 weeks after sowing. Monocrotophos 500 ml/ha, 30 days after sowing either alone or in combination with AVP (Anti Viral Principle) extracted from sorghum or coconut leaves. Spray the crop with 10 per cent AVP at 500 lit/ha, ten and twenty days after sowing.

EXTRACTION OF 10 PER CENT AVP

Dried sorghum or coconut leaves are cut and powdered. To one kg of leaf powder, two litres of water is added and heated to 60°C for one hour. It is then filtered through muslin cloth and diluted to 10 litres and sprayed. Five hundred litres of extract is required to cover one hectare.

Minor diseases

Stem rot	<i>Corticium rolfsii</i>	Light brown coloured areas develop on the stem or just below ground level. Leaves turn yellow followed by withering of the plant. White fungal mycelium with
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		dark brown sclerotia are seen in the rotten area.
Wilt	<i>Fusarium oxysporum</i>	In two months old plant, the yellowing of leaves, followed by wilting and drying occur. Roots turn brown and brittle. Vascular browning can be seen.
Anthracnose	<i>Colletotrichum dematium</i>	Brownish grey lesions occur on both the surfaces of leaflets. Infection spreads to stipules, petioles and branches. The lesions when sporulation occurs.
Grey mould	<i>Botrytis cinerea</i>	Infection is seen on leaves, stem and underground parts of the groundnut. Initially infection occurs at ground level by a light grey fungal rot which causes death of the plants.
Yellow mould	<i>Aspergillus flavus</i>	The seeds are attacked and covered by yellowish green spore masses. Seeds disintegrate in 4-8 days. In the emerging seedling, cotyledons are attacked and covered by yellow-green spores, leading to death.
Bacterial wilt	<i>Pseudomonas solanacearum</i>	Infected plants appear unhealthy, chlorotic and wilt under water stress. Dark brown discolouration of xylem is seen. Grey slimy liquid ooze out of the vascular bundles.
Peanut stunt	Virus	Leaflets and petiole are drastically reduced in size and leaves frequently curl upwards. Diseased plants are usually chlorotic and paler than healthy ones. Vectors : <i>Aphis craccivora</i> and <i>Myzus persicae</i> .

GINGELLY (*Sesamum indicum*)

Root rot or stem rot or charcoal rot

Macrophomina phaseolina

Syn : *cercospora personata*

(Sclerotial stage : *Rhizoctonia bataticola*)

Symptoms

The disease symptom starts as yellowing of lower leaves, followed by drooping and defoliation. The stem portion near the ground level shows dark brown lesions and bark at the collar region shows shredding. The sudden death of plants is seen in patches. In the grown-up plants, the stem portion near the soil level shows large number of black pycnidia. The stem portion can be easily pulled out leaving the rotten root portion in the soil. The infection when spreads to pods, they open prematurely and immature seeds become shrivelled and black in colour. Minute pycnidia are also seen on the infected capsules and seeds. The rotten root as well as stem tissues contain a large number of minute black sclerotia. The sclerotia may also present on the infected pods and seeds.

Pathogen

The fungus produces dark brown, septate mycelium showing constrictions at the hyphal junctions. The sclerotia are minute, dark black and 110-130µm in diameter. The pycnidia are dark brown with a prominent ostiole. The conidia are hyaline, elliptical and single celled.

Favourable Conditions

Day temperature of 30°C and above and prolonged drought followed by copious irrigation.

Mode of Spread and Survival

The fungus remains dormant as sclerotia in soil as well as in infected plant debris in soil. The infected plant debris also carry pycnidia. The fungus primarily spreads through infected seeds which carry sclerotia and pycnidia. The fungus also spreads through soil-borne sclerotia. The secondary spread is through the conidia transmitted by wind and rain water.

Management

Treat the seeds with *Trichoderma viride* at 4g/kg or *Pseudomonas fluorescens* 10 g/kg or treat the seeds with carbendazim or Thiram at 4g/kg. Apply farm yard manure or green leaf manure at 10t/ha or neem cake 250 kg/ha. Spot drench with Carbendazim at 0.5 g/litre.

Leaf blight

Alternaria sesami

Symptoms

Initially small, circular, reddish brown spots (1-8mm) appear on leaves which enlarge later and cover large area with concentric rings. The lower surface of the spots are greyish brown in colour. In severe blighting defoliation occurs. Dark brown lesions can also be seen on petioles, stem and capsules. Infection of capsules results in premature splitting with shriveled seeds.

Pathogen

The mycelium of the fungus is dull brown and septate and produce large number of pale grey-yellow conidiophores which are straight or curved. The conidia are light olive coloured with transverse and longitudinal septa. There are around 3-5 septate and conidia are borne in chain over short conidiophore.

Favourable Conditions

Low temperature (20-25°C), high relative humidity and cloudy weather.

Mode of Spread and Survival

The fungus is seed-borne and also soil-borne as it remains dormant in the infected plant debris.

Management

Treat the seeds with Thiram or Carbendazim at 2g/kg. Spray Mancozeb at 1kg/ha.

Leaf spot *Cercospora sesami*

Symptoms

The disease first appears on the leaves as minute water-soaked lesions, which enlarge to form round to irregular spots of 5-15 mm diameter on both the leaf surface. The spots coalesce to form irregular patches of varying size leading to premature defoliation. The infection is also seen on stem and petiole forming spots of varying lengths. Dark linear spots also occur on pods causing drying shedding.

Pathogen

The hypha of the fungus is irregularly septate, light brown and thick walled. Conidiophores are produced in cluster and are 1-3 septate, hyaline at the tip and light brown coloured at base. Conidia are elongated, 7-10 septate, hyaline to light yellow, broad at the base and tapering towards the apex.

Mode of Spread and Survival

The fungus is externally and internally seed-borne. The fungus also survives in plant debris. Primary infection may be from the seed and infected debris. The secondary spread is through wind-borne conidia.

Management

Treat the seeds with carbendazim or Thiram at 2g/kg. Spray with Mancozeb at 1Kg/ha.

Wilt *Fusarium oxysporum f.sp. sesami*

Symptoms

The disease appears as yellowing, drooping and withering of leaves. The plants gradually wither, show wilting symptom leading to drying. The infected portions of root and stem show long, dark black streaks of vascular necrosis.

Pathogen

The fungus produces macroconidia, microconidia and chlamydospores. Macroconidia are falcate shape, hyaline and 5-9 celled. Microconidia are hyaline, thin walled, unicellular and ovoid. The dark walled chlamydospores are also produced.

Mode of Spread and Survival

The fungus survives in the soil in the infected plant debris. It is also seed-borne and primary infection occurs through infected seeds or through chlamydospores in soil. The secondary infection may be caused by conidia disseminated by rain splash and irrigation water.

Management

Treat the seeds with Thiram or Carbendazim at 2g/kg or pellet the seeds with *Trichoderma viride* at 4g/kg. Apply heavy doses of green leaf manure or farm yard manure.

Stem blight

Phytophthora parasitica var. *sesami*

Symptoms

Black coloured lesions appear on the stem near the soil level. The disease spreads further and affects branches and may girdle the stem, resulting in the death of the plant. Leaves may also show water-soaked patches and spread till the leaves wither. Infection may be seen on flowers and capsules. Infected capsules are poorly developed with shrivelled seeds.

Pathogen

The fungus produces non-septate, hyaline mycelium. The sporangiophores are hyaline and branched sympodially and bear sporangia. The sporangia are hyaline and spherical with a prominent apical papilla. The oospores are smooth, spherical and thick walled.

Favourable Conditions

Prolonged rainfall, low temperature (25°C) and high relative humidity (above 90 per cent)

Mode of Spread and Survival

The fungus can survive in the soil as dormant mycelium and oospores. The seeds also carry the fungus as dormant mycelium, which causes the primary infection. Secondary spread of the disease is through wind-borne sporangia.

Management

Treat the seeds with Captan or Thiram at 2g/kg. Avoid continuous cropping of sesamum in the same field. Remove and destroy infected plant debris.

Powdery mildew

Erysipha cichoracearum
(Syn : *Oidium acanthospermum*)

Symptoms

Initially greyish-white powdery growth appears on the upper surface of leaves. When several spots coalesce, the entire leaf surface may be covered with powdery coating. In severe cases, the infection may be seen on the flowers and young capsules, leading to premature shedding. The severely affected leaves may be twisted and malformed. In the advanced stages of infection, the mycelial growth changes to dark or black because of development of cleistothecia.

Pathogen

The fungus produces hyaline, septate mycelium which are extrophytic and send haustoria into the host epidermis. Conidiophores arise from the primary mycelium and are short and non septate bearing conidia in long chains. The conidia are ellipsoid or barrel-shaped, single celled and hyaline. The cleistothecia are dark, globose with the hyaline or pale brown myceloid appendages. The asci are ovate and each ascus produces 2-3 ascospores, which are thin walled, elliptical and pale brown in colour.

Favourable Conditions

Dry humid weather and low relative humidity.

Mode of Spread and Survival

The fungus is an obligate parasite and disease perennates through cleistothecia in the infected plant debris in soil. The ascospores from the cleistothecia cause primary infection. The secondary spread is through wind-borne conidia.

Management

Remove the infected plant debris and destroy. Spray Wettable sulphur at 2.5 kg/ha or dust Sulphur at 25 kg/ha and repeat after 15 days.

Bacterial leaf spot

Xanthomonas campestris p.v. sesami

Symptoms

Initially water-soaked spots appear on the undersurface of the leaf and then on the upper surface. They increase in size, become angular and restricted by veins and dark brown in colour. Several spots coalesce together forming irregular brown patches and cause drying of leaves. The reddish brown lesions may also occur on petioles and stem.

Pathogen

The bacterium is bacilliform with a monotrichous flagellum. It is gram negative and non-spore forming.

Mode of Spread and Survival

The bacterium survives in the infected plant debris and is seed-borne. The secondary spread is by rain water.

Management

Remove and burn infected plant debris. Spray Streptomycin sulphate or Oxytetracycline hydrochloride at 100g/ha.

Bacterial leaf spot

Pseudomonas sasami

Symptoms

The disease appears as water-soaked yellow specks on the upper surface of the leaves. They enlarge and become angular as restricted by veins and veinlets. The colour of spot may be dark brown with shiny oozes of bacterial masses.

Pathogen

The bacterium is gram negative and rod shaped. It is an aerobic bacterium with one or more polar flagella.

Mode of Spread and Survival

The bacterium remains viable in the infected plant tissues. It is internally seed-borne and secondary spread through rainsplash and storms.

Management

Keep the field free of infected plant debris. Spray with Streptomycin sulphate or Oxytetracycline hydrochloride at 100g/ha.

Phyllody

Mycoplasma Like Organism

Symptoms

The disease manifests itself mostly during flowering stage, when the floral parts are transformed into green leafy structures, which grow profusely. The plants bear cluster of leaves and malformed flowers at the tip. The flower is rendered sterile. The veins of phylloid structure is thick and prominent. Stamens also become leaf like to certain extent. Anthers become green and do not dehisce. Ovary is transformed into a elongated out growth resembling a shoot. The plant is stunted with reduced internodes and abnormal branching gives a bushy appearance.

Mode of Spread and Survival

The pathogen has a wide host range and survives on hosts like *Brassica campestris* var. *toria*, *B. rapa*, *Cicer arietinum*, *Crotalaria* sp., *Trifolium* sp., *Arachis hypogaea* and some weed hosts. The disease is transmitted by jassid, *Orosius albicinctus*. Optimum acquisition period of vector is 3-4 days and inoculation feeding period is 30 minutes. The incubation period of the pathogen in leaf hoppers may be 15-63 days and 13-61 days in sesamum. Nymphs are incapable of transmitting the MLO. Vector population is more during summer and less during winter months.

Management

Remove all the reservoir and weed hosts. Avoid growing sesaumu near cotton, groundnut and grain legumes. Rogue out the infected plants periodically. Spray Monocrotophos or Dimethoate at 500ml/ha to control the jassids.

Minor diseases

Anthracnose	<i>Colletotrichum</i> sp.	Dark brown lesions on leaf, stem and capsules with black acervuli in the central portion.
Leaf curl	Virus	Stunted plant growth with small sized leaves which show mottling and downward curling.

SUN FLOWER (*Helianthus annuus*)

Root rot or charcoal rot
Rhizoctonia bataticola
(Pycnidial stage : *Macrophomina phaseolina*)

Symptoms

The fungus is seed-borne and primarily causes seedling blight and collar rot in the initial stages. The grownup plants also show symptoms after flowering stage. The infected plants show drooping of leaves and death occurs in patches. The bark of the lower stem and roots shreds and are associated with a large number of sclerotia. Dark coloured, minute pycnidia also develop on the lower portion of the stem.

Pathogen

The fungus produces a large number of black, round to irregular shaped sclerotia. The pycnidia are dark brown to black with a ostiole and contain numerous single celled, thinwalled, hyaline and elliptical pycnidiospores.

Mode of Spread and Survival

The pathogen survives in soil and in infected crop residues as sclerotia and pycnidia. The pathogen is seed-borne and it serves as primary source of infection. Wind-borne conidia cause secondary spread. The soil borne sclerotia also spreads through rain splash, irrigation water and implements.

Management

Treat the seeds with Carbendazim at 2 g or Thiram at 4g/kg or with *Trichoderma viride* at 4g/kg. Spot drench with Carbendazim at 1g/litre.

Leaf blight
Alternaria helianthi

Symptoms

The fungus produces brown spots on the leaves, but the spots can also be seen on the stem, sepals and petals. The lesions on the leaves are dark brown with pale margin surrounded by a yellow halo. The spots later enlarge in size with concentric rings and become irregular in shape. Several spots coalesce to show bigger irregular lesions leading to drying and defoliation.

Pathogen

The fungus produces cylindrical conidiophores, which are pale grey-yellow coloured, straight or curved, geniculate, simple or branched, septate and bear single conidium. Conidia are cylindrical to long ellipsoid, straight or slightly curved, pale grey-yellow to pale brown, 1 to 2 septate with longitudinal septa.

Favourable Conditions

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

Mode of Spread and Survival

The fungus survives in the infected host tissues and weed hosts. The fungus is also seed-borne. The secondary spread is mainly through wind blown conidia.

Management

Remove and destroy infected plant debris. Rogue out weeds at periodical intervals. Sow the crop early in the season (June sowing). Treat the seeds with Thiram or Carbendazim at 2 g/kg. Spray Mancozeb at 1 kg/ha.

Rust

Puccinia helianthi

Symptoms

Small, reddish brown pustules (uredia) covered with rusty dust appear on the lower surface of bottom leaves. Infection later spreads to other leaves and even to the green parts of the head. In severe infection, when numerous pustules appear on leaves, they become yellow and dry. The black coloured telia are also seen among uredia on the lower surface.

The disease is a autoecious rust. The pycnial and aecial stages occur on volunteer crops grown during off-season.

Pathogen

The uredospores are round or elliptical, dark cinnamon-brown in colour and minutely echinulated with 2 equatorial germ pores. Teliospores are elliptical or oblong, two celled, smooth walled and chestnut brown in colour with a long, colourless pedicel.

Mode of Spread and Survival

The pathogen survives in the volunteer sunflower plants and in infected plant debris in the soil as teliospores. The disease spreads by wind-borne uredospores from infected crop.

Management

Remove and burn the infected plant debris in the field. Remove the volunteer sunflower plants. Spray Mancozeb at 1kg/ha.

Head rot

Rhizopus sp.

Symptoms

The affected heads show water soaked lesions on the lower surface, which later turns brown. The discoloration may extends to stalk from head. The affected portions of the head become soft and pulpy and insects are also seen associated with the putrified tissues. The larvae and insects which attack the head pave way for the entry of the fungus which attacks the inner part of the head and the developing seeds. The seeds are converted into a black powdery mass. The head finally withers and droops down with heavy fungal mycelial nets.

Pathogen

Fungus produces dark brown or black coloured, non-septate hyphae. It produces many aerial stolens and rhizoids. Sproangia are globose and black in colour with a central columella. The sporangiospores are aplanate, dark coloured and ovoid.

Favourable Conditions

Prolonged rainy weather at flowering and damages caused by insects and caterpillars.

Mode of Spread and Survival

The fungus survives as a saprophyte in host debris and other crop residues. The disease is spread by wind blown spores.

Management

Treat the seeds with Thiram or Carbendazim at 2g/kg. Control the caterpillars feeding on the heads. Spray the head with Mancozeb at 1kg/ha during intermittent rainy season and repeat after 10 days, if the humid weather persists.

Minor diseases

Powdery mildew	<i>Erysiphe cichoracearum</i>	White powdery growth on upper surface of leaves, causing drying of leaves in severe cases.
Basal rot	<i>Sclerotium rolfsii</i>	Dark brown lesions appear on the base of the stem near ground level, leading to withering. Large number of sclerotia are seen.
White rust	<i>Albugo tragopogonis</i>	White blisters appear on the lower surface of leaves, spread and produce white powdery sporangia in chains.
Aster Yellows	<i>Mycoplasma like organism</i>	The affected plant shows stunting with yellow coloured leaves and size of the leaves also reduced greatly.
Mosaic	Virus	Typical mosaic mottling with dark green and light green patches. The infected plants have small chlorotic leaves.

CASTOR (*Ricinus communis*)

Seedling blight

Phytophthora parasitica

Symptoms

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

Pathogen

The fungus produces non-septate and hyaline mycelium. Sporangioophores emerge through the stomata on the lower surface singly or in groups. They are unbranched and bear single celled, hyaline, round or oval sporangia at the tip singly. The sporangia germinate to produce abundant zoospores. The fungus also produces oospores and chlamydospores in adverse seasons.

Favourable Conditions

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

Mode of Spread and Survival

The fungus remains in the soil as chlamydospores and oospores which act as primary source of infection. The fungus also survives on other hosts like potato, tomato, brinjal, sesamum etc. The secondary spread takes place through wind-borne sporangia.

Management

Remove and destroy infected plant residues. Avoid low-lying and ill drained fields for sowing. Treat the seeds with Thiram or Captan at 4g/kg.

Rust

Melampsora ricini

Symptoms

Minute, orange-yellow coloured, raised pustules appear with powdery masses on the lower surface of the leaves and the corresponding areas on the upper surface of the leaves are yellow. Often the pustules are grouped in concentric rings and coalesce together to for drying of leaves.

Pathogen

The fungus produces only uredosori in castor plants and other stages of the fungus are unknown. Uredospores are two kinds, one is thick walled and other is thin walled. They are elliptical to round, orange-yellow coloured and finely warty.

Mode of Spread and Survival

The fungus survives in the self sown castor crops in the off season. It can also survive on other species of *Ricinus*. The fungus also attacks *Euphorbia obtusifolia*, *E.geniculata*, and *E.marginata*. The infection spreads through air-borne uredospores.

Management

Rogue out the self-sown castor crops and other weed hosts. Spray Mancozeb at 1kg/ha or dust Sulphur at 25kg/ha.

Leaf blight

Alternaria ricini

Symptoms

All the aerial parts of plants viz., leaves, stem, inflorescences and capsules are liable to be attacked by the fungus. Irregular brown spots with concentric rings form initially on the leaves and covered with fungal growth. When the spots coalesce to form big patches,

premature defoliation occurs. The stem, inflorescence and capsules are also show dark brown lesions with concentric rings. On the capsules, initially brown sunken spots appear, enlarge rapidly and cover the whole pod. The capsules crack and seeds are also get infected.

Pathogen

The pathogen produces erect or slightly curved, light grey to brown conidiophores, which are occasionally in groups. Conidia are produced in long chains. Conidia are obclavate, light olive in colour with 5-16 cells having transverse and longitudinal septa with a beak at the tip.

Favourable Conditions

High atmospheric humidity (85-90 per cent) and low temperature (16-20°C)

Mode of Spread and Survival

The fungus also survives on hosts like *Jatropha pandurifolia* and *Bridelia hamiltoniana*. The pathogen is externally and internally seed-borne and causes primary infection. The secondary infection is through air-borne conidia.

Management

Treat the seeds with Captan or Thiram at 4g/kg. Remove the reservoir hosts periodically. Spray Mancozeb at 1kg/ha.

Brown leaf spot *Cercospora ricinella*

Symptoms

The disease appears as minute brown specks surrounded by a pale green halo. The spots enlarge to greyish white centre portion with deep brown margin. The spots may be 2-4 mm in diameter and when several spots coalesce, large brown patches appear but restricted by veins. Infected tissues often drop off leaving shot-hole symptoms. In severe infections, the older leaves may be blighted and withered.

Pathogen

The fungal hyphae collect beneath the epidermis and form a hymenial layer. Clusters of conidiophores emerge through stomata or epidermis. They are septate and unbranched with deep brown base and light brown tip. The conidia are elongated, colourless, straight or slightly curved, truncate at the base and narrow at the tip with 2-7 septa.

Mode of Spread and Survival

The fungus remains as dormant mycelium in the plant debris. The fungus mainly spreads through wind borne conidia.

Management

Remove the infected plant debris. Spray Mancozeb at 1kg/ha.

Minor diseases

Powdery mildew *Leveillula taurica* White cottony growth on

		the lower surface of leaves with yellow discolouration on upper surface.
Sterm rot	<i>Macrophomina phaseolina</i>	Black discolouration appears near base of stem leading to withering and drying.
Bacterial leafspot	<i>Xanthomonas campestris p.v. ricinicola</i>	Water soaked lesions appear, which later become brown and angular with shining beads of bacterial oozing.

SAFFLOWER (*Carthamus tinctorius*)

Rust

Puccinia carthami

Symptoms

The fungus attacks cotyledons, young leaves, tender stems and underground parts. Infection of the cotyledons is seen as yellow discoloration accompanied by drooping and wilting. The pustules (uredosori) are chestnut brown in colour, errumpent scattered through out the leaves. Later in the season, black teliosori are formed on the same spots. Seedlings sometime die suddenly without exhibiting symptoms in the aerial parts. Infection on the hypocotyl causes hypertrophy of the tissues due to accumulation of mycelium between cells. Stem girdling occurs in order plants. The rust pustules also appear on tap root and lateral roots.

Pathogen

The fungus is an obligate parasite with autoecious life cycle in safflower. Uredia and telia are produced and pycnial and aerial stages are unknown. Uredopores are single celled, light brown coloured with echinulations and have 3-4 equatorial germ pores. Teliospores are globose to broadly ellipsoid, two celled, chestnut brown in colour, thick walled with hyaline pedicels.

Mode of Spread and Survival

The fungus remains on the seeds and infected crop debris in the soil as teliospores for more than a year. The fungus also produces uredial and telial stages in the collateral host *Carthamus oxyacantha* and this also serves as primary source of infection in addition to soil-dormant teliospores. The secondary spread occurs through wind-borne uredos-pores.

Management

Treat the seeds with Thiram or Carbendazim at 2g/kg. Remove and destroy the plant debris in the soil. Rogue out the collateral host. Follow a long crop rotation with non-hosts. Spray Mancozeb at 1kg/ha.

Leaf spot

Cercospora carthami

Symptoms

The disease attacks the plant at all stages. Initially round, brown spots appear on the lower with sunken centre and irregular yellow border. Several spots coalesce to cause drying of leaves. The affected tissues disintegrate and holes are formed between the veins. The spots may be noticed on nodes, bracts and entire inflorescence in severe infection.

Pathogen

The fungal mycelium is hyaline initially and gradually turns to smoky brown. The conidiophores develop from the stomata formed beneath the epidermis. They are simple, occasionally branched and bear conidia. The conidia are hyaline, sub-clavate, 5-7 septate broad base and taper towards the end.

Mode of spread and Survival

The fungus is externally seed-borne and also viable in the infected plant debris. Primary source of infection is the infected seeds and secondary spread occurs through air-borne conidia.

Management

Treat the seeds with Thiram or Captan at 4g/kg. Spray the crop with Mancozeb at 1 kg/ha. Remove and burn the infected crop residues in the soil.

Leaf blight *Alternaria carthami*

Symptoms

The disease is severe on leaves and occasionally attacks stem and flowers. Minute brown to dark brown spots with concentric rings appear initially, expand gradually causing irregular lesions. The centre of the spot is light brown with a dark brown margin. Irregular cracking of affected leaves is seen. Elongated black lesions can be seen on the petiole and stem. The fungal infection on flower buds leads to drying and shedding.

Pathogen

The mycelium of the fungus is sub-hyaline initially and become brown coloured on maturity. The conidiophores are stout, erect, rigid, unbranched, septate and arise singly or in clusters. The conidia are 3-11 celled with irregular shape, light brown in colour with a long beak.

Mode of Spread and Survival

The fungus is externally seed-borne and also survives in plant debris. The disease spread is through wind blown conidia.

Management

Treat the seeds with Thiram or Captan at 4g/kg. Spray Mancozeb at 1 kg/ha.

COCONUT (*Cocos nucifera*)

Bud rot *Phytophthora palmivora*

Symptoms

Palms of all ages are susceptible to the disease, but it is more severe in young palms of 5-20 years. The first indication of the diseases is seen on the central shoot of the tree

(spindle). The heart leaf shows discolouration which becomes brown instead of yellowish brown. This is followed by drooping and breaking off the heart leaf. With the progress of diseases, more number of leaves get affected with loss of lustre and turn pale yellow. The entire base of the crown may be rotten emitting a foul smell. The central shoot comes off easily on slight pulling. The leaves fall in succession starting from the top of the crown. The leaf falling and bunch shedding continue until a few outer leaves are left unaffected. But within few months the infection leads to complete shedding of leaves, within subsequent wilt and death of the tree.

Pathogen

The fungus produces intercellular, non-separate, hyaline mycelium. Sporangiophores are hyaline and simple or branched occasionally. The sporangiophores are hyaline, thin-walled, pear-shaped with a prominent papillae. Sporangia release reniform, biflagellate zoospores upon germination. The fungus also produces thick-walled, spherical oospores. In addition, thick-walled, yellowish-brown chlamydospores are also produced.

Favourable Conditions

High rainfall, high atmospheric humidity (above 90 per cent), low temperature (18-20°C) and wounds caused by tappers and Rhinoceros beetles (*Oryctes rhinoceros*)

Mode of Spread and Survival

The fungus remains as dormant mycelium in the infected tissues and also survives as chlamydospores and oospores in crop residues in the soil. The diseases spread is mainly through air-borne sporangia and zoospores. Rainfall also helps in spreading the diseases. Insects and tappers also help in the spread of the inoculum from diseased trees.

Management

Remove and burn badly affected trees which are beyond recovery. If diseases are detected in early stage, remove the infected tissue thoroughly by cutting the infected spindle along with two leaves surrounding it and protect the cut portion with Bordeaux paste. Give prophylactic spray with 1% Bordeaux mixture to all the healthy plants in the vicinity of diseased ones and also before onset of monsoon rains.

Basal Stem Rot / Thanjavur wilt / Bole rot *Ganoderma lucidum*

Symptoms

The trees in the age group of 10-30 years are easily attacked by the pathogen. The fungus is soil-borne and infects the roots. The most usual symptoms are yellowing, withering and drooping of the outer fronds which remain hanging around the trunk for several months before shedding. The younger leaves remain green for sometime and later turn yellowish brown. The new fronds produced become successively smaller and yellowish in colour which do not unfold properly. Soft rot occurs in the bud with a bad newly formed leaves wither away. More often the spindle is blown off leaving the decapitated stem.

The wilting plants also show bleeding patches near the base of the trunk. A brown gummy liquid oozes out from the cracks in the tree which slowly result in the death of outer tissues. As the infection advances, fresh bleeding patches appear above the old ones, up to 3-5 meters height. The decay of the basal portion occurs slowly and tree succumbs to the diseases in 2-3 years. In the advanced stages of infection, the fungus produces fruiting body (Bracket) along the side of the basal trunk. The roots of wilting trees show discolouration and severe rotting.

Pathogen

The fungus produces a semi circular basidiocarp (bracket), which is attached to the tree with a stalk. The bracket is very big about 10-12 cm diameter and woody. The upper surface is tough, shining, light to dark brown or almost black with concentric furrows. The lower surface is white and soft with numerous minute pores. These pores represent the opening of the hymenial tubes, which are lined with basidia and basidio-spores. Basidiospores are oval, brown and thick walled.

Favourable Conditions

Trees grown in sandy loam and sandy soils, water logging during severe rains, low soil moisture content during summer months and damages caused by weevils and beetles.

Mode of Spread and Survival

The fungus is soil-borne and survives in the soil for long time. The primary infection is through basidiospores in the soil, which attack roots. The irrigation water and rain water also help in the spread of the fungus.

Management

Remove and burn severely infected trees which are beyond recovery. Isolate the diseased trees by digging a trench all around to check further spread. Irrigate the palms at least once in a fortnight during summer months. Apply heavy doses of farm yard manure or compost for green manure at 50 Kg/tree/year along with 5 kg of neem cake. Drench the soil near the tree with 40 litres of 1 per cent Bordeaux mixture at quarterly interval for thrice a year and repeat after 2-3 years. Apply Aureofunginsol 2g+Copper sulphate 1g in 100 ml of water or Tridemorph 2ml/100 ml of water through stem injection or root feeding at quarterly interval for one year.

Stem bleeding *Ceratocystis paradoxa*

Symptoms

The characteristic symptom is the exudation of reddish brown fluid from the cracks in the stem. The fluid trickles down to several feet on the stem and the exudate dries up forming a black crust. The tissues below the cracks turn yellow and decay. As the disease progresses, more area underneath the bark gets decayed and the bleeding patch extends further up. The vigour of the tree is affected and nut yield is reduced. The tree is not killed outright but become uneconomical to maintain. In extreme cases, the trees may become barren and die.

Pathogen

The fungus produces two type of conidia. Macroconidia are produced on conidiophores singly or in chains. They are spherical and dark green in colour. Microconidia are produced endogenously inside the long cells ruptures when mature and release the microconidia in long chain. Microconidia (endoconidia) are thinwalled, hyaline and cylindrical in form. *C. paradoxa* also produces hyaline perithecia with a long neck base is ornamented with knobbed appendages and ostiole is covered by numerous pale-brown, erect, tapering hyphae. Asci are clavate and ascospores are hyaline ad ellipsoid.

Favourable Conditions

Copious irrigation or rainfall followed by drought, shallow loamy soils or laterite soil with clay or rock layer beneath the soil, poor maintenance of gardens and damages by *Diocalandra* and *Xyleborus* beetles.

Mode of Spread and Survival

The fungus survives in the infected plant debris and soil as perithecia and conidia. The spread is mainly through wind-borne conidia. The irrigation and rain water also help in the disease spread. The beetles which feed on the diseased plants also help in transmission.

Management

Maintain the gardens properly with adequate fertilization. Scoop out the diseased tissue with a portion of healthy tissues, burn the exposed tissue and apply molten coal tar followed by swabbing Bordeaux paste. When stem bleeding is observed in association with *Ganoderma*, follow root feeding or stem injection technique. Irrigate during the summer months.

Kerala wilt / Root wilt disease Mycoplasma Like Organism

Symptoms

Palms of all ages are found infected by the pathogen. The 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 are also conspicuously. Wilting of leaves from middle whorl to outward and shedding of buttons and immature nuts occur. The size of mature nuts are small with thin kernel. The crown size also gets reduced in advanced stages and trees remain unproductive. The roots show rotting symptoms, which rot from tip backwards. The older roots show cracks and blotches and cortex turns brownish black resulting in drying in flakes.

The root wilt affected palms become highly susceptible to leaf rot disease caused by *Bipolaris halodes*. Occurrence of leaf rot independent of root wilt is very rare. The first symptom is blackening and shrivelling of the distal ends of leaflets in the central spindle and in some of the young leaves. Later the affected portion breaks off in bits giving the leaf a fan-like appearance. This rotting hastens the decline of the palms.

Pathogen

The disease is caused by Mycoplasma Like Organism, which is frequently identified in the phloem tissues of infected trees. The MLO was also successfully transmitted from infected tree by a vegetative vector (Dodder) to Periwinkle (*Catharanthus roseus*).

Favourable Conditions

Sandy and sandy loam soils, severe floods and abundance of lace wing bug *Stephanitis typia*.

Mode of Spread and Survival

The severely infected plants serve as primary sources of inoculum. The MLO is transmitted by the lace wing bug *Stephanitis typicuc* from diseased to healthy palms.

Management

Remove all severely infected and uneconomic palms and replant with healthy hybrid seedling like CDO X WCT or WCT X CDO. Remove all the juvenile (young) palms showing symptoms irrespective of its intensity. Spray the leaves with 0.01 per cent Monocrotophos or Thiodan alternatively. Apply balanced doses of fertilizers (1kg Urea, 1.7kg Super phosphate, 1.7kg Muriate of potash and 3kg Magnesium sulphate per palm per year in two splits, 1/3 during April-May and 2/3 during September-October for rainfed palms and in 4 splits during January, April, July and October for irrigated palms).

Apply 50kg of farmyard manure/palm/year. Grow green manure crops like *Pueraria phaseoloides* in basin and incorporate at the time of fertilizer application. Control the leaf rot disease by spraying 1% Bordeaux mixture or 0.3% Mancozeb. Irrigate the palm during summer months at the rate of 600-900 litres of water/basin once in 4 to 6 days. Avoid water logging by providing proper drainage during rainy seasons. Raise the intercrops like Tapioca, elephant yam and yam for a period of three years to increase the nut yield. Raise fodder crops in the interspace and maintain the milch cows to recycle the manure and other organic wastes to increase the nut yield in affected gardens.

Grey leaf blight *Pestalotia palmarum*

Symptoms

Initially symptoms develop only on the outer whorl of leaves, especially in older leaves. Minute yellow spots surrounded by a greyish margin appear on the leaflets. Gradually, the centre of the spots turns to greyish white with dark brown margins with a yellow halo. Many spots coalesce into irregular grey necrotic patches. Complete drying and shrivelling of the leaf blade occur giving a blighted or burnt appearance. Large number of globose or ovoid black acervuli appear on the upper surface of leaves.

Pathogen

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

Favourable conditions

I will drained soils, soils with potash deficiency, continuous rainy weather for 4-5 days and strong winds.

Mode of Spread and Survival

The fungus remains in the infected plant debris in soil. The disease is spread through wind-borne conidia

Management

Remove and burn the infected, fallen leaves periodically. Apply heavy doses of potash. Improve the drainage conditions of the soil. Spray the crown with 0.25 per cent copper oxychloride or 1 per cent Bordeaux mixture before the onset of rains.

Minor diseases

Tatipaka disease	Mycoplasma Like Organism	Development of abnormally larger crown with dark green inner
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		leaves. Subsequently crown becomes smaller and produce smaller, unfolded leaves and smaller bunches.
Pencil point	Micronutrient deficiency	Affected trees produce a fewer small leaves with yellowing. The stem tapers gradually and small crown fails to produce new leaves and trunk remains barren like a pointed pencil.

Management of Pencil Point

Dissolve 225g each of Borax, Zinc Sulphate, Manganese Sulphate, Copper Sulphate and 10g of Ammonium Molybdate in 10 litres of water and apply around the root zone.

COTTON (*Gossypium spp.*)

Wilt

Fusarium oxysporum f.sp. *vasinfectum*

Symptoms

The disease affects the crop at all stages. The earliest symptoms appear on the seedlings in the cotyledons which turn yellow and then brown. The base of petiole shows brown ring, followed by wilting and drying of the seedlings. In young and grown up plants, the first symptom is yellowing of edges of leaves and area around the veins i.e. discolouration starts from the margin and spreads towards the midrib. The leaves lose their turgidity, gradually turn brown, droop and finally drop off. Symptoms start from the older leaves at the base, followed by younger ones towards the top, finally involving the branches and the whole plant. The defoliation or wilting may be complete leaving the stem alone standing in the field. Sometimes partial wilting occurs, where in only one portion of the plant is affected, the other remaining free. The taproot is usually stunted with less abundant laterals. Browning or blackening of vascular tissues is the other important symptom, black streaks or stripes may be seen extending upwards to the branches and downwards to lateral roots. In severe cases, discolouration may extend throughout the plant starting from roots extending to stem, leaves and even bolls. In transverse section, discoloured ring is seen in the woody tissues of stem. The plants affected later in the season are stunted with fewer bolls which are very small and open before they mature.

Pathogen

The fungus produces three types of spores. Macroconidia are 1 to 5 septate, hyaline, thinwalled, falcate with tapering ends. The microconidia are hyaline, thinwalled, spherical or elliptical, single or two celled. Chlamydospores are dark coloured and thick walled. The fungus also produces a vivotoxin, Fusaric acid which is partially responsible for wilting of the plants.

Favourable Conditions

Soil temperature of 20-30°C, hot and dry periods followed by rains, heavy black soils with an alkaline reaction, increased doses of nitrogen and phosphatic fertilizers, wounds caused by nematode (*Meloidogyne incognita* and grubs of Ashweevil (*Mylloceris pustulatus*).

Mode of Spread and Survival

The fungus can survive in soil as saprophyte for many years and chlamydospores act as resting spores. The pathogen is both externally and internally seed-borne. The primary infection is mainly from dormant hyphae and chlamydospores in the soil. The secondary spread is through conidia and chlamydospores which are disseminated by wind and irrigation water.

Management

Treat the acid-delinted seeds with Carboxin or Chlorothalonil at 4 g/kg. Remove and burn the infected plant debris in the soil after deep summer ploughing during June-July. Apply increased doses of potash with a balanced dose of nitrogenous and phosphatic fertilizers. Apply heavy doses of farm yard manure or other organic manures at 100/ha. Follow mixed cropping with non-host plants. Grow disease resistant varieties of *G. hirsutum* and *G. barbadense* like Varalakshmi, Vijay Pratap, Jayadhar and Verum.

Verticillium wilt

Verticillium dahliae

Symptoms

The symptoms are seen when the crop is in squares and bolls. Plants infected at early stages are severely stunted. The first symptoms can be seen as bronzing of veins. It is followed by interveinal chlorosis and yellowing of leaves. Finally the leaves begin to dry, giving a scorched appearance. At this stage, the characteristic diagnostic feature is the drying of the leaf margins and areas between veins, which gives a "Tiger stripe" or "Tiger claw" appearance. The affected leaves fall off leaving the branches barren. Infected stem and roots, when split open, show a pinkish discolouration of the woody tissue which may taper off into longitudinal streaks in the upper parts and branches. The infected leaf also show brown spots at the end of the petioles. The affected plants may bear a few smaller bolls with immature lint.

Pathogen

The fungus produces hyaline, septate mycelium and two types of spores. The conidia are single celled, hyaline, spherical to oval, borne singly on verticillate conidiophores. The micro sclerotia are globose to oblong, measuring 48-120 X 26-45µm.

Favourable Conditions

Low temperature of 15-20°C, low lying and ill-drained soils, heavy soils with alkaline reaction and heavy doses of nitrogenous fertilizers.

Mode of Spread and Survival

The fungus also infects the other hosts like brinjal, chilli, tobacco and bhendi. The fungus can survive in the infected plant debris and in soils as micro sclerotia upto 14 years. The seeds also carry the micro sclerotia and conidia in the fuzz. The primary spread is through the micro sclerotia or conidia in the soil. The secondary spread is through the contact of diseased roots to healthy ones and through dissemination of infected plant parts through irrigation water and other implements.

Management

Treat the delinted seeds with Carboxin or Carbendazim at 4 g/kg. Remove and destroy the infected plant debris after deep ploughing in summer months (June-July). Apply heavy doses of farmy and manure or compost at 100t/ha. Follow crop rotation by growing paddy or lucerne or chrysanthemum for 2-3 years. Spot drench with 0.05 per cent Benomyl or Carbendazim. Grow disease resistant varieties like Sujatha, Suvin and CBS 156 and tolerant variety like MCU 5 WT.

Root rot

Rhizoctonia bataticola

(Pycnidial stage : *Macrophomina phaseolina*)

Symptoms

The fungus causes three types of symptoms viz., seedling disease, sore-shin and root rot. Germinating seedling and seedlings of one to two weeks old are attacked by the fungus at the hypocotyl and cause black lesions, girdling of stem and death of the seedling, causing large gappiness in the field. In sore-shin stage (4 to 6 weeks old plants), dark reddish-brown cankers are formed on the stems near the soil surface, later turning dark black and plant breaks at the collar region leading to drying of the leaves and subsequently the entire plant. Typical root rot symptom appears normally at the time of maturity of the plants. The most prominent symptom is sudden and complete wilting of plants in patches. Initially, all the leaves droop suddenly and die within a day or two. The affected plants when pulled, reveal the rotting of entire root system except tap root and few laterals. The bark of the affected plant shreds and even extends above ground level. In badly affected plants the woody portions may become black and brittle. A large number of dark brown sclerotia are seen on the wood or on the shredded bark.

Pathogen

The fungal hyphae are septate and fairly thick and produce black, irregular sclerotia which measure 100 µm in diameter.

Favourable Conditions

Dry weather following heavy rains, high soil temperature (35-39°C), low soil moisture (15-20 per cent), cultivation of favourable hosts like vegetables, oil seeds and legumes preceding cotton and wounds caused by ashweevil grubs and nematodes.

Mode of Spread and Survival

The disease is mainly soil-borne and the pathogen can survive in the soil as sclerotia for several years. The spread is through sclerotia which are disseminated by irrigation water, implements, heavy winds and other cultural operations.

Management

Treat the seeds with *Trichoderma viride* @ 4g/kg or *Pseudomonas fluorescens* @ 10g/kg of seed. Treat the seeds with Carboxin or Thiram at 5 g or Carbendazim at 2g/kg. Spot drench with 0.1% Carbendazim or 0.05% Benomyl. Apply farm yard manure at 10t/ha or neem cake at 2.5t/ha. Adjust the sowing time, early sowing (First Week of April) or late sowing (Last week of June) so that crop escapes the high soil temperature conditions. Adopt intercropping with sorghum or moth bean (*Phaseolus aconitifolius*) to lower the soil temperature.

Anthraxnose

Colletotrichum capsici

Symptoms

The fungus infects the seedlings and produces small reddish circular spots on the cotyledons and primary leaves. The lesions develop on the collar region, stem may be girdled, causing seedling to wilt and die. In mature plants, the fungus attacks the stem, leading to stem splitting and shredding of bark. The most common symptom is boll spotting. Small water soaked, circular, reddish brown depressed spots appear on the bolls. The lint is stained to yellow or brown, becomes a solid brittle mass of fibre. The infected bolls cease to grow and burst and dry up prematurely.

Pathogen

The pathogen forms large number of acervuli on the infected parts. The conidiophores are slightly curved, short, and club shaped. The conidia are hyaline and falcate, borne single on the conidiophores. Numerous black coloured and thick walled setae are also produced in acervulus.

Favourable Conditions

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

Mode of Spread and Survival

The pathogen survives as dormant mycelium in the seed or as conidia on the surface of seed for about a year. The pathogen also perpetuates on the rotten bolls and other plant debris in the soil. The secondary spread is by air-borne conidia. The pathogen also survives in the weed hosts viz., *Aristolachia bractiata* and *Hibiscus diversifolius*.

Management

Treat the delinted seeds with Carbendazim or Carboxin or Thiram or Captan at 2g/kg. Remove and burn the infected plant debris and bolls in the soil. Rogue out the reservoir weed hosts. Spray the crop at boll formation stage with Mancozeb 2kg or Copper oxychloride 2.5 kg or Ziram 2.5 lit or Carbendazim 500g/ha.

Grey or Areolate mildew

Ramularia areola

(Sexual stage : *Mycosphaerella areola*)

Symptoms

The disease usually appears on the under surface of the bottom leaves when the crop is nearing maturity. Irregular to angular pale translucent lesions which measure 1-10 mm (usually 3-4 mm) develop on the lower surface, usually bound by veinlets. On the upper surface, the lesions appear as light green or yellow green specks. A frosty or whitish grey powdery growth, consisting of conidiophores of the fungus, appears on the lower surface. When several spots coalesce, the entire leaf surface is covered by white to grey powdery growth. White or grey powdery growth may occur on the upper surface also. The infection spreads to upper leaves and entire plant may be affected. The affected leaves dry up from margin, cup inward, turn yellowish brown and fall off prematurely.

Pathogen

The fungus produces endophytic, septate mycelium. Conidiophores are short, hyaline and branched at the base. Conidia are borne singly or in chains at the tips of conidiophores. The conidia are hyaline, irregularly oblong with pointed ends, sometimes rounded to flattened

ends, unicellular or 1-3 septate. The perfect stage of the fungus produces perithecia containing many asci. The ascospores are hyaline and usually two celled.

Favourable Conditions

Wet humid conditions during winter cotton season, intermittent rains during North-East monsoon season, low temperature (20-30°C) during October-January, close planting, excessive application of nitrogenous fertilizers, very early sowing or very late sowing of cotton and growing highly susceptible varieties/hybrids like Suvin, DCH 32, MCU 5, MCU 9 and LRA 5166.

Mode of Spread and Survival

The fungus survives during the summer in the infected crop residues. The perennial cotton plants and self-sown cotton plants also harbour the pathogen during summer months. The primary infection is through conidia from infected plant debris and secondary spread is through wind, rain splash, irrigation water and implements.

Management

Remove and burn the infected crop residues. Rogue out the self-sown cotton plants during summer months. Avoid excessive application of nitrogenous fertilizers/manures. Adopt the correct spacing based on soil conditions and varieties. Spray the crop with Carbendazim at 250-375g or Wettable sulphur at 1.25-2.0 kg/ha, repeat after a week. Grow the resistant varieties like Sujatha and Varalakshmi.

Boll rot

It is a complex disease caused by several fungal pathogens viz., *Fusarium moniliforme*, *Colletotrichum capsici*, *Aspergillus flavus*, *A. niger*, *Rhizopus nigricans*, *Nematospora nagpuri* and *Botryodiplodia* sp.

Symptoms

Initially, the disease appears as small brown or black dots which later enlarge to cover the entire bolls. Infection spreads to inner tissues and rotting of seeds and lint occur. The bolls never burst open and fall off prematurely. In some cases, the rotting may be external, causing rotting of the pericarp leaving the internal tissues free. On the affected bolls, a large number of fruiting bodies of fungi are observed depending upon the nature of the fungi involved.

Favourable Conditions

Heavy rainfall during the square and boll formation stage, punctures caused by the insects, especially red cotton bug *Dysdercus cingulatus*, close spacing and excessive nitrogen application.

Mode of Spread and Survival

The fungi survive in the infected bolls in the soil. The insects mainly help in the spread of the disease. The fungi make their entry only through the insect punctures. The secondary spread of the disease is also through air-borne conidia.

Management

Adopt optimum spacing. Apply the recommended doses of fertilizers. Spray Fenvalerate 75g a.i./ha + Copper oxychloride 2.5kg or Carbendazim 1kg or Mancozeb 2 kg/ha from 45th day at 15 days interval. Two or three sprays are necessary.

Leaf blight
Alternaria macrospora

Symptoms

The disease may occur in all stages but more severe when plants are 45-60 days old. Small, plate to brown, irregular or round spots, measuring 0.5 to 6mm diameter, may appear on the leaves. Each spot has a central lesion surrounded by concentric rings. Several spots coalesce together to form blighted areas. The affected leaves become brittle and fall off. Sometimes stem lesions are also seen. In severe cases, the spots may appear on bracts and bolls.

Pathogen

The fungus produces dark brown, short, 1-8 septate, irregularly bend conidiophores with a single conidium at the apex. The conidia are obclavate, light to dark brown in colour with 3-9 transverse septa and four longitudinal septa, with a prominent beak.

Favourable Conditions

High humidity, intermittent rains and moderate temperature of 25-28°C.

Mode of Spread and Survival

The pathogen survives in the dead leaves as dormant mycelium. The pathogen primarily spreads through irrigation water. The secondary spread is mainly by air-borne conidia.

Management

Remove and destroy the infected plant residues. Spray Mancozeb or Copper oxychloride at 2kg/ha at the intimation of the disease. Four to five sprays may be given at 15 days interval.

Bacterial blight
Xanthomonas campestris p.v malvacearum

Symptoms

The bacterium attacks all stages from seed to harvest. Usually five common phases of symptoms are noticed.

i) Seedling blight : Small, water-soaked, circular or irregular lesions develop on the cotyledons, Later, the infection spreads to stem through petiole and cause withering and death of seedlings.

ii) Angular leaf spot : Small, dark green, water soaked areas develop on lower surface of leaves, enlarge gradually and become angular when restricted by veins and veinlets and spots are visible on both the surface of leaves. As the lesions become older, they turn to reddish brown colour and infection spreads to veins and veinlets.

iii) Vein blight or vein necrosis or black vein : The infection of veins cause blackening of the veins and veinlets, gives a typical 'blighting' appearance. On the lower surface of the leaf, bacterial oozes are formed as crusts or scales. The affected leaves become crinkled and twisted inward and show withering. The infection also spreads from veins to petiole and cause blighting leading to defoliation.

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

v) Square rot / Boll rot : On the bolls, water soaked lesions appear and turn into dark black and sunken irregular spots. The infection slowly spreads to entire boll and shedding occurs. The infection on mature bolls lead to premature bursting. The bacterium spreads inside the boll and lint gets stained yellow because of bacterial ooze and loses its appearance and market value. The pathogen also infects the seed and causes reduction in size and viability of the seeds.

Pathogen

The bacterium is a short rod with a single polar flagellum. It is gram negative, non-spore forming and measures 1.0-1.2 X 0.7-0.9 μ m.

Favourable Conditions

Optimum soil temperature of 28°C, high atmospheric temperature of 30-40°C, relative humidity of 85 per cent, early sowing, delayed thinning, poor tillage, late irrigation and potassium deficiency in soil. Rain followed by bright sunshine during the months of October and November are highly favourable.

Mode of Spread and Survival

The bacterium survives on infected, dried plant debris in soil for several years. The bacterium is also seed-borne and remains in the form of slimy mass on the fuzz of seed coat. The bacterium also attacks other hosts like *Thumburgia thespesioides*, *Eriodendron anfructuosum* and *Jatropha curcus*. The primary infection starts mainly from the seed-borne bacterium. The secondary spread of the bacteria may be through wind, wind blown rain splash, irrigation water, insects and other implements.

Management

Delint the cotton seeds with Concentrated sulphuric acid at 100ml/kg of seed. Treat the delinted seeds with Carboxin or Oxycarboxin at 2 g/kg or soak the seeds in 1000 ppm Streptomycin sulphate overnight. Remove and destroy the infected plant debris. Rogue out the volunteer cotton plants and weed hosts. Follow crop rotation with non-host crops. Early thinning and early earthing up with potash. Grow resistant varieties like Sujatha, 1412 and CRH 71. Spray with Streptomycin sulphate+tetra-cycline mixture 100g along with Copper oxychloride at 2kg/ha or spray Copper oxychloride alone at 2.5kg/ha.

Stenosis or small leaf *Mycoplasma Like Organism*

Symptoms

The disease appears when the plants are two to three months old and affected plants are stunted. They put forth numerous extremely small leaves in cluster and the dormant buds are stimulated resulting in profuse vegetative growth. The leaves are disfigured and variously lobed. Flowers remain small with abortive ovary. Large number of flower buds and young seeds. Root system is poorly developed and can be easily pulled out. Sometimes, the disease affects only the base of the plant, resulting in the formation of clump of short branches which bear small and deformed leaves. The mode of transmission of disease and the role of vector are unknown.

Management

Rogue out the infected plants periodically. Cotton varieties developed from *Gossypium hirsutum* and *G. barbadense* are found to be resistant to the disease.

Minor diseases

Leaf spot	<i>Cercospora gossypina</i>	Round or irregular greyish spots with dark brown or blackish borders appear on older leaves.
Myrothecium leaf spot	<i>Myrothecium roridum</i>	Reddish spots of 0.5 mm-1 cm diameter may appear near the margins of the leaves. The affected portions fall off leaving irregular shot holes in the leaves.
Rust	<i>Phakopsora desmium</i>	Yellowish brown raised pustules appear on the lower surface of leaves with rusty spores. Several pustules join to give rusty appearance to entire leaf. The sori may also develop on bolls.
Sooty mould	<i>Capnodium</i> sp.	Dark specks appear on the leaves and bolls, slowly spread and black powdery growth covers the entire leaf area and bolls.

SUGARCANE (*Saccharum officinarum*)

Red rot

Colletotrichum falcatum

(Sexual stage: *Physalospora tucumanensis*)

Symptoms

The first external symptom appears mostly on third or fourth leaf which withers away at the tips along the margins. The whole crown may wither away in eight to twelve days. Typical symptoms of red rot are observed in the internodes of a stalk by splitting it longitudinally. These include the reddening of the internal tissues which are usually elongated at right angles to the long axis of the stalk. The presence of cross-wise white patches is the important diagnostic character of the disease. The diseased cane also emits acidic-sour smell. As the disease advances, the stalk becomes hollow and covered with white mycelial growth. Later the rind shrinks longitudinally with minute black, velvety fruiting bodies protruding out of it.

The pathogen also produces tiny reddish lesions on the upper surface of leaves with dark dots in the centre. Minute red spots also appear on the centre of the mid-rib and develop in both directions forming small or long lesions. The lesions are initially blood red with

dark margins and later on with straw coloured centres. Often the infected leaves may break at the lesions and hang down, with large number of minute black dots.

Pathogen

The fungus produces thin, hyaline, septate, profusely branched hyphae containing oil droplets. The fungus produces black, minute velvety acervuli with long, rigid bristle-like, septate setae. Conidiophores are closely packed inside the acervulus, which are short, hyaline and single celled. The conidia are single celled, hyaline, falcate, granular and guttulate. Fungus also produces large number of globose and dark brown to black perithecia with a papillate ostiole. Asci are clavate, unitunicate and eight-spored. Large number of hyaline, septate, filiform paraphyses are also present among asci. Ascospores are ellipsoid or fusoid, hyaline, straight or slightly curved and unicellular which measure 18-22 µm x 7-8 µm.

Favourable Conditions

Monoculturing of sugarcane, successive ratoon cropping, water logged conditions and injuries caused by insects.

Mode of Spread and Survival

The fungus is sett-borne. The fungus also persists in the soil on the diseased clumps and stubbles as chlamydospores and dormant mycelium. The primary infection is mainly from infected setts. Secondary spread in the field may be through irrigation water and cultivation tools. The rain splash, air currents and dew drops also help in the spread of conidia from the diseased to healthy plants in the field. The fungus also survives on collateral hosts like *Sorghum vulgare*, *S. halepense* and *Saccharum spontaneum*.

Management

Adopt crop rotation by including rice and green manure crops. Select the setts from the disease free fields or disease free area. Avoid ratooning of the diseased crop. Soak the setts in 0.1% Carbendazim solution (1 g / litre) or 0.25% Emisan (2.5g/litre) for 20 minutes before planting. Grow resistant varieties like Coc 62198, Coc 90003, Coc 91061, Co 6806 and Co 7704 and moderately resistant varieties like Coc 8001, Coc 85061 and Coc 8201. Setts can be treated with aerated steam at 52°C for 4 to 5 hours and by moist hot air at 54°C for 2 hours.

Smut

Ustilago scitaminea

Symptoms

It is a culm culm culm smut. The affected plants are stunted and the central shoot is converted into a long whip-like, dusty black structure. The length of the whip varies from few inches to several feet. In early stages, this structure is covered by a thin, white papery membrane. The whip may be straight or slightly curved. On maturity it ruptures and millions of tiny black smut spores (teliospores) are liberated and disseminated by the wind. Affected plants are usually thin, stiff and remain at acute angle. The whip like structure, representing the central shoot with its various leaves, may be produced by each one of the shoots/tillers arising from the clump. The smutted clumps also produce mummified arrows in which lower portion consisted of a normal inflorescence with typical flowers and the upper portion of the rachis is converted into a typical smut whip. Occasionally smut sori may develop on the leaves and stem.

Pathogen

The fungal hyphae are primarily intercellular and collect as a dense mass between the vascular bundles of host cell and produce tiny black spores. The thin membrane which covers the smutwhip represents the host epidermis. The smut spores are light brown in colour, spherical, echinulated and measuring 6.5-8.5µm in diameter. Smut spores germinate to produce 3-4 celled, hyaline promycelium and produce 3-4 sporidia which are hyaline and oval shaped with pointed ends.

Favourable Conditions

Monoculturing of sugarcane, continuous ratooning and dry weather during tillering stage.

Mode of Spread and Survival

Teliospores may survive in the soil for long periods, upto 10 years. The spores and sporidia are also present in the infected plant materials in the soil. The smut spores and dormant mycelium also present in or on the infected setts. The primary spread of the disease is through diseased seed-pieces (setts). In addition, sporidia and spores present in the soil also spread through rain and irrigation water and cause soil-borne infection. The secondary spread in the field is mainly through the smut spores developed in the whips, aided by air currents. The fungus also survives on collateral hosts like *Saccharum spontaneum*, *S. robustum*, *Sorghum vulgare*, *Imperata arundinacea* and *Cyperus dilatatus*.

Management

Plant healthy setts taken from disease free area. Remove and destroy the smutted clump (Collect the whips in a thick cloth bag/polythene bag and immerse in boiling water for 1 hr to kill the spores). Discourage ratooning of the diseased crops having more than 10 per cent infection. Follow crop rotation with green manure crops or dry fallowing. Grow redgram as a companion crop between 2 rows of sugarcane. Treat the setts in hot water at 55-60°C for 10 minutes or 52°C for 30 minutes. Grow resistant varieties like Co 7704, Co 449, Co 6806, Co 62175, Co 7807, Co 8139, Co 62198, Coc 8001 and moderately resistant varieties like Coc 85061 and Coc 8201.

Sett rot or Pineapple disease

Ceratocystis paradoxa

Symptoms

The disease primarily affects the setts usually two to three weeks after planting. The fungus is soil-borne and enters through cut ends and proliferates rapidly in the parenchymatous tissues. The affected tissues first develop a reddish colour which turns to brownish black in the later stages. The severely affected setts show internodal cavities covered with the mycelium and abundant spores. A characteristic pineapple smell is associated with the rotting tissues. The setts may decay before the buds germinate or the shoots may die after reaching a height of about 6-12 inches. In infected shoots survive, they are much stunted and chlorotic.

Pathogen

The fungus produces both macroconidia and microconidia. Conidiophores are linear, thinwalled with short cells at the base and a long terminal cell. The microconidia are hyaline when young but becomes almost black at maturity. They are thinwalled, cylindrical and produced endogenously in chains in the long cells of conidiophores and pushed out in succession. Macroconidia are produced singly or in chains on a short, lateral conidiophores. Macroconidia are spherical or elliptical or truncate or pyriform and are hyaline to olive green or black measuring 16-19x10-12 µm. The fungus also produces chlamydospores on short

lateral hyphae in chains, which are oval, thick walled and brown in colour. The perithecia are flask shaped with a very long neck. The bulbous base of the perithecium is hyaline or pale yellow, 200-300um in diameter and ornamented with irregularly shaped, knobbed appendages. The neck is black at base and pale-brown at the apex and 1150-1350um in length. The ostiole is covered by numerous pale-brown, erect tapering hyphae. Asci are clavate and measures 25x10um and ascospores are single celled, hyaline, ellipsoid, more convex on one side, measures 7-10 x 2.5-4um.

Favourable Conditions

I will drained fields, heavy clay soils, temperature of 25-30OC and prolonged rainfall after planting.

Mode of Spread and Survival

The fungus survives as conidia and chlamydospores in the soil and in the infected, burried cane tissues. The inoculum moves from field to field through wind-borne conidia or irrigation or rain water. The insects like cane borer (*Diatraea dyari*) also helps in the spread of the disease. The pathogen also survives on coconut, cocoa, mango, papaya, coffee, maize and arecanut.

Management

Soak the setts in 0.05% Carbendazim oor 0.25% Emisan for 15 minutes. Use long setts having 3 or 4 buds. Provide adequate drainage during rainy seasons.

Wilt

Cephalosporium sacchari

Symptoms

The first symptom of the disease is visible in the canes of 4-5 month age. The canes may wither in groups. The affected plants are stunted with yellowing and withering of crown leaves. The midribs of all leaves in a crown generally turn yellow, while the leaf lamina may remain green. The leaves dry up and stem develop hollowness in the core. The core shows the reddish discolouration with longitudinal red streaks passing from one internode to another. In severe cases, spindle shaped cavities tapering towards the nodes develop in each internode. The canes emit a disagreeable odour, with lot of mycelial threads of the fungus cover the cavity.

Pathogen

The fungal mycelium is hyaline, septate and thin walled. The conidiophores are simple or branched and produce single celled, hyaline, oval to elliptical micro conidia.

Favourable Conditions

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

Mode of Spread and Survival

The fungus is soil-borne and remains in the soil as saprophyte for 2-3 years. The disease is primarily transmitted through infected seed pieces. The secondary spread is aided by wind, rain and irrigation water.

Management

Select the seed material from the disease-free plots. Avoid the practice of rathooning in diseased fields. Burn the trashes and stubbles in the field. Grow coriander or mustard as a companion crop in the early stages of crop. Dip the setts in 40ppm Boron or Manganese for 10 minutes or in 0.25% Emisan or 0.05% Carbendazim for 15 minutes.

Rust

Puccinia erianthi (Syn : *P. melanocephala* and *P. kuehnii*)

Symptoms

Minute, elongated, yellow spots (uredia), usually 2-10 x 1-3 mm appear on both the surfaces of young leaves. The pustules turn to brown on maturity. Late in the season, dark brown to black telia appear on the lower surface of leaves. In severe cases, the uredia also appear on the leaf sheath and the entire foliage looks brownish from a distance.

Pathogen

The mycelium is hyaline, branched and septate. *P.kuehnii* produces ovoid or pear shaped, single celled uredospores measuring 29-57 x 8-37µm with apical thickening and golden yellow in colour. Teliospores are produced in scanty which are yellow in colour, club shaped, two celled, smooth walled and measuring 24-34 X 18-25µm single celled, dark yellow coloured with 4 equatorial pores. Teliospores are produced in abundance, which are pale to brick colour, two celled, smooth walled and slightly constricted at septum. Occurrence of pycnial and aecial stages and the role of alternate host are unknown.

Favourable Conditions

Temperature of 30°C, relative humidity between 70 and 90 per cent, high wind velocity and continuous cloudiness.

Mode of Spread and Survival

The fungus survives on collateral hosts like *Erianthus fulvus* and *Saccharum spontaneum*. The uredospores also survive in the infected stubbles in the soil. The disease is mainly spread through air-borne uredospores.

Management

Remove the collateral hosts. Spray Tridemorph 1 kg or Mancozeb 2 kg/ha.

Gummosis

Xanthomonas campestris p.v. *vasculorum*

Symptoms

The bacterium produces two distinct types of symptoms. On the mature leaves, longitudinal stripes or streaks, 3-7mm in width and several cm in length, appear around the affected veins, near the tip. Initially these stripes are pale yellow in colour, later turn to brown. The affected tissues slowly dry up. The infected canes are stunted with short internodes, giving a bushy appearance. When such canes are cut transversely or split open longitudinally, a dull yellow bacterial ooze comes out from the cut ends and bacterial pockets are seen inside the slitted cane. The fibrovascular bundles are deep red and internodal cavities formed in the severe cases are filled with yellow coloured bacterial gums.

Pathogen

The bacterium is a short rod, Gram negative, non spore forming non capsular measuring 1.0 to 1.5µm X 0.4 to 0.5µm, with a single polar flagellum. It is facultative anaerobe and it produces yellow slimy growth.

Mode of Spread and Survival

The bacterium remains viable in the soil as well as in infected canes. The primary transmission is through naturally affected diseased setts or through soil-borne contamination. The secondary spread may be through wind splashed rain, harvesting implements, animals and insects. The bacterium also perpetuates on maize, sorghum, cumbu and other weed hosts, which also serve as sources of inoculum.

Management

Remove and burn the affected clumps and the stubbles in the field. Select setts from disease free areas. Avoid growing collateral hosts like maize, sorghum and cumbu near the sugarcane fields.

Red stripe

Pseudomonas rubriligneans

Symptoms

The disease first makes its appearance on the basal part of the young leaves. The stripes appear as water soaked, long, narrow chlorotic streaks and become reddish brown in few days. These stripes are 0.5 to 1 mm in width and 5-100 mm in length, run parallel to the midrib. The stripes remain confined to lower half of the leaf lamina and whitish flakes spread to growing points of the shoot and yellowish stripes develop, which later turn reddish brown. The rotting may commence from the tip of the shoot and spread downwards. The core is discoloured to reddish brown and shrivelled form cavity in the centre. In badly affected field, a foul and nauseating smell is easily recognised.

Pathogen

The bacterium is a short rod (0.7 X 1.67µm), gram negative, non capsulate with a polar flagellum.

Favourable Conditions

Continuous ratooning and prolonged rainy weather with low temperature (25°C)

Mode of Spread and Survival

The pathogen remains viable in the soil and infected plant residues. The bacterium also survives on sorghum, cumbu, maize, ragi and other species of *Saccharum*. The bacterium primarily spreads through infected canes. The secondary spread is mainly through rainsplash, irrigation water and insects.

Management

Remove and destroy the infected clumps and stubbles in the field. Select setts from the healthy fields. Avoid growing collateral hosts near the sugarcane fields.

Mosaic

Sugarcane Mosaic Virus

Symptoms

The disease appears more prominently on the basal portion of the younger foliage as chlorotic or yellowish stripes alternate with normal green portion of the leaf. As infection becomes severe, chlorotic area considerably increases over the normal green area and yellow stripes appear on the leaf sheath and stalks. Elongated necrotic lesions are produced on the stalks and stem splitting occurs. The necrotic lesions also develop on the internodes and the entire plant becomes stunted and chlorotic.

Pathogen

Sugarcane mosaic virus is rod shaped, measuring 650-770 X 12-15µm. It belongs to Potato Virus Y group.

Mode of Spread and Survival

The virus is mainly transmitted through infected setts. The virus remains viable on several other hosts like *Zea mays*, *Sorghum vulgare*, *Pennisetum americanum*, *Eleusine indica*, *Setaria lutescens*, *Echinochloa crusgalli*, *Stenotaphrum secundatum*, *Digitaria didactyla* etc., which serve as potential sources of virus inoculum. The disease mainly spreads from other aphids viz., *Melanaphis sacchari* and *M. indoscchari* also help in the spread of the disease.

Management

Rogue out the diseased clumps periodically. Select setts from the healthy fields as the virus is sett-borne. Treat the setts in hot water as follows : 52°C for 20 minutes on the first day, 57.3°C for 20 minutes, on the second day and 57°C for 20 minutes on the third day or Aerated Steam Therapy (AST) at 56°C for 3 hrs.

Grassy shoot

Mycoplasma Like Organism (MLO)

Symptoms

The disease symptoms are usually seen two months after planting. The disease is characterised by the production of numerous lanky tillers from the base of the affected shoots. Leaves become pale yellow to completely chlorotic, thin and narrow. The plants appear bushy and 'grass like' due to reduction in the length of internodes premature and continuous tillering. The affected clumps are stunted and in many instances exhibit premature proliferation of axillary buds. Cane formation rarely occurs in the affected clumps and if formed, they are thin with shorter internodes having aerial roots at the lower nodes. The buds on such canes are usually papery and abnormally elongated.

Pathogen

MLO is found to present in the sieve cells of infected plants. Two types of bodies are noticed, spherical bodies of 300-400 nm diameter and filamentous bodies of 30-53 µm diameter.

Mode of Spread and Survival

The pathogen is transmitted by aphids viz., *Rhopalosiphum maidis*, *Melanaphis sacchari* and *M. indosacchari*. In addition, leaf hopper, *Proutista moesta* also involves in the transmission. Sorghum serves as a natural collateral host.

Management

Select setts from middle of the healthy fields or from the commercial seed nursery. Remove and burn the infected clumps periodically. Treat the setts before planting as

follows: Hot Water Treatment (HWT) at 50°C for 21/2 hr. Hot Air Treatment (HAT) at 54°C for 8 hr or Aerated Steam Therapy (AST) at 50°C for 1 hr or Moist Hot Air Treatment (MHAT) at 54°C for 2 hr.

Ratoon stunting Rickettsia Like Organism (RLO)

Symptoms

Diseased clumps usually display stunted growth, reduced tillering, thin stalks with shortened internodes and yellowish foliage. Orange-red vascular bundles in shades of yellow at the nodes are seen in the infected cane.

Pathogen

The RLO is known to present in the xylem cells of infected plants. They are small, thin, rod shaped or coryneform (0.15 to 0.32µm wide and 1.0-2.7µm long).

Mode of Spread and Survival

The disease spreads through use of diseased setts. The disease also spreads through harvesting implements contaminated with the juice of the diseased canes. Maize, sorghum, sudan grass and *Cynodon* are the some of the collateral hosts for the pathogen.

Management

Select the setts from disease free fields or from disease free commercial nursery. Remove and burn the clumps showing the disease incidence. Treat the setts before planting, as specified for grassy shoot disease.

Minor diseases

Damping-off	Pythium aphanidermatum P. debaryanum P. graminicola P. arrhenomanes and P. ultimum	Germinating seeds and young seedlings are attacked and killed in pre-emergence phase and seedlings show water soaked lesions at collar region, leading to withering and drying in post emergence stage.
Downy mildew	<i>Peronosclerospora sacchari</i>	Downy fungal growth with yellow stripes on upper surface, shredding of older leaves, rapid elongation of internodes of affected canes.
Eye spot	<i>Helminthosporium Sacchari</i>	The water soaked spot develops on leaves, later elongated and turns to form "eye" shaped spot with reddish brown centre surrounded by straw yellow tissues.

Ring spot	<i>Leptosphaeria sacchari</i>	The water soaked spots appear on leaves and turns to straw colour later surrounded by a thin reddish brown band and a diffused discolouration zone.
Leaf scald	<i>Xanthomonas albilineans</i>	Whitish lines appear on the leaves, run to the full length of leaves and sheaths. Later leaves wither and dry from tip down-wards, gives a scald appearance to the clump. Sprouting of lateral buds of the matured canes occurs in acropetal fashion.
Spike	Virus	Shortened internodes with reduced, stiff and crowded leaves, giving a "spike" like appearance. Vector : Melay bug - <i>Pseudococcus saccharifolii</i>
White leaf	<i>Mycoplasma Like Organism</i>	The plants exhibit pure white leaves, stripped leaves and mottled leaves. Vector : Leaf hopper- <i>Matsumuratettix hiroglyphicus</i>
Phanerogamic parasite	<i>Striga euphrasioides</i>	Partial root parasite.

TOBACCO (*Nicotiana tabacum*)

Damping off

Pythium aphanidermatum

Symptoms

The fungus may attack the seedling at any stage in the nursery. Sprouting seedlings are infected and wither before emergence from the soil (Pre-emergence damping off). Water soaked minute lesions appear on the stems near the soil surface, soon girdling the stem, spreading up and down in the stems and with in one or two days stem may rot leading to toppling over of the seedlings (Post-emergence damping off). The young seedlings in the nursery are killed in patches and infection spreads quickly. Under the favourable conditions, the entire seedlings in the nursery are killed within 3 to 4 days. A thick weft of mycelium may be seen on the surface of the soil.

Pathogen

The fungus produces thick, hyaline, thinwalled, non-septate mycelium. It produces irregularly lobed sporangia which germinate to produce vesicle containing zoospores. The zoospores are kidney shaped and biflagellate. Oospores spherical, light to deep yellow or yellowish brown coloured, measuring 17-19µm in diameter.

Favourable Conditions

Over crowding of seedling, ill drained nursery beds, heavy shade in nursery, high atmospheric humidity (90-100 per cent), high soil moisture, low temperature (below 24°C) and low soil temperature of about 20°C.

Mode of Spread and Survival

The fungus survives in the soil as oospores and chlamydospores. The primary infection is from the soil-borne fungal spores and secondary spread through sporangia and zoospores transmitted by wind and irrigation water.

Management

Prepare raised seed beds with adequate drainage facility. Burn the seed beds with paddy husk before sowing. Drench the seed bed with 1 per cent Bordeaux mixture or 0.2 per cent Copper oxychloride, two days before sowing. Avoid over crowding of seedlings by using recommended seed rate (1 to 1.5g/2.5m²).

Avoid excess watering of the seedlings. Spray the nursery beds two weeks after sowing with 1 per cent Bordeaux mixture or 0.2 per cent Copper oxychloride or 0.2 per cent Mancozeb and repeat subsequently at 4 days interval under dry weather and at 2 days interval under wet cloudy weather or spray 0.2 per cent Metalaxyl compound (Ridomil MZ) at 10 days interval commencing from 20 days after germination.

Black shank

Phytophthora parasitica var. *nicotianae*

Symptoms

The pathogen may affect the crop at any stage of its growth. Eventhough all parts are affected, the disease infects chiefly the roots and base of the stem. Seedlings in the nursery show black discolor of the stem near the soil level and blackening of roots, leading the wet rot in humid condition and seedling blight in dry weather with withering and drying of tips. The pathogen also spreads to the leaves and causes blighting and drying of the bottom leaves. In the transplanted crop, the disease appears as minute black spot on the stem, spreads along the stem to produce irregular black patches and often girdling occurs. The upward movement leads to development of necrotic patches on the stems. The infected tissues shrink, leaving a depression and in advanced condition the stem shrivels and plant wilts. When the affected stem is split open, the pith region is found to be dried up in disc-like plates showing black discolouration. On the leaves large brown concentrically zonate patches appear during humid weather, leading to blackening and rotting of the leaves.

Pathogen

The fungus produces hyaline and non-septate mycelium. The sporangia, which are hyaline, thin walled, ovate or pyriform with papillae, develop on the sporangiophores in a sympodial fashion. Sporangia germinate to release zoospores which are usually kidney shaped, biciliate and measure 11-13 x 8-9µm. The fungus also produces globose and thick walled chlamydospores, measuring 27-42µm in diameter. Oospores are thickwalled, globose, smooth and light yellow coloured, measuring 15-20µm in diameter.

Favourable Conditions

Frequent rainfall, high soil moisture and high population of rootknot nematodes *Meloidogyne incognita* var. *acrita*.

Mode of Spread and Survival

The fungus lives as a saprophyte on organic wastes and infected crop residues in soil. The fungus also presents in the soil as dormant mycelium, oospores and chlamydospores for more than 2 years. The primary infection is by means of oospores and chlamydospores in the soil. Secondary spread is by wind-borne sporangia. The pathogen in the soil spreads through irrigation water, transport of soil, farm implements and animals.

Management

Burn the seed beds with paddy husk or groundnut shell at 15-20 cm thick layer. Provide adequate drainage in the nursery. Drench the nursery beds with 1 per cent Bordeaux mixture or 0.2 per cent Copper oxychloride, two days before sowing. Spray the beds two weeks after sowing with 0.2 per cent Metalaxyl or 0.2 per cent Captafol or 0.2 per cent Copper oxychloride or 1 per cent Bordeaux mixture and repeat after 10 days. Select healthy, disease free seedlings for transplanting. Remove and destroy the affected plants in the field. Spray Mancozeb 1 kg or Copper oxychloride 1 kg or Ziram 1 lit/ha. Spot drench with 0.4 per cent Bordeaux mixture or 0.2 per cent Copper oxychloride.

Frog eye spot *Cercospora nicotianae*

Symptoms

The disease appears mostly on matured, lower leaves as small ashy grey spots with brown border. The typical spots have a white centre, surrounded in succession by grey and brown portions, surrounded by a dark brown to black margin, resembling the eyes of a frog. Under favourable conditions, several spots coalesce to form large necrotic areas, causing the leaf to dry up from the margin and wither prematurely. Both yield and quality are reduced greatly. The disease may occur in the seedlings also, leading to withering of leaves and death of the seedlings.

Pathogen

The mycelium is intercellular and collects beneath the epidermis and clusters of conidiophores emerge through stomata. The conidiophores are septate, dark brown at the base and lighter towards the top bearing 2-3 conidia. The conidia are hyaline, slender, slightly curved, thin-walled and 2-12 septate.

Favourable Conditions

Temperature of 20-30°C, high humidity (80-90 per cent), close spacing, frequent irrigation and excess application of nitrogenous fertilizers.

Mode of Spread and Survival

The fungus is seed-borne. The fungus also persists on crop residues in the soil. The primary infection is from the seed and soil-borne inoculum. The secondary spread is through wind-borne conidia.

Management

Remove and burn plant debris in the soil. Avoid excess nitrogenous fertilization. Adopt optimum spacing. Regulate irrigation frequency. Spray the crop with 0.4 per cent Bordeaux mixture or Thiophanate Methyl 750g/ha or Carbendazim 750 g/ha and repeat after 15 days.

Powdery mildew

Erysiphe cichoracearum var. *nicotianae*

Symptoms

Initially the disease appears as small, white isolated patches on the upper surface of the leaves. Later, it spreads fast and cover the entire lamina. The disease initially appears on the lower leaves and as disease advances, the rest of the leaves are also infected and sometimes powdery growth can be seen on the stem also. The affected leaves turn to brown and wither and show scorched appearance. The severe infection leads to defoliation and reduction in quantity and quality of the curable leaves.

Pathogen

The fungus is ecotophytic and produce hyaline, septate and highly branched mycelium. Short, stout and hyaline conidiophores arise from the mycelium and bear conidia in chains. The conidia are barrel shaped or cylindrical, hyaline and thin walled. Cleistothecia are black, spherical with no ostiole, with numerous densely-woven septate, brown-coloured appendages. They contain 10-15 asci which are ovate with a short stalk. Each ascus contains two ascospores which are oval to elliptical, thinwalled, hyaline and single celled.

Favourable Conditions

Humid cloudy weather, low temperature (16-23OC), close planting and excess doses of nitrogenous fertilizers.

Mode of Spread and Survival

The fungus remains dormant as mycelium and cleistothecia in the infected plant debris in soil. The primary infection is mainly from soil-borne inoculum. The secondary spread is aided by wind blown conidia.

Management

Apply balanced fertilizers. Avoid overcrowding of plants. Remove and destroy the affected leaves. Plant early in the season so that crop escapes the cool temperature at maturity phase. Apply Sulphur dust to the soil at 40kg/ha. (Mix 1 part of Sulphur with 3 parts of fine sand or ash and apply). Spray Dinocap at 375 ml or Carbendazim at 500g/ha.

Wild fire

Pseudomonas tabaci

Symptoms

The leaf spots may occur at any stage of plant growth including the nursery seedlings. Dark brown to black spots with a yellow halo spreads quickly causing withering and drying of leaves. In advanced cases, lesions develop on the young stem tissues leading to withering and drying of the seedlings. In the fields, initially numerous water soaked black spots appear and latter become angular when restricted by the veins and veinlets. Several spots may coalesce to cause necrotic patches on the leaves. In advanced conditions, the entire leaf is fully covered with enlarged spots with yellow haloes. The leaves slowly wither and dry. Under humid weather condition, the disease spreads very fast and cover all the leaves and the entire plant gives a blighted appearance.

Pathogen

The bacterium is a rod, motile with a single polar flagellum, non-capsulated, non-spore forming and Gram negative.

Favourable Conditions

Close planting, humid wet weather and strong winds.

Mode of Spread and Survival

The bacterium survives in the infected crop residues in the soil, which is the primary source of infection. The secondary spread of the pathogen in the field is through wind splashed rain water and implements.

Management

Remove and burn the infected crop residues in the soil. Avoid very close planting.

Mosaic Tobacco Mosaic Virus (TMV)

Symptoms

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

Pathogen

Tobacco mosaic is caused by *Nicotiana virus I (Marmor tabaci var. vulgare)*. It is a rod shaped particle measuring 300 X 150-180um with a central hollow tube of about 4um diameter. It is made up of centrally placed Ribo Nucleic Acid molecules (RNA) covered with a protein coat. It is capable of remaining infective when stored dry for over 50 years.

Mode of Spread and Survival

The virus remains viable in the plant debris in the soil. The virus has a wide host range, affecting nearly 50 plant species belonging to nine different families. The virus is sap-transmissible and enters the host through wounds. The virus is not seed-transmitted in tobacco but tomato seeds transmit the virus. In the field, the virus is transmitted by contact. The farm workers engaged in topping and clipping operations transmit it through their dresses. The implements used in the field also transmit the virus.

Management

Remove and destroy infected plants. Keep the field free of weeds which harbour the virus. Wash hands with soap and running water before or after handling the plants or after weeding. Prohibit smoking, chewing and snuffing during field operations. Spray the nursery and main field with leaf extracts of *Bougainvillea* or *Basella alba* at 1 litre of extract in 150 litres of water, two to three times at weekly intervals. Adopt crop rotation by growing non-host plants for two seasons. Grow resistant varieties like TMV RR2, TMV RR 2a and TMV RR3.

Leaf curl Nicotiana Virus 10 (*Ruga tabaci*)

Symptoms

The virus may attack the plant at any stage. When young plants are infected the entire plant remains very much dwarfed. Three forms of leaf curl expression are observed. The leaf margins curl downward towards the dorsal side and show thickening of veins with enation on the lower surface. Crinkle form shows curling of whole leaf edge towards dorsal side with enation on the veins and the lamina arching towards the ventral side between the veinlets. The transparent symptom shows the curling of leaves towards the ventral side with clearing of the veins and enations are absent.

Pathogen

The virus is spherical and measuring 35um in diameter. The virus is Nicotiana virus 10 or Ruga tabaci.

Mode of Spread and Survival

The virus has wide host range of 63 crops species belonging to fourteen families. The virus is not transmissible through sap or seed. It is graft-transmissible. The whitefly, *Bemisia tabaci* is the vector responsible for transmission in the field.

Management

Remove and destroy the infected plants. Rogue out the reservoir weed hosts which harbour the virus and whiteflies. Avoid growing solanaceous crops like tomato near tobacco fields. Spray Methyldemeton at 0.1 to 0.2 per cent to control the vectors.

Phanerogamic parasite

Broom rape

Orobanche cernua var. *desertorum*

Symptoms

The affected tobacco plants are stunted and show withering and drooping of leaves to wilting. These are the indicates of underground parasitism of the tobacco roots by the parasite. The young shoot of the parasite emerges from the soil at the base of the plants 5-6 weeks after transplanting. Normally, it appears on clusters of 50-100 shoots around the base of a single tobacco plant. The plants which are attacked very late exhibit no external symptoms but the quality and yield of leaves are reduced.

Parasite

It is a total root parasite. It is an annual, fleshy flowering plant with a short, stout stem, 10-15 inches long. The stem is pale yellow or brownish red in colour and covered by small, thin, brown scaly leaves and the base of the stem is thickened. White-coloured flowers appear in the leaf axils. The floral parts are well developed with a lobed calyx, tubular corolla, superior ovary, numerous ovules and a large four-lobed stigma. The fruits are capsules containing small, black, reticulate and ovoid seeds.

Mode of Spread and Survival

The seeds of the parasite remain dormant in the soil for several years. Primary infection occurs from the seeds in the soil. The seeds spread from field to field by irrigation water, animals, human beings and implements. The dormant seeds are stimulated to germinate by the root exudates of tobacco and attaches itself to the roots by forming haustoria. Later, it grows rapidly to produce shoot and flowers. *Orobanche* also attacks the crops like brinjal, tomato, cauliflower, turnip and other cruciferous crops.

Management

Rogue out the tender shoots of the parasite before flowering and seed set. Spray the soil with 25 per cent Copper sulphate. Spray 0.1 per cent Allyl alcohol. Apply few drops of kerosene directly on the shoot. Grow decoy or trap crops like chilli, motherbean, sorghum or cowpea to stimulate seed germination and kill the parasite.

Minor diseases

Brown spot	<i>Alternaria longipes</i>	Small dark brown spots appear and enlarge in size with concentric rings. Several spots coalesce to cause large irregular spots leading to drying of leaves.
Anthrachnose	<i>Colletotrichum tabacum</i>	Small brown spots initially develop and enlarge to form black depressed spots with dark brown margin with numerous black dots in the centre.

BETELVINE (*Piper betle*)

Foot rot or Leaf rot or wilt

Phytophthora parasitica var. *piperina*

Symptoms

The fungus attacks the vines at all stages of crop growth. Initial symptom is sudden wilting of vines. The affected vines show yellowing and drooping of the leaves from tip downwards. The leaves become dull due to loss of lustre. The affected plant dry up completely within 2 or 3 days. The succulent stem turns brown, brittle and dry as stick. The lower portion of the stem near the soil level shows irregular black lesions upto second or third internode. The diseased internodes undergo 'wet rot' and the tissue become soft, slimy with a fishy odour. The roots of the affected plants also show extensive discolouration and rotting.

In the young crop, the fungus produces 'Leaf rot' symptoms. The leaves near the soil region show circular to irregular water soaked spots, often starting from the edge. The spots rapidly enlarge and cover a part or whole of the leaf blade, which shows rotting. The leaves turn brown to dark brown or dirty black and defoliation occurs. The leaves with in 2-3 feet height of the vine show the leaf rot symptom.

Pathogen

The fungus produces hyaline, non septate mycelium. The sporangia are thinwalled, hyaline ovate or pear shaped with papillae, measuring 30-40 X 15-20um. Zoospores, which are liberated from the sporangia, are kidney-shaped and biflagellate. Oospores are dark brown, globose and thick walled.

Favourable Conditions

September to February months with high atmospheric humidity and low night temperature (23°C and below) are highly favourable.

Mode of Spread and Survival

The fungus is soil-borne and survives as facultative saprophyte in the infected plant debris and in the soil as oospores and chlamydospores. The fungus mainly spreads from field to field through irrigation water. The secondary spread is through sporangia and zoospores disseminated by splash irrigation and wind-borne rains.

Management

Select well matured (more one year old) seed vines from fields. Soak the seed vines in Streptocycline 500 ppm + Bordeaux mixture 0.05 per cent solution for 30 minutes. Apply 150 kg N/ha/year through neemcake (75 kg N) and 100 kg P₂O₅ through Super phosphate and 50 kg Muriate of potash in 3 split doses, first at 15 days after lifting the vines and second and third dose at 40-45 days interval. Apply shade dried Neem leaf or *Calotrophis* leaves at 2t/ha in 2 split doses and cover it with mud. Collect and destroy the infected vines and leaves. Regulate irrigation during the cold weather period. Drench the soil with 0.5 per cent Bordeaux mixture at 500 ml/hill during the cool weather period (October-January) at monthly intervals.

Sclerotium foot rot and wilt

Sclerotium rolfsii

Symptoms

The vines of all stages are susceptible to the disease. The infection usually starts at the collar region. Whitish cottony mycelium is seen on the stem and roots. The stem portion shows rotting of tissues at the point of attack and the plants show dropping of leaves and withering finally dry up.

Pathogen

The fungus produces white to grey mycelium which have profuse branching. Sclerotia are spherical smooth and shiny. Brown coloured mustard like sclerotia are seen on the infected stem and soil near the vines.

Favourable Conditions

May-July months with high temperature of 28-30°C

Mode of Spread and Survival

The fungus is soil-borne and grows saprophytically in the dead plant tissue in soil. The fungus also survives as sclerotia in the infected plant debris in the soil for more than one year. The sclerotia spread through irrigation water. The pathogen also survives on other hosts like chilli groundnut and brinjal.

Management

Remove the affected vines along with the roots and burn. Apply more of soil amendments like neemcake, mustard cake or farmyard manure. Drench the soil with 0.1 per cent Carbendazim.

Powdery mildew

Oidium piperis

Symptoms

The disease affects the crop at all stages of its growth and infection is mainly noticed on tender shoots and leaves. Whitish powdery growth is seen on both the surface of leaves which later enlarges and cover the major portion of the leaves. The affected tender shoots and buds are deformed and shrivelled and margins of leaves turn inwards. When the disease advances, the whitish growth turns to brown blotches and in severe cases, the leaves turn yellow and defoliation occurs.

Pathogen

The fungus is ectophytic and produces profusely branched, hyaline and septate hyphae on the surface of the leaves. The conidiophores are short, club shaped, non-septate and hyaline and produce conidia in chains. Conidia are single celled, hyaline elliptical, and borne over short conidiophore.

Favourable Conditions

Dry humid weather during the months of May-July.

Mode of Spread and Survival

The fungus survives in the infected crop residues in the soil. The primary infection is from soil-borne inoculum. The secondary spread in the field is through wind-borne conidia and carried through splash irrigation.

Management

Collect and burn the infected leaves. Spray 0.2 per cent Wettable Sulphur or dust Sulphur at 25 kg/ha after plucking the leaves.

Anthraxnose
(*Colletotrichum piperis*)

Symptoms

The leaves show small black circular spots initially which later enlarge and develop to a size of 2 cm in size, become concentric and covered with a yellow halo. The affected leaves turn pale yellow and dry up with large black dots in the centre of the spots. Black, circular lesions may develop on the stem, enlarge rapidly and girdle the stem resulting in withering and drying.

Pathogen

The fungus produces large number of acervuli containing short, hyaline conidiophores and black coloured setae. The conidia are single celled, hyaline and falcate.

Mode of Spread and Survival

The fungus remain in the infected plant debris in the field. The primary infection is through the soil-borne conidia, spread by rainwater splash or splash irrigation. The secondary spread in the field is aided by air-borne conidia.

Management

Collect and destroy the infected vines and leaves. Spray 0.2 per cent Ziram or 0.5 per cent Bordeaux mixture after plucking the leaves.

Bacterial leaf spot or stem rot
Xanthomonas campestris p.v. *betlicola*

Symptoms

The disease initiates as tiny, brown water soaked specks on the leaves surrounded by a yellow halo, which enlarge later and become necrotic and angular, mostly confined to interveinal areas. The infected leaves lose their lustre, turn yellow, show withering and fall off. Under wet weather condition, infection spreads to stem showing small elongated black lesions on lower nodes and inter nodes. These lesions increase in size in both directions and blackening may spread to the length of several nodes. The stem tissues become weak and break easily at the infected nodes and the vine shows withering and drying.

Pathogen

Bacterium is a small rod with a single polar flagellum. It is Gram negative and non-spore forming.

Favourable Conditions

Cloudy weather with intermittent rains and high relative humidity. Two to three years old vines are highly susceptible.

Mode of Spread and Survival

The bacteria which are viable in the infected vines and leaves serve as a primary source of inoculum. Rain splashes and splash irrigation water help in the secondary spread.

Management

Remove and burn the infected vines and stubbles in the field. Regulate irrigation during cold weather season. Spray Streptocycline 400 ppm+Bordeaux mixture 0.25 per cent at 20 days intervals, after plucking the leaves.

Minor diseases

Alternate leaf spot	<i>Alternaria alternata</i>	Irregular brown spots appear near the petiole region of leaves, enlarge slowly become concentric and cause drying of leaves.
Tip burn	Physiological disease (High temperature)	The tip of the leaves shows browning and extends slowly along the margin and towards midrib causing blighting of leaves.