1. Diseases of Rice

Fungal Diseases

Blast-*Pyriculariaoryzae*(Syn:*P.grisea*)(Sexualstage:*Magnaporthegrisea*)

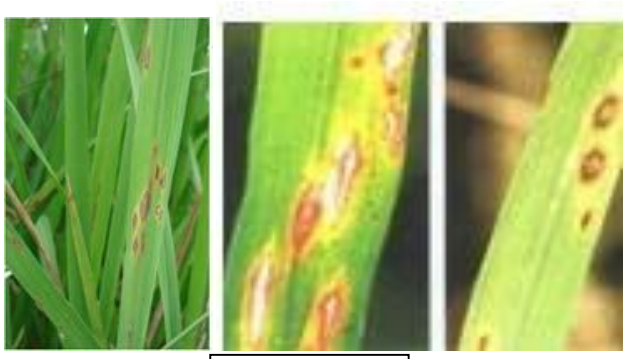
Symptoms

The fungus attacks the crop at all stages of crop growth. Symptomsappear on leaves, nodes, rachis, and glumes. On the leaves, the lesionsappear as small bluish green flecks, which enlarge under moist weatherto form the characteristic spindle shapedspots with grey centre and dark brown margin **(Leaf blast).**

The spots coalesceas the disease progresses and large areas of the leaves dry up and wither. Spots also appear on sheath. Severely infected nursery and field appear as burnt. Black lesionsappear on nodes girdling them. The affected nodes may break up and all the plant parts above the infected nodes may die **(nodal blast).**

During flower emergence, the fungus attacks the peduncle and the lesion turns to brownish-black which is referred to as rotten neck / neck rot / panicle blast **(neck blast**).

In early neck infection, grain filling does not occur while in late infection, partial grain filling occurs. Small brown to black spots may also be observed on glumes of the heavily infected panicles. The pathogen causes yield losses ranging from 30-61 per cent depending upon the stages of infection.

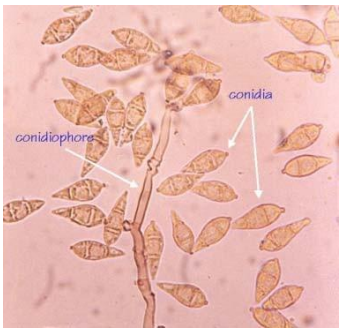


Leafblast

Pathogen

The mycelium is hyaline to olivaceous and septate. Conidiaare produced in clusters on long septate, olivaceousconidiophores. Conidia are pyriformto ellipsoid, attached at the broader basebyahilum.Conidiaarehyalinetopaleolivegreen,usually3celled.Theperfectstateofthe

fungusis*M.grisea*producingperithecia.Theascosporesarehyaline,fusiform,4celledand slightly curved.



ConidiaandConidiophore of *P. grisea*

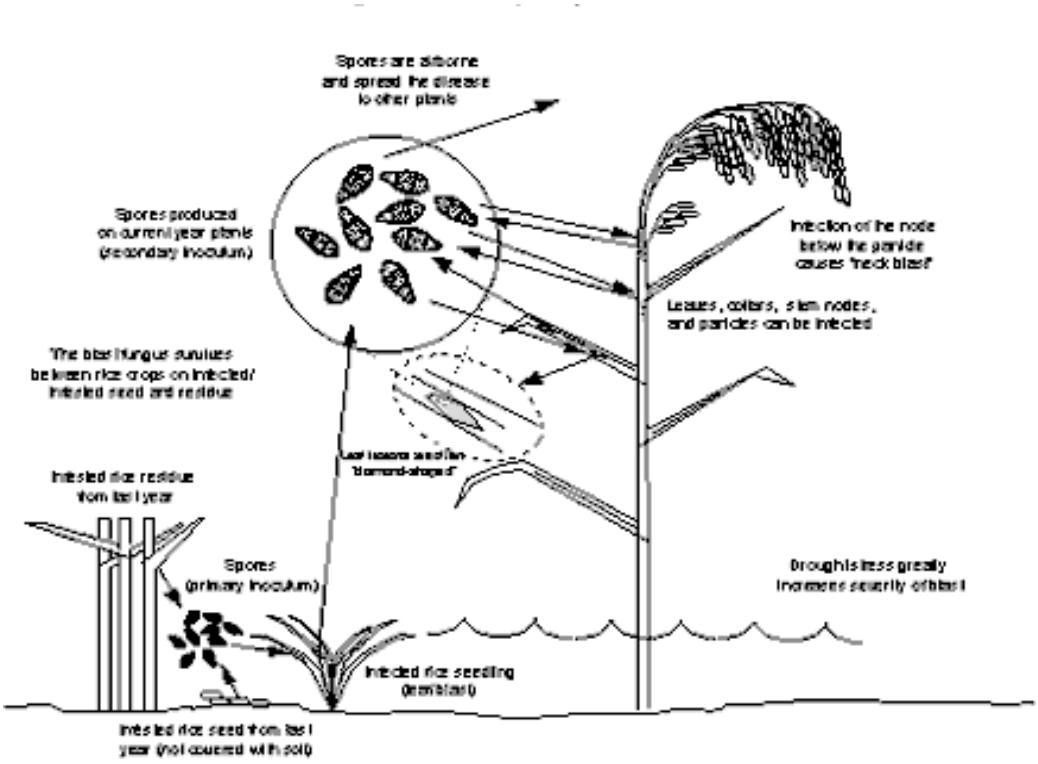
FavourableConditions

- Intermittent drizzles, cloudy weather, more of rainy days, longer duration of dew high relative humidity (93-99 per cent).
- Low night temperature (between 15-20˚C or less than 26˚C).
- Aavailability ofcollateral hostsand excess dose of nitrogen.

Forecastforriceblastcanbemadeonthebasisofminimumnighttemperature rangeof20-26˚Cinassociationwithahighrelativehumidityof90percentandabovelastingfor aperiodofaweekormoreduringanyofthethreesusceptiblephasesofcropgrowth,viz., seedlingstage,posttransplantingtilleringstageandneckemergencestage.InJapan,thefirstleaf blast forecasting model was developed named as BLAST. Later several other models have alsobeen developed namely, PYRICULARIA, PYRIVIEW, BLASTAM, EPIBLAand PBLAST. **Disease Cycle**

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 major sources of inoculum. Irrigation water may carry the conidia to different fields.The fungus also survives on collateral hosts*viz.*, *Panicum repens*, *Digitaria marginata*, *Brachiariamutica*, *Leersiahexandra*and *Echinochloacrusgalli*.

Spores land on leaves, germinate, penetrate the leaf, and cause a lesion 4 days later; more spores are produced in as little as 6 days. Infections from spores arriving from a distance are termed primary infections.



Primary infections generally result in a few widely scattered spots on leaves. Spores arising from the primary infections are capable of causing many more infections. This cycling is called secondary spread. Secondary spread is responsible for the severe epidemics of blast in fields and localized areas.

Management

- Grow resistant to moderately resistant varieties CO47, IR 20, ADT36, ADT39, ASD 18 and IR64. Avoid cultivation of highly susceptible varieties *viz.,* IR50 and TKM6 in disease favourable season.
- Remove and destory the weed hosts in the field bunds and channels.
- Treat the seeds with Captanor Thiramor Carbendazimor Tricyclazoleat 2 g/kg. or *Pseudomonas fluorescens*@ 10g/kg of seed. Spray the nursery with carbendazim 500mg/L or tricyclazole 300mg/L.

- Spray the main field with Edifenphos500 ml or Carbendazim500 g or Tricyclazole500g or Iprobenphos(IBP) 500 ml /ha.

BrownSpot - *Helminthosporiumoryzae*(*Syn: Drechsleraoryzae; Bipolarisoryzae*)

(Sexual stage:*Cochliobolusmiyabeanus*)

Symptoms

The fungus attacks the crop from seedling to milky stage inmainfield. Symptoms appear asminutespotsonthecoleoptile,leafblade,leafsheath,andglume,beingmostprominentonthe leaf blade and glumes.

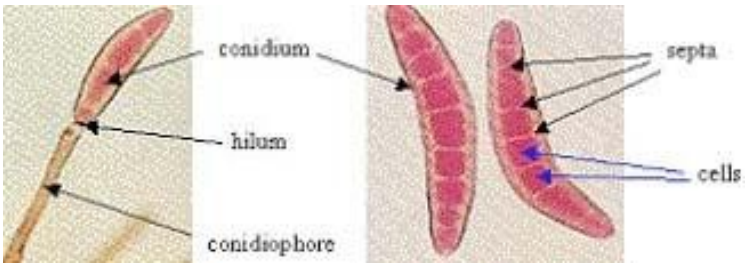
Leaf symptoms

Glume infection

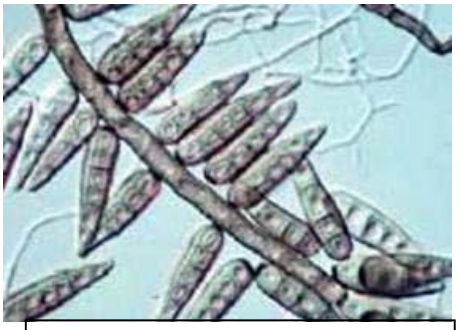
The spotsbecomecylindrical or oval, dark brown with yellow halolater becoming circular. Several spots coalesce and the leaf dries up. The seedlings die and affected nurseriescan be often recognised from a distance by scorched appearance. Dark brown or black spots also appear on glumes leading to grain discoloration. It causes failure of seed germination, seedling mortality and reduces the grain quality and weight.

Pathogen

*Bipolaris oryzae*produces brown septate mycelium. Conidiophoresarise singly or in small groups. They are geniculate, brown in colour. Conidiaare usually curved with a bulged center and tapered ends. They are pale to golden brown in colour and are 6-14 septate. The perfect stage of the fungus is *C. miyabeanus.*



Itproducesperithecia withascicontaining6-15septate,filamentousorlongcylinderical, hyaline to pale olive green ascospores. The fungus produces 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.



Coidia and Conidiophore

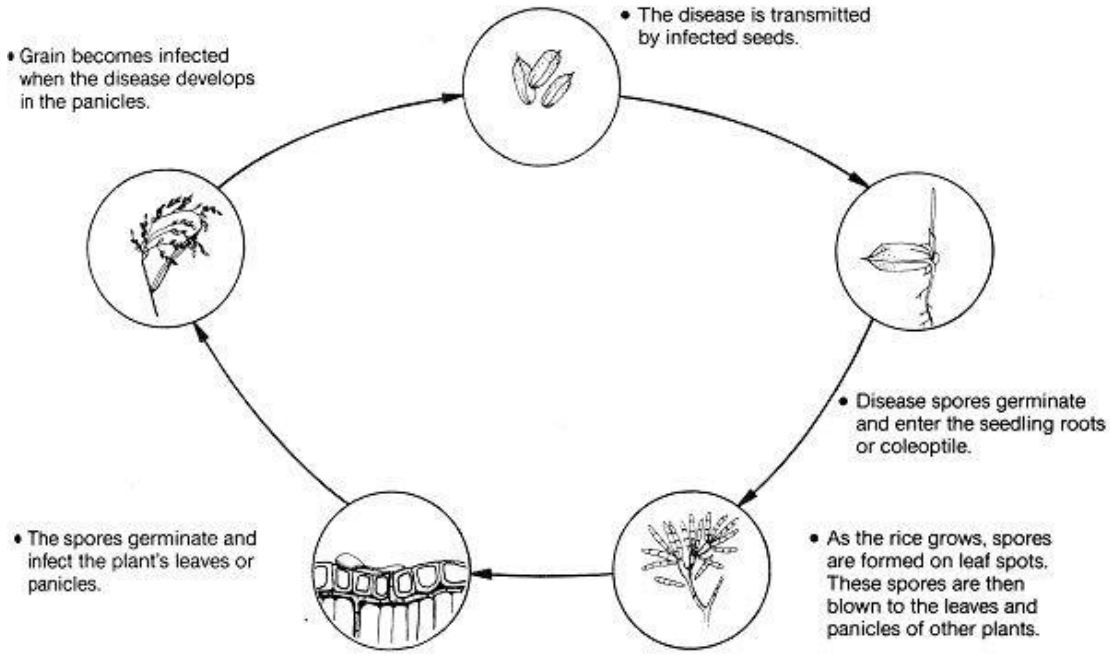
FavourableConditions

- Temperature of 25-30˚Cwithrelativehumidityabove80percentarehighlyfavourable.
- Excess of nitrogen aggravates the disease severity.

Disease Cycle

Infected seeds and stubbles are the most common source of primary infection.

Theconidiapresentoninfectedgrainandmyceliumintheinfectedtissueareviablefor2to3 years. Airborne conidia infect the plants both in nursery and in main field.



The fungus also survives on collateral hosts like *Leersiahexandra*and *Echinochloacolonum*. The brown spot fungus is normally present in areas with a long history of rice culture. Airbornesporesthatarecapableofcausinginfectionareproducedininfesteddebrisand older lesions.

Management

- Field sanitation-removal of collateral hostsand infected debris from the field.
- Useofslowreleasenitrogenousfertilizersisadvisable.
- Grow tolerant varieties*viz.*, Co44 and Bhavani.
- Use disease free seeds.
- Treat the seeds with Thiramor Captanat 4 g/kg. Spray the nursery with Edifenphos40ml or Mancozeb80 g for 20 cent nursery.
- SpraythecropinthemainfieldwithEdifenphos500mlorMancozeb2kg/hawhen grade reaches 3. If needed repeat after 15 days.

Narrowbrownleafspot-*Cercosporajanseana*(Sexualstage:*Sphaerulinaoryzina*) Symptoms

Thefungusproducesshort,linearbrownspotsmostlyonleavesandalsoonsheaths, pedicels and glumes. The spots appear in large numbers during later stages of crop growth.

Symptoms

Pathogen

Conidiophoresare produced in groups and brown in colour. Conidiaare hyaline or subhyaline, cylindrical and 3-5 septate.

Management

Spray Carbendazim500 g or Mancozeb2 kg/ha.

Sheath rot -*Sarocladium oryzae (Syn: Acrocylindriumoryzae)*

Symptoms

Initial symptoms are noticed only on the upper most leaf sheath enclosing youngpanicles. 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 paniclesremain within the sheath or emerge partially. The panicles rotand abundant whitish powdery fungal growth is seen inside the leaf sheath.

Symptoms

Pathogen

The fungus produces whitish, sparsely branched, septate mycelium. Conidiaare hyaline, smooth, single celled and cylindrical in shape.

FavourableConditions

- Closer planting
- High doses of nitrogen
- Highhumidityandtemperaturearound25-30˚C
- Injuries made by leaf folder, brown plant hopper and mites increase infection

Disease Cycle

The disease spreads mainly through air-borne conidiaand also seed-borne. Primary source of inoculumis by means of infected plant debris. Secondary spread is by means of air borne conidia produced on the leaf sheath.

Management

- Spray Carbendazim500g or Edifenphos1L or Mancozeb2 kg/ha at boot leaf stage and15 days later.
- Soil application ofgypsum(500 kg/ha) in two splits.
- Application of Neem Seed Kernal Extract(NSKE) 5% or neem oil 3 % or Ipomoeaor Prosopisleaf powder extract 25 Kg/ha. First spray at boot leaf stage and second 15 days later.

Sheathblight-*Rhizoctoniasolani*(Sexualstage:*Thanetophoruscucumeris*)

Symptoms

The fungus affects the crop from tilleringto heading stage. Initial symptoms are noticed on leaf sheaths near water level. On the leaf sheath oval or ellipticalor irregular greenish grey spots are formed. As the spots enlarge, the centre becomes greyish white with an irregular blackish brown or purple brown border.

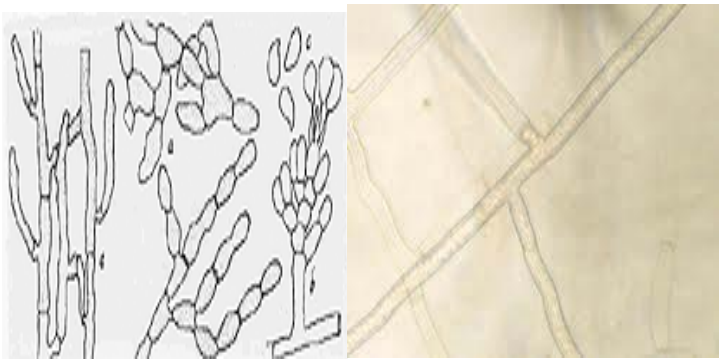
Lesionson the upper parts of plants extend rapidly coalesing with each other to cover entire tillers from the water line to the flag leaf. The presence of several large lesions on a leaf sheath usually causes death of the whole leaf, and in severe cases all the leaves of a plant may be blighted

Symptoms

The infection extends to the inner sheaths resulting in death of the entire plant. Older plantsarehighlysusceptible.Plantsheavilyinfectedintheearlyheadingandgrainfillinggrowth stages produce poorly filled grain, especially in the lower part of the panicle.

Pathogen

The fungus produces septate mycelium which are hyaline when young, yellowish brown when old. It produces large number of spherical brown sclerotia.

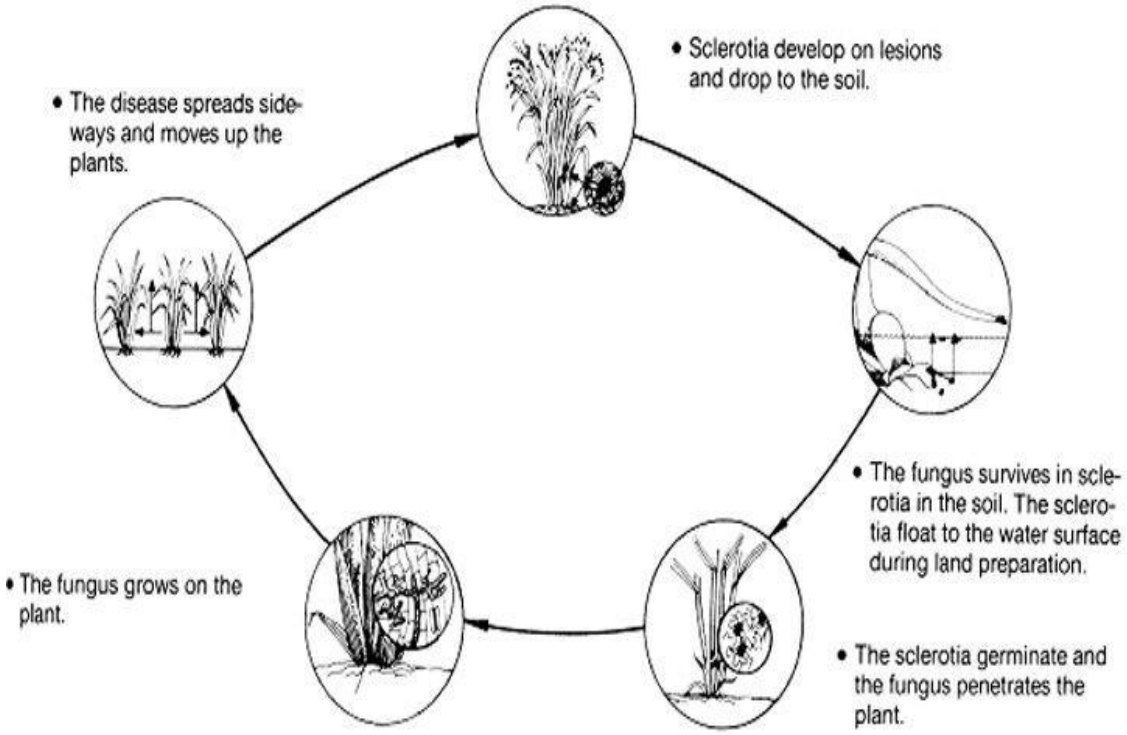


FavourableConditions

- High relative humidity (96-97 per cent), high temperature (30-32˚C).
- Closer planting.
- Heavy doses of nitrogenous fertilizers.

Disease cycle

Thepathogencansurviveassclerotiaormyceliumindrysoilforabout20monthsbutfor 5-8 months in moist soil. Sclerotia spread through irrigation water. The fungus has a wide host range.



Management

- Grow resistant varieties like Mansarovar, Swarau Dhan, Pankaj etc.
- Applyorganicamendmentsviz.,neemcake@150Kg/haorFYM12.5tons/ha.Avoid flow of irrigation water from infected fields to healthy fields.
- Deepploughingin summer and burning of stubbles.
- SprayCarbendazim500 g/ha
- Soil application of *P.fluorescens*@ of 2.5 kg/ha after 30 days of transplanting (productshould be mixed with 50 kg of FYM/Sand and applied).
- Foliar spray *P.fluorescens*at0.2%atbootleafstageand10dayslater

Falsesmut -*Ustilaginoidea virens*(Syn: *Clavicepsoryzae-sativa)*

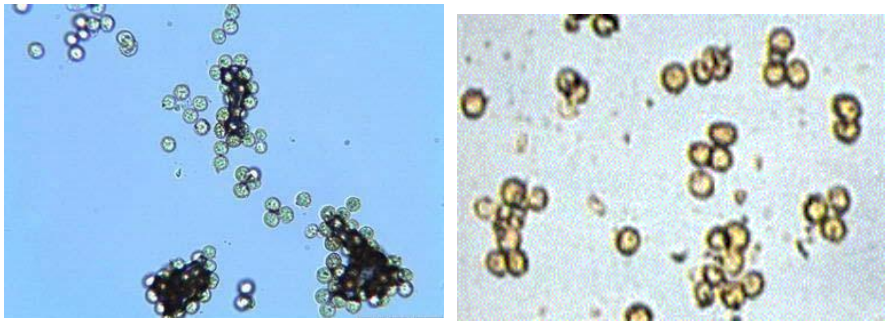
Symptoms

Thefungustransformsindividualovaries/grainsintogreenishsporeballsof_velvetty appearance. Only a few spikeletsin a panicle are affected.

Symptoms

Pathogen

Chlamydosporesareformedassporeballswhicharesphericaltoelliptical,wartyand olivaceous.



Spore balls

Disease Cycle

Grasses and wild rice species are alternate hosts. The main source of inoculum is air-bornespores. Ascosporesproduced from sclerotiaact as primary source of infection while chalmydosporesare secondary source of infection. Chlamydosporesare air - borne, abundant at heading stage.

Favorable conditions

- Rainfall and cloudy weather during flowering and maturity

Udbattadisease-*Ephelisoryzae*(Sexualstage:*Balansiaoryzae-sativa)*

Symptoms

Symptoms appear at the time of panicle emergence. The entire ear head is converted into a straight compact cylindricalblack spikelike structure since the infected panicle is matted together by the fungal mycelium. The spikelets are cemented to the central rachis and the size is remarkably reduced. The entire spike is covered by greyish stromawith convex pycnidiaimmersed inside.

Pathogen **Symptoms**

Pycnidiosporesarehyaline,needleshapedand4-5celled.

Management

- Thepathogenisinternallyseedborne.
- Hotwater seed treatment at 45˚Cfor10min.effectivelycontrolsthedisease.
- Removal of collateral hosts*Isachne elegans*, *Eragrostis tenuifolia*and*Cynadondactylon.*

Stackburndisease-Trichoconis***padwickii*****(Syn:***Alternaria***padwickii*****)**

Symptoms

Leaves and ripening grains are affected. On leaves circular to ovalspots with dark brown margins are formed. The center of the spot turns light brown or white with numerous minutedots. On the glumesreddish brown spots appear. The kernelsmay shrivelland become brittle.

Symptoms

Pathogen

Conidiareelongatedwithalongbeakatthetip,3to5septate,thickwalledand constrictedat the septa.

Management

- Treat the seeds withThiramor Captanor Mancozebat 2g/kg.
- Hotwater treatment at 54˚Cfor15minutesisalsoeffective.
- Burn the stubbles and straw in the field.

Bunt or Kernel Smut or black smut - *Tilletiabarclayana*

Minute black pustulesor streaksare formed on 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 chlamydosporesfor one or more years under normal condition and 3 years in stored grains.

Stem rot – *Sclerotium oryzae*(Sexual stage:*Magnaporthesalvinii*)

Symptoms

Small black lesions are formed on the outer leaf sheathand they enlarge and reach the inner leaf sheath also. The affected tissues rot and abundant small black sclerotiaare seen in the rotting tissues. The culmcollapses and plants lodge. The sclerotiaare carried in stubbles after harvest.

Symptoms

Pathogen

Whitetogreyishhyphae,sphericalblackandshinysclerotia,visibletonakedeyesas black masses.

FavourableConditions

- Infestationof leaf hoppers and stem borer.
- High doses of nitrogenous fertilizers.

Disease Cycle

The sclerotiasurvive in stubbles and strawthose are carried through irrigation water. The fungus over winters and survives for long periods as sclerotia in the upper layers (2-3 inches) of the soil profile. The half-life of sclerotiain the field is about 2 years. Viable sclerotia have been found in fields for up to 6 years after a rice crop. The sclerotia are buoyantand floatto the surface of floodwater where they contact, germinate, and infect rice tillers near the water line.

Management

- Deep ploughing in summer and burning stubbles to eliminatesclerotia.

- Useofbalancedapplicationoffertilizer.
- Avoid flow of irrigation water from infected to healthy fields.
- Draining irrigation water and letting soil to dry.

Foot rot or Bakanae disease - *Fusarium moniliforme*(Sexual stage:*Gibberellafujikuroi*)

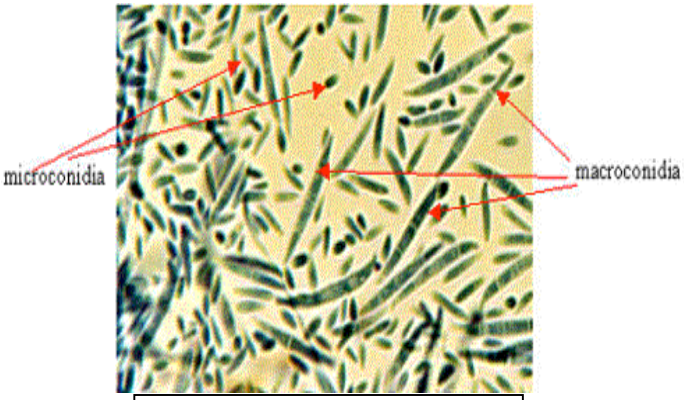
Symptoms

Infected seedlings in nursery are lean and lanky, much taller and die after some time. In the main field, the affected plants have tall lanky tillers with 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.

Symptoms

Pathogen

Fungus produces both macroconidiaand microconidia. Microconidia are hyaline, single celledandoval.Macroconidiareslightlysickleshaped,andtwotofivecelled.Thefungus produces the phytotoxin, fusaric acid, which is non-host specific.



Micro and macro conidia

Management

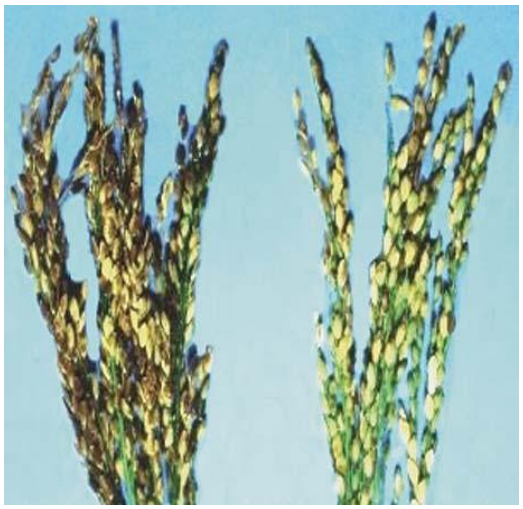
- The fungus is externally seed-borne.
- Treat the seeds withThiramor Captanor Carbendazimat 2 g/kg.

Grain discolouration - *Drechslera oryzae*, *D. rostratum*, *D.tetramera*, *Curvularialunata*, *Trichoconispadwickii*, *Sarocladium oryzae*, *Alternaria tenuis*, *Fusarium moniliforme*, *Cladosporium herbarum*, *Epicoccumpurpurascens*,*Cephalosporium sp.*,*Phoma sp.*, *Nigrospora*sp.

Symptoms

The grains may be infected by various organisms before or after harvesting causing discoloration, 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 discoloration 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.



Symptoms

FavourableConditions

- High humidity and cloudy weather during heading stage

Disease cycle

The disease spreads mainly through air-borne conidiaand the fungus survives as parasiteand saprophytein the infected grains, plant debris and also on other crop debris.

Management

- Preandpost-harvestmeasuresshouldbetakenintoaccountforpreventionofgrain discolouration.
- Spraythecropatbootleafstageandat50%floweringwithCarbendazim+Mancozeb(1:1) @ 0.2%.
- Store the grains with 13.5-14% moisture content.

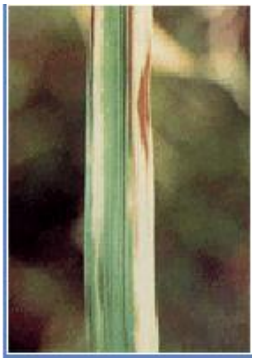
Bacterial Disesases

Bacterialleafblight- ***Xanthomonas oryzae pv. oryzae***

Symptoms

The disease is usually noticed at the time of heading but it can occur earlier also. Seedlings in the nursery show circular, yellow spots in the margin, that enlarge, coalesce leading to drying of foliage. **"Kresek"**symptom is seen in seedlings, 1-2 weeks after transplanting. The bacteria enter through the cut wounds in the leaf tips, become systemic and cause death of entire seedling.

Kreseksymptom



Leaf blight symptom

In grown up plants water soaked, translucent lesions appear near the leaf margin. The lesionsenlarge both in length and width with a wavy margin and turn straw yellow within a few days, covering the entire leaf. As the disease advances, the lesions cover the entire lamina which turns white or straw coloured. Milky or opaquedew drops containing bacterial masses areformed on young lesions in the early morning. They dry up on the surface leaving a white encrustation. The affected grains have discoloured spots. If the cut end of leaf is dipped in water, it becomes turbid because of bacterial ooze.

Pathogen

The bacterium is aerobic, gram negative, non spore forming, rod with size ranging from 1-2 x 0.8-1.0µm with monotrichouspolar flagellum. Bacterial colonies are circular, convex with entire margins, whitish yellow to straw yellow colored and opaque.

Bacterium

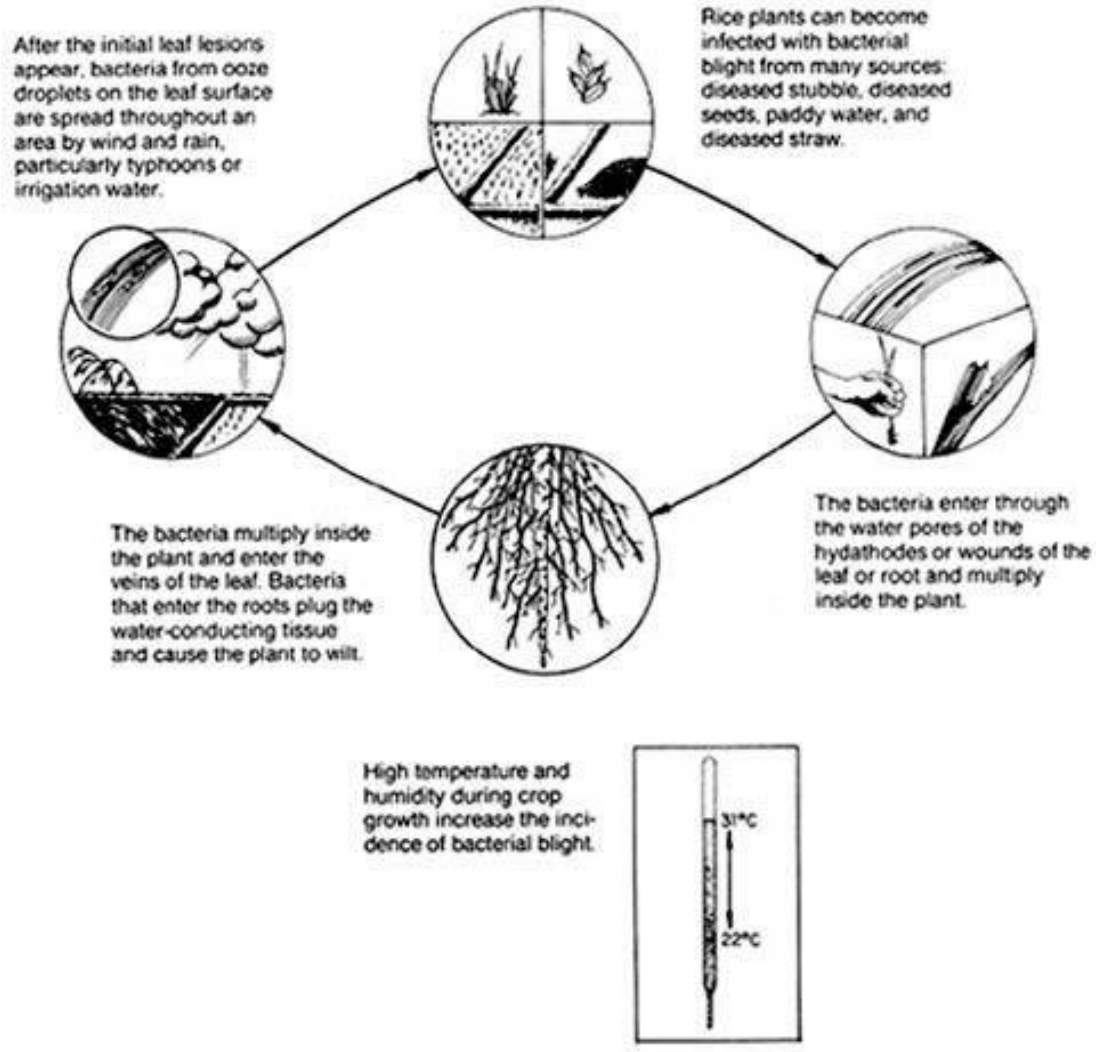
Favorable Conditions

- Clipping of tip of the seedling at the time of transplanting

- Heavy rain, heavy dew, flooding, deep irrigation water
- Severe wind and temperature of 25-30 C
- Application of excessive nitrogen, especially late top dressing

Disease Cycle

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 *Leersia*spp., *Plantago najor*, *Paspalum dictum*, and *Cyanodondactylon*. The pathogen spreads through irrigation water and also through rain storms.



Management

- Burnthestubbles.
- Use optimum dose of fertilizers.
- Avoid clipping of tip of seedling at the time of transplanting.
- Avoidfloodedconditions.Removeweedhosts.
- GrowresistantcultivarsIR20andTKM6.
- SprayStreptomycin_sulphateandtetracyclinecombination300g+Copperoxychloride 1.25 Kg/ha.

Bacterialleafstreak-*Xanthomonas oryzae pv. oryzicola*

Symptoms

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

Management

- Burnthestubbles.
- Use optimum dose of fertilizers.
- Avoid clipping of tip of seedling at the time of transplanting.
- Avoidfloodedconditions.
- Removeweedhosts.GrowresistantcultivarsIR20andTKM6.
- SprayStreptomycinsulphateandtetracyclinecombination300g+Copperoxychloride 1.25 Kg/ha.

Viral Diseases

RiceTungroDisease(RTD)-*Ricetungrobacilliformvirus*(RTBV)and*Ricetungrosphericalvirus*(RTSV)

Symptoms

Infection occurs both in the nursery and main field. Plants are markedly stunted. Leaves show yellow to orange discoloration and interveinal chlorosis. Young leaves are sometimes mottledwhilerustyspotsappearonolderleaves.Tilleringisreducedwithpoorrootsystem.

Paniclesnotformedinveryearlyinfection,ifformed,remainsmallwithfew,deformedand chaffy grains.

Symptoms

Pathogen

Two morphologically unrelated viruses present in phloem cells. Rice tungro bacilliformvirus (RTBV) bacilliform capsid, circular ds DNAgenome and Rice tungro spherical virus(RTSV)isometric capsid ss RNAgenome.

Disease Cycle

Transmission mainly by the leaf hopper vector *Nephotettix virescens* Males, females and nymphs of the insect can transmit the disease. Both the particles are transmitted semi-persistently, in the vector the particles are noncirculativeand nonpropagative. Plants infected with RTSV alone may be symptomless or exhibit only mild stunting. RTBV enhances the symptoms caused by RTSV. RTSV can be acquired from the infected plant independently of RTBV, but acquisitionof RTBV is dependent on RTSV which acts as a helper virus. Both the viruses thrive in rice and several weed hosts which serve as source of inoculum for the next. Ratoon from infected rice stubble serve as reservoirs of the virus. Disease incidence depends on rice cultivars, time of planting, time of infection and presence of vectors and favorable weather conditions

Management

- Field sanitation, removal of weed hosts of the virus and vectors.
- Grow disease tolerant cultivars like Pankhari203, BM66, BM68, Latisail, Ambemohar102, Kamod253, IR50 and Co45.
- Controlthevectorsinthenurserybyapplicationof Carbofuran 170g/cent 10days after sowing to control hoppers.
- Spray Phosphomidan 500ml or Monocrotophos 1lit/ha (2ml/litre) or Neemoil 3% or NSKE 5% to control the vector in the main field 15 and 30 days after transplanting.
- Set up light traps to monitor the vector population.

Rice Grassy stunt disease - *Rice grassy stunt tenuivirus*

Symptoms

Plants are markedly stunted with excessive tillering and an erect growth habit. Leaves becomenarrow,palegreenwithsmallrustyspots.Mayproduceafewsmallpanicleswhichbear dark brown unfilled grains.

Symptoms

Pathogen

Ricegrassystunttenuivirus, flexuous, filamentous 950-1350nmlongx6nmwide,ssRNAgenome

Disease Cycle

Disease spreads by the brown plant hopper, *Nilaparvatalugens*, in a persistent manner having a latent period of 5 to 28 days in the vector. Ratoon crop and presence of vector perpetuate the disease from one crop to other.

Ricedwarf– *Rice dwarf virus*

Symptoms

Infected plants show stunted growth, reduced tillering and root system. Leaves showchlorotic specksturning to streaks along the veins. In early stage of infection no ear heads formed.

Pathogen

- Thevirus isspherical, 70nm diameterwith anenvelope,dsRNAgenome.

Disease Cycle

Spreadsbyleafhopperfeedingby*Nephotettixcincticeps*, *Reclliadorsalis*and *N.nigropictus*inapersistentmanner.Thetransmissionistransovarialthrougheggs.Gramineous weeds *Echinochloacrusgalli*and *Panicum miliaceaum*serve as source of inoculum. **Management**

- Destory weed host that serve as source of inoculum
- Spray Phosphamidonor Fenthinon500 ml orMonocrotophos1 lit/ha.

Rice ragged stunt disease – *Riceraggedstuntvirus*

Symptoms

- Formation of ragged leaves with irregular margins, vein swelling, enationson leaf veins may be formed
- Stuntingofplants,delayedflowering,productionofnodalbranchesandincomplete emergence of panicles.

Symptoms

Pathogen

- Sphericalvirus(Figivirus), 65nm diameter,dsRNAgenome

Disease Cycle

Spreadsthroughbrownplanthopper,*Nilaparvatalugens*transmittedinapersistentmanner. Multiplies in the vector, latent periodof 3 to 35 days, but not transmitted congenitally **Rice yellow dwarf disease – *Rice yellow dwarf virus***

Symptoms

Prominent stunting of plants and excessive tillering are the characteristic symptoms of the disease. Leaves yellowish green to whitish green, become soft and droop. Plants usually remain sterile but sometimes may produce small panicles with unfilled grains.

Symptoms

Pathogen

- Caused by a phytoplasma(rice yellow dwarf phytoplasma designated as a novel taxon,'*Candidatus*Phytoplasma oryzae')

Disease Cycle

The disease is transmitted by leafhopper vectors *Nephotettix sp. Nephotettix*with a latentperiodof 25-30 days in the vector. The pathogen survives on several grass weeds.

Management

- Deepploughingduringsummermonthsandburningofstubbles.
- RicevarietiesIR62andIR64aremoderatelyresistanttothedisease.
- The management practices followed for Rice Tungro disease holds good for this disease also.

2. DiseasesofSorghum

DownyMildew- ***Peronosclerosporasorghi***

Symptoms

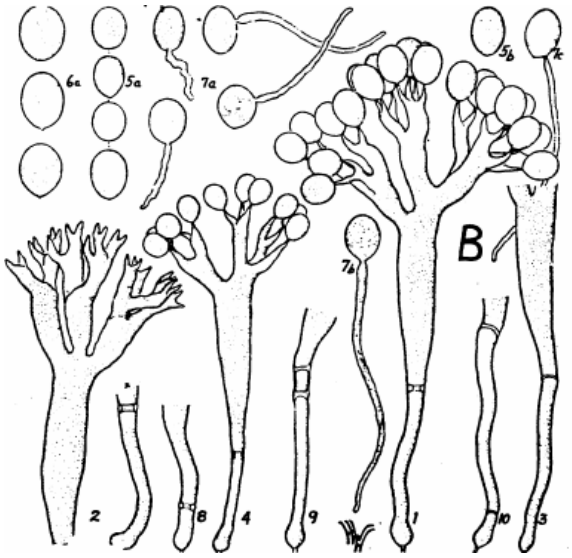
The fungus causes systemic downy mildew of sorghum. It invades the growing points of young plants, either through oosporeor conidial infection.As the leaves unfold they exhibit green or yellow colouration. Abundant downywhite growth is produced on the lower surface of the leaves, which consists of sporangiophoresand sporangia.

Symptoms

Normally three or four leaves develop the chloroticdowny growth. Subsequent leaves show progressively more of a complete bleaching of the leaf tissue in streaks or stripes. As the infected bleached leaves mature they become necroticand the interveinal tissues disintegrate, releasing the resting spores (oospores) and leaving the vascular bundles loosely connected togive the typical shredded leaf symptom.

Pathogen

*P. sorghi*is an obligate parasitesystemic in young plant. The mycelium is intercellular, non-septate. Sporangiophoresemerge through the stomata in single or in clusters which are stout and dichotomously branched. Spores are single celled, hyaline, globose and thin walled. Oosporesare spherical, thick walled and deep brown in colour.



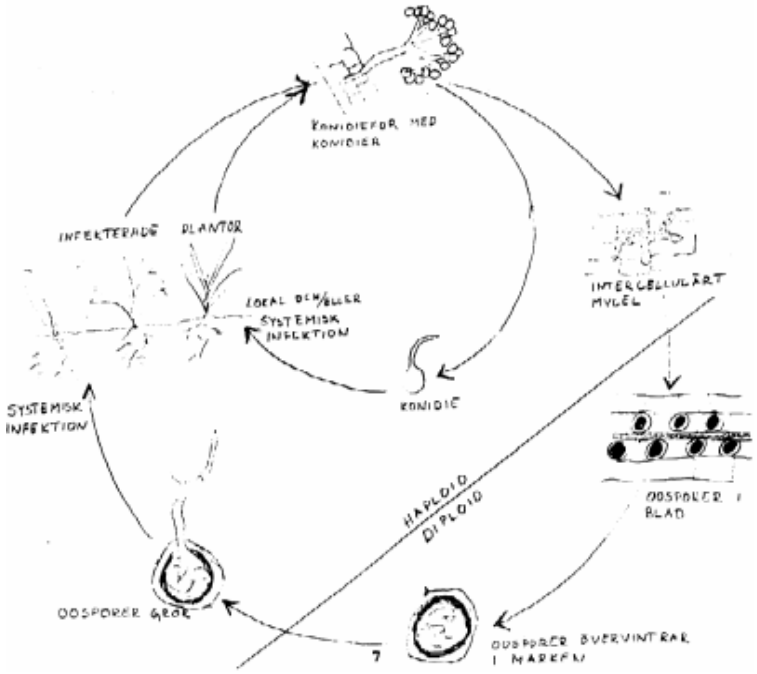
Sporangia and sporangiophores

FavourableConditions

- Maximumsporulationtakesplaceat100percentrelativehumidity.
- Optimum temperature for sporulation is 21-23˚Cduringnight.
- Light drizzling accompanied by cool weather is highly favourable.

Disease Cycle

The primary infection is by means of oospores present in the soil which germinate and initiate the systemic infection. Oosporespersist in the soil for several years. Secondary spread is by air-borne sporangia. Presence of mycelium of the fungus in the seeds of systemically infected plantsisalsoasourceofinfection.Thediseasehasbeenknowntooccurthroughacollateralhost, *Heteropogencentortus*on which the fungus perpetuates of the host. The breakdown of tissue causes shredding. The oospores either fall to the soil or are wind blown, often within host tissue. They can remain viable in the soil for 5-10 years. Conidiaare formed at night in large numbers. The optimum temperature for production is 20-23^{0}C.



Management

- Crop rotationwith other crops viz., pulses and oilseeds.
- Avoidthesecondaryspreadofthediseasebyroguingouttheinfectedplantssincethe wind plays a major role in the secondary spread of the disease.
- Grow moderately resistant varieties like Co25 and Co26.
- Seed treatment withMetalaxylat 6 g/kg of seed.
- Spray Metalaxyl500 g or Mancozeb2 kg or Ziram1 kg or Zineb1kg/ha.

Leafblight-*Exerohilumturcicum*(Syn:*Helminthosporiumturcicum*)

Symptoms

The pathogen also causesseed rotand seedling blightof sorghum. The disease appears as small narrow elongated spots in the initial stage and in due course they extend along the lengthof the leaf. On older plants, the typical symptoms are long ellipticalnecrotic lesions, straw coloured in the centre with dark margins.

Symptoms

The straw colouredcentre becomes 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 burnt appearance.

Pathogen

The mycelium is localised in the infected lesion. Conidiophoresemerge through stomata andaresimple,olivaceous,septateandgeniculate.Conidiareolivaceousbrown,3-8septateand thick walled.

FavourableConditions

- Cool moist weather.
- Highhumidity(90percent)
- High rainfall.

Diseasecycle

Thepathogenisfoundtopersistintheinfectedplantdebris.Seedborneconidiaare responsible for seedling infection. Secondary spread is through wind-borne conidia.

Management

- Use disease free seeds.
- Treat the seeds withCaptanor Thiramat 4 g/kg.
- Spray Mancozeb1.25 kg or Captafol1 kg/ha.

Rectangular Leaf spot - *Cercosporasorghi*

Symptoms

Thesymptomsappearassmallleafspotswhichenlargetobecomerectangularlesions(whichcan be5-15mmlongby2to5mmwide)ontheleafandleafsheath.Usuallythelower

leaves are first attacked. The lesions are typical dark red to purplish with lighter centers. The lesions are mostly isolated and limited by veins. The colour of the spots varies 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.

FavourableConditions

- Cool moist weather.
- Highhumidity(90percent)
- High rainfall.

Diseasecycle

Theconidiasurviveupto5months.Thediseasespreadsthroughair-borneandseed- borne conidia.

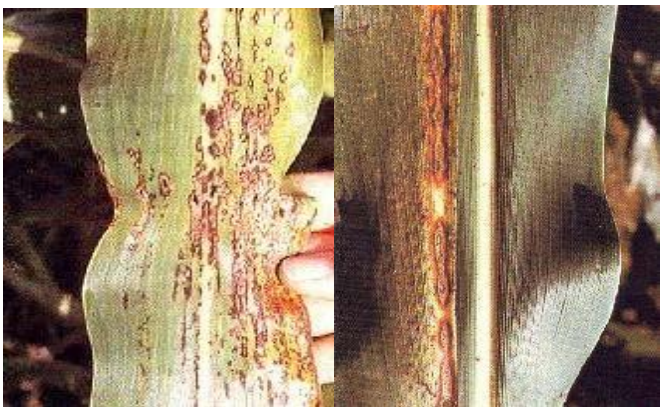
Management

- Use disease free seeds.
- Treat the seed with Captan or Thiram at 4 g/kg.
- SprayMancozeb2kg/ha.

Anthracnose and red rot- *Colletotrichum graminicolum*

Symptoms

The fungus causes both leaf spot (anthracnose) and stalk rot (red rot). The diseaseappearsassmallredcolouredspotsonbothsurfacesoftheleaf.Thecentreofthespotiswhitein colour encircled by red, purple or brown margin.



Symptoms

Numerous small black dots like acervuliare seen on the white surface of the lesions. Red rot can be characterized externally by the development of circular cankers, particularly in the inflorescence. Infected stem when split open shows discoloration, which may be continuous over a large area or more generally discontinuous giving the stem a marbeled appearance.

Pathogen

Themyceliumofthefungusislocalisedinthespot.Acervuliwithsetaearisethrough epidermis. Conidia are hyaline, single celled, vacuolateand falcatein shape.

FavourableConditions

- Continuous rain.
- Temperature of 28-30˚C.
- High humidity.

Diseasecycle

Thediseasespreadbymeansofseed-borneandair-borneconidiaandalsothroughthe infected plant debris.

Management

- Treat the seeds with Captan or Thiram at 4 g/kg.
- SpraythecropwithMancozeb2kg/ha.

Rust-*Pucciniapurpurea*

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. 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.

Symptomson leavesand stalk

Pathogen

The uredosporesare pedicellate, elliptical or oval, thin walled, echinulated anddarkbrown in colour. The teliosporesare reddish or brown in colour and two celled, rounded at the apex with one germ pore in each cell. The teliospores germinate and produce promyceliumand basidiospores. Basidiospores infect *Oxalis corniculata*(alternate host) where pycnialand aecial stages arise.

FavourableConditions

- Lowtemperature of 10 to 12˚C favours teliospore germination.
- A spell of rainy weather favours the onset of the disease.

Disease cycle

The uredosporessurvive 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 comiculata*.
- Spray the crop with Mancozeb at 2 kg/ha.

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

Symptoms

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

Symptoms

Loose smut/ kernel smut - *Sphacelothecacruenta*

Symptoms

The affected plants can be detected before the ears come out. They are shorter than the healthy plants with thinner stalks and marked tillering. The ears come out muchearlier than the healthy.Theglumesarehypertrophiedand the earheadgivesalooseappearancethanhealthy.

The sorus is covered by a thin membrane which ruptures very early, exposing the spores even as the head emerges from the sheath.

Symptom

Long smut -*Tolyposporiumehrenbergii*

Symptoms

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

Symptoms

Head smut -*Sphacelothecareiliana*

Symptoms

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

Symptoms

Management for all smuts

- Treat the seed with Captan or Thiram at 4 g/kg.
- Use disease free seeds.
- Followcroprotation.
- Collectthesmuttedearheadsinclothbagsandburyinsoil.

Ergot or Sugary disease - *Sphaceliasorghi*

Symptoms

The disease is confined to individual spikelets. The first symptom is the secretion ofhoney dew from infected florets. Under favourable conditions, long, straight or curved, cream to light brown, hard sclerotia develop. Often the honey dew is colonised by *Crerebellasorghivulgaris*which gives the head a blackened appearance.

Symptom

Pathogen

The fungus produces septate mycelium. The honey dew is a concentrated suspension ofconidia, which are single celled, hyaline, elliptic or oblong.

FavourableConditions

- Aperiodofhighrainfallandhighhumidityduringfloweringseason.
- Cool night temperature and cloudy weather aggravate the disease.

Disease Cycle

The primary source of infection is through the germination of sclerotia which release ascospores that 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 favor the disease.
- Spray any one of the following fungicides viz., Mancozeb 2 kg/ha (or) Carbendazim at 500 g/ha at emergence of ear head (5-10 per cent flowering stage) followed by a spray at 50 per cent flowering and repeat the spray after a week, if necessary.

Headmould/Grainmould/Headblight

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 mouldingoccusr. The most frequently occurring genera are *Fusarium*, *Curvularia*, *Alternaria*, *Aspergillus*and *Phoma*. *Fusariumsemitectum*and *F.moniliforme*develop a fluffy white or pinkish coloration. *C.lunata*colours the grain black. Symptom varies depending upon the organism involved and the degree of infection.

Symptoms

FavourableConditions

- Wetweatherfollowingthefloweringfavorsgrainmoulddevelopment.
- Thelongerthewetperiodthegreaterthemoulddevelopment.
- Compact ear heads are highly susceptible.

Disease cycle

The fungi mainly spread through air-borne conidia. The fungi survive as parasites as well as saprophytesin 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.

Phanerogamicparasite- *Strigaasiatica* and *Striga densiflora*

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

The root exudates of sorghum stimulate the seeds of the parasite to germinate. The parasite then slowly attaches to the root of the host byhaustoriaand grows below the soil surface producing 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.

Symptoms

Management

- Regularweedingandinterculturaloperationduringearlystagesofparasitegrowth.
- Spray Fernoxone (sodium salt of 2, 4-D) at 450g /500 litre of water.

3. DiseasesofPearlmillet

Downy mildew - *Sclerosporagraminicola*

Symptoms

Infection is mainly systemicand symptoms appear on leaves and inflorescence. Theinitial symptoms appear in seedlings at three to four leaf stages. The affected leaves showpatches of light green to light yellow colour on the upper surface and the corresponding lower surface bears white downy growth of the fungus consisting of sporangiophoresand sporangia.Theyellowdiscolourationoftenturnstostreaksalongveins.Asaresultofinfectionyoungplants 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.

Symptoms

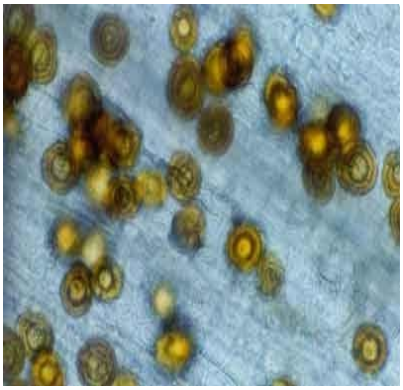
The inflorescence of infected plants gets completely or partially malformed with florets converted into leafy structures, giving the typical symptom of **green ear**.

Infected leaves and inflorescences produce sporangia over a considerable period of time under humid conditions and necrosisbegins. The dry necrotic tissues contain masses ofoospores.

Green ear symptoms

Pathogen

The mycelium is systemic, non septae and intercellular. Short, stout, hyaline sporangiophoresarise through stomataand branch irregularly, with stalks bearing sporangia. Sporangia are hyaline, thin walled, ellipticaland bear prominent papilla. Oosporesare round in shape, surrounded by a smooth, thick and yellowish brown wall.



Oospores

FavourableConditions

- Very high humidity (90%).
- Presence of water on the leaves
- Low temperature of 15-25˚C favor the formation of sporangiophore and sporangia.

Disease cycle

The oospores remain viable in soil for 5 years or longer giving rise to the primary infectiononseedlings.Secondaryspreadisthroughsporangiaproducedduringrainyseason.The dormant mycelium of the fungus is present in embryo of infected seeds.

Management

- Deepploughingtoburytheoospores.
- Roguing out infected plants.
- Adoptcroprotation.
- Grow resistant varieties WCC-75, Co7 and Co (Cu)9.
- TreattheseedswithMetalaxylat6g/kg.
- Spray Mancozeb 2 kg or Metalaxyl + Mancozebat 1 kg/ha on 20th day after sowing inthe field.

Smut -*Tolyposporiumpenicillariae*

Symptoms

The pathogen infects few florets and transforms them into plump sori containing smut spores. The sori are larger than normal healthy grains and when the sori mature they becomedark brown releasing millions of black smut spore balls.

Symptoms

Pathogen

The fungus is mostly confined to the sorus. The soricontain spores in groups and are not easy to separate. Each spore is angular or round and light brown.

FavourableConditions

- Highrelativehumidity.
- Successive cropping with pearlmillet.

Disease cycle

- The pathogen survives as spore balls in the soil and serves as primary source ofinoculum. Secondary spread is by air-borne conidia.

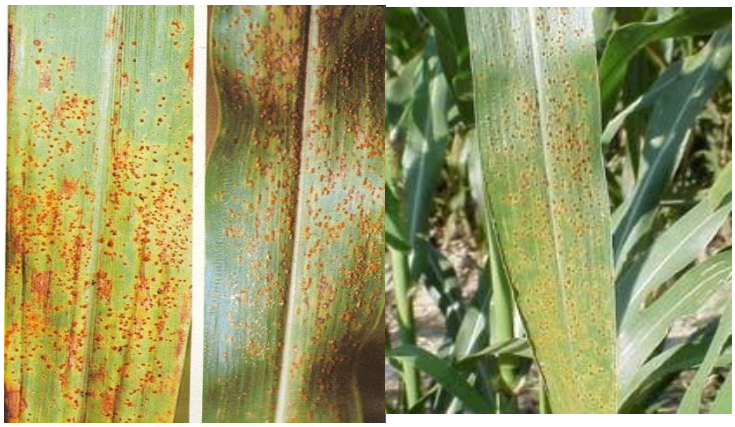
Management

- The damage caused by the fungus is negligible.
- Removal and destruction of affected ear head will help in controlling the disease.

Rust-*Pucciniapennisetti*

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. The pustulesmay be formed on leaf sheath, stem and on peduncles.Later, telial formation takes place on leaf blade, leaf sheath and stem. While brownish uredia are exposed at maturity, the black telia remain covered by the epidermis for a longer duration.



Symptoms

Pathogen

Uredosporesare oval, elliptic, sparsely echinulated and pedicellate. Teliosporesare dark brown in colour, two celled, cylindrical to club shaped, apex flattened, broad at top and tapering towards base. The fungus is macrocyclic producing uredial and telial stages on pearlmillet and aecialand pycnialstages on brinjal.

FavourableConditions

- Closer spacing.
- Presenceofabundantbrinjalplantsandotherspeciesof*Solanum*viz.,*S.torvum*,*S.xanthocarpum* and *S. pubescens.*

Disease cycle

Air-borne uredospores are the primary sources. The uredial stages also occur on several species of *Pennisetum*, which helps in secondary spread of the pathogen.

Management

Spray with Wettable Sulphur 3 kg orMancozeb2 kg/ha.

Ergot or Sugary disease - *Claviceps fusiformis*

Symptoms

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

Symptoms

Pathogen

The pathogen produces septate mycelium which produces conidiophoresand is closely arranged. Conidiaare hyaline and one celled. The sclerotiaare small (3-8mm x 0.3-15mm) and dark grey but white inside.

Disease cycle

Sclerotiaare 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 airborne 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

- Adjustthesowingdatesothatthecropdoesnotflowerduring 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.
- Removecollateralhosts.

- SpraywithCarbendazim500gorMancozeb2kgorZiram1kg/hawhen5-10percent flowers have opened and again at 50 per cent flowering stage.

Minor diseases

Grain mould - Fungal complex

Grains covered with white, pink or black moulds.

Blast - ***Pyriculariasetariae***

Diamond shaped to circular lesions with dark brown margins and chlorotic haloes.

Zonate leaf spot - ***Gloeocercospora*****sp.**

Roughcircularlesionswithalternatingconcentricbandsofstrawandbrowncolour,often coalescing over the leaf surface.

Banded leaf spot - ***Rhizoctonia spp.***

Patchoflightanddark,discolouredareasandoftenbearingfluffytolightbrownfungal mats.

4. DiseasesofMaize

Downy mildew/Crazy top

Sorghum downy mildew -

***Peronosclerosporasorghi*Phlippinedownymildew-**

***Peronosclerosporaphilippinensis*Crazy top -**

Sclerophthoramacrospora

Symptoms

The most characteristic symptom is the development of chlorotic streakson the leaves. Plants exhibit a stunted and bushy appearance due to shortening of the internodes. White downy growth is seen on the lower surface of leaf.Downy growth also occurs on bracts of green unopened male flowers in the tassel. Small to large leaves are noticed in the tassel. Proliferationof auxillary buds on the stalk of tassel and the cobs is common **(Crazy top).**

Symptoms

Pathogen

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

FavourableConditions

- Low temperature (21-33˚C)
- Highrelativehumidity(90percent)anddrizzling.
- Young plants are highly susceptible.

Disease cycle

The primary source of infection is through oospores in soil and also dormant mycelium present in the infected maize seeds. Secondary spread is through airborne conidia. Depending on the pathogen species, the initial source of disease inoculum can be oospores that over winter in the soil or conidia produced in infected, over wintering crop debris and infected neighboring plants.Some species that cause downy mildew can also be seed borne, although this is largely restricted to seed that is fresh and has high moisture content.

At the onset of the growing season, at soil temperatures above 20°C, oospores in the soil germinate in response to root exudates from susceptible maize seedlings.The germ tube infects the underground sections of maize plants leading to characteristic symptoms of systemic infection including extensive chlorosisand stunted growth.If the pathogen is seed borne, whole plants show symptoms.Oosporesare reported to survive in nature for up to 10 years.

Once the fungus has colonised host tissue, sporangiophores (conidiophores) emerge from stomata and produce sporangia (conidia) which are wind and rain splash disseminated andinitiate secondary infections.Sporangia are always produced in the night.They are fragile and can not be disseminated more than a few hundred meters and do not remain viable for more than a few hours.

Germination of sporangia is dependent on the availability of free water on the leaf surface.Initialsymptomsofdisease(chloroticspecksandstreaksthatelongateparalleltoveins)

occurin3days.Conidiaareproducedprofuselyduringthegrowingseason.Asthecropapproaches senescence, oospores are produced in large numbers.

Management

- Deep ploughing.
- Croprotationwithpulses.
- Rogueoutinfectedplants.
- Treattheseedswithmetalaxylat6g/kg.
- SpraythecropwithMetalaxyl+Mancozeb@1kgon20thdayaftersowing.
- Grow resistant varieties and hybrids *viz.* CO1, COH1and COH2.

Leafblight-*Helminthosporium maydis*(Syn: *H. turcicum*)

Symptoms

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

Symptoms

Pathogen

Conidiophoresareingroup,geniculate,middarkbrown,paleneartheapexandsmooth. Conidiaare distinctly curved, fusiform, pale to mid dark golden brown with 5-11 septa.

Conidia

FavourableConditions

- Optimumtemperatureforthegerminationofconidiais8to27˚Cprovidedwithfreewater on the leaf.
- Infection takes place early in the wet season.

Disease cycle

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

- TreattheseedswithCaptanorThiramat4g/kg.
- Spray Mancozeb 2 kg or captan 1 kg/ha.

Rust -*Puccinia sorghi*

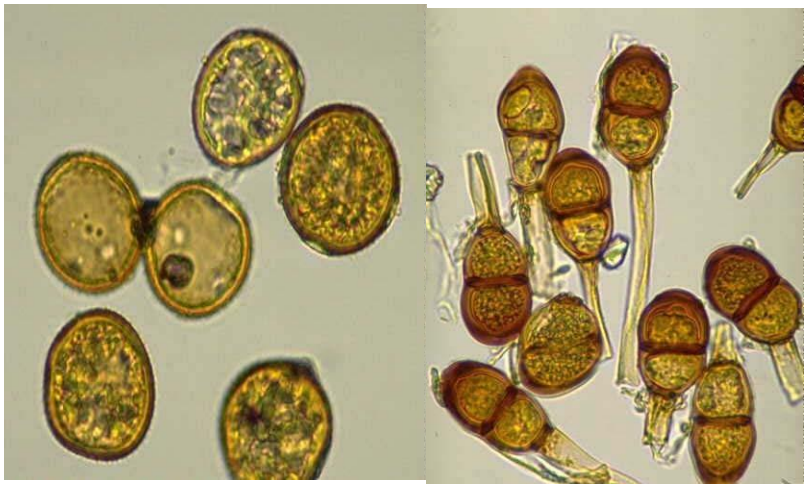
Symptoms

Circular to oval, elongated cinnamon-brown powdery pustulesare scattered over both surface of the leaves. As the plant matures, the pustules become brown to black owing to the replacement of red uredospresby black teliospres.

Symptoms

Pathogen

Uredosporesare globose or elliptical finely echinulate, yellowish brown with 4 germpores. Teliosporesare 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.



Uredosporesandteliospoes

FavourableConditions

- Cool temperature and high relative humidity.

Diseasecycle

Primarysourceofinoculumsisuredosporessurvivingonalternatehosts*viz.*,*Oxaliscorniculata*and *Euchlaenamexicana*.

Management

- Removethealternatehosts.
- Spray Mancozeb at 2 kg/ha.

Headsmut-

***Sphacelothecareiliana*Symptoms**

Symptoms are usually noticed on the cob and tassel. Large smut sori replace the tasseland the ear.Sometimes the tassel is partially or wholly converted into smut sorus. The smutted plants are stunted produce little yield and remain greener than that of the rest of the plants.

Symptoms

Pathogen

Smutsporesareproducedinlargenumberswhicharereddishbrowntoblack,thick walled, finely spined, spherical.

FavourableConditions

- Low temperature favours more infection and this fungus also infects the sorghum

Disease cycle

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

Management

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

Charcoalrot-

Macrophominaphaseolina(Rhizoctoniabataticola)**Symptoms**

The affected plants exhibit wilting symptoms. The stalk of the infected plants can be recognized by grayish streak. The pith becomes shredded and grayish black minute sclerotiadeveloponthevascularbundles.Shreddingoftheinteriorofthestalkoftencausesstalksto

break in the region of the crown. The crown region of the infected plant becomes dark in colour. Shreddingof root bark and disintegration of root system are the common features.


Symptoms

Pathogen

Thefungusproduceslargenumberofsclerotiawhichareroundandblackincolour. Sometimes, it producespycnidiaon the stems or stalks.

FavourableConditions

- High temperature and low soil moisture (drought)

Disease cycle

The fungus has a wide host range, attacking sorghum, pearlmillet, fingermillet andpulses. It survives for more than 16 years in the infected plant debris. The primary source of infection is through soil-borne sclerotia. The pathogen also attacks many other hosts, whichhelps in its perpetuation. Since the fungus is a facultative parasite it is capable of living saprophytically on dead organic tissues, particularly many of its natural hosts producingsclerotial bodies. The fungus over winters as a sclerotiain the soil and infects the host at susceptible crop stage through roots and proceeds towards stem.

Management

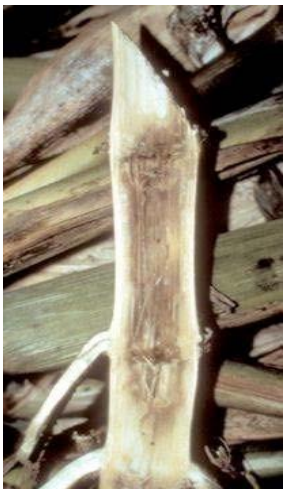
- Long crop rotation with crops that are not natural host of the fungus.
- Irrigate the crops at the time of earhead emergence to maturity.
- TreattheseedswithCarbendazimorCaptanat2g/kg.
- Grow disease tolerant varieties viz., SN-65, SWS-8029, Diva and Zenit.

Minor diseases

BacterialStalkrot- ***Erwinia dissolvens***

Symptoms

The basal internodes develop soft rot and give a water soaked appearance. A mild sweet fermenting odour accompanies such rotting. Leaves some time show signs of wilting andaffected plants topple down in few days. Ears and shank may also show rot. They fail to develop further and the ears hang down simply from the plant



Symptoms

Disease cycle

Borerinsectsplayasignificantroleininitiationofthedisease.Theorganismissoilborne and makes its entry through wounds and injuries on the host surface. The organism survives saprophytically on debris of infected materials and serves primary inoculum in the next season.

Mosaic-*Maizemosaicpotyvirus*

Symptoms

Symptomsappearaschloroticspots,whichgraduallyturnintostripescoveringentireleaf blade. Chlorotic stripes and spots can also develop on leaf sheaths, stalks and husks. Moderate to severe rosetting of new growth is observed. Size of stalk, leaf blades and tassel tend to be normal in late infection.

Pathogen

It is caused by *Maize mosaic potyvirus*. Virions are flexuous, 750-900nm long, ssRNAgenome.

Disease cycle

Symptoms

Itis transmitted in nature by leaf hopper vector,*Perigrimusmaidis*.

Brown spot - *Physodermamaydis*

Watersoakedlesions,whichareoval,laterturnintolightgreenandfinallybrown.

5. DiseasesofGroundnut

Tikka leaf spots

Earlyleaf spot: ***Cercoporaarachidicola***(Sexual Stage:*Mycosphaerellaarachidis)*

Late leaf spot: ***Phaeoisariopsispersonata***(Syn :*Cercosporapersonata*)

(Sexual stage :*Mycosphaerellaberkeleyii)*

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 appearance, spot colour and shapes. Both the fungi produce lesions also on petiole, stem and pegs. Thelesions 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*(Se x **Symptoms** *achidis***)**

Thepathogenisintercellularanddonotproducehaustoriaandbecomeintracellularwhen host cells die. The fungus produces abundant sporulationon the upper surface of the leaves. Conidiophoresare olivaceous brown or yellowish brown in colour, short, 1 or 2 septate, unbranched and geniculate and arise in clusters.

Conidiaaresubhyalineorpaleyellow,obclavate,oftencurved3-12septate,35-110x 2.5 - 5.4 µm in size with rounded to distinctly truncate base and sub-acute tip. The perfect stage of the fungus produces perithecias ascostromata. They are globose with papillate ostiole. Asciare 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 ***)(*** **Sexualstage:** ***M.*** berkeleyii ***)***

The fungus produces internal and intercellularmycelium with the production ofhaustoria.Theconidiphoresarelong,continuous,1-2septate,geniculate,ariseinclustersand olive

brown in colour. The conidia are cylindrical or obclavate, short, measure 18-60 x 6-10µm, hyaline to olive brown, usually straight or curved slightly with 1-9 septa, notconstrictedbutmostly3-4septate.Thefungusinitsperfectstageproducesperitheciaas ascostromatawhichareglobooseorbroadlyovatewithpapillateostiole.Asciarecylindricalto ovate, contain 8 ascospores. Ascospores are 2 celled and constricted at septum and hyaline.

FavourableConditions

- Prolonged high relative humidity for 3 days.
- Low temperature (20 C) with dew on leaf surface.
- Heavy doses of nitrogen and phosporusfertilizers
- Deficiency of magesium in soil.

Disease cycle

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

Management

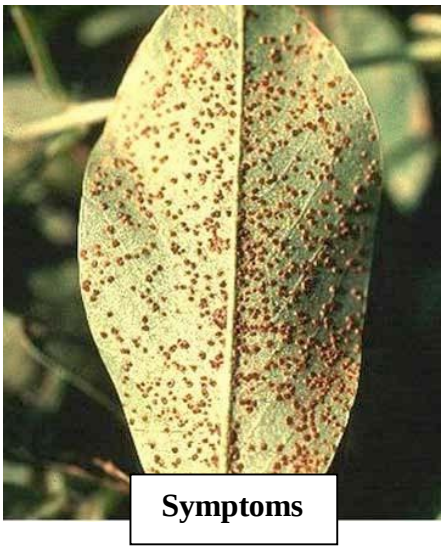
- Removeanddestorytheinfectedplantdebris.

- Eradicate the volunteer groundnut plants.
- Keepweedsundercontrol.
- TreattheseedswithCarbendazimorThiramat2g/kg.
- Spray Carbendazim 500g or mancozeb 2 kg or Chlorothalonil 2 kg/ha and if necessary,repeat after 15 days.
- Grow moderately resistant varieties like ALR 1.

Rust -*Pucciniaarachidis*

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 ruptures 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.



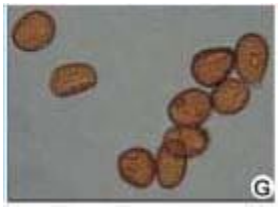
Symptoms

Pathogen

Thepathogenproducesbothuredialandtelialstages.Uredialstagesareproduced abundantingroundnutandproductionofteliaislimited.Uredosporesarepedicellate,

unicellular, yellow, oval or round and echinulated with 2 or 3 germpores. 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.

Teliospores



Uredospores

FavourableConditions

- Highrelativehumidity(above85percent).
- Heavy rainfall.
- Low temperature (20-25˚C).

Disease cycle

The pathogen survives as uredospores on volunter 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

- Avoidmonoculturingofgroundnut.
- Removevolunteergroundnutplantsandreservoirhosts.
- Spray mancozeb 2 kg or Wettable Sulphur 3 kg or Tridemorph 500ml or Chlorothalonil2 kg/ha.
- Grow moderatelyresistant varieties like ALR 1.

Collarrotorseedlingblightorcrownrot-*Aspergillus niger*and *A. pulverulentum*

Symptoms

The disease usually appears in three phases.

i. Pre-emergence rot

Seeds are attacked by soil-borne conidia and caused rotting of seeds. The seeds 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 discolored spotsappear 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

Symptoms

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 mostlyglobose 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 andproduce in long chains.

FavourableConditions

- Deep sowing of seeds.
- Highsoil temperature (30-35˚ C).
- Low soil moisture.

Disease cycle

The pathogen survive in plant debris in the soil, not necessarily from a groundnut crop.Soil-borneconidiacausediseasecarryoverfromseasontoseason.Theotherprimary source is the infeced seeds. The pathogen is also seedborne in nature.

Management

- Croprotation.
- Destruction of plant debris.
- Remove and destroy previous season's infested crop debris in the field
- Seed treatment with *Trichoderma viride*/ *T.harzianum*@ 4 g/kg of seeds and soil application of *Trichoderma viride*/ *T.harzianum*at 2.5kg/ha, preferably with organic amendments such as castor cake or neem cake or mustard cake @ 500 kg/ ha.

Root rot -*Macrophominaphaseolina*

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 with 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.

FavourableConditions

- Prolonged rainy season at seedling stage and low lyingareas.

Disease cycle

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 and cattle etc.

Management

- Treat the seeds with thiram or carbendazim 2g/kg or *Trichoderma viride*at4g/kg.
- Spot drench with Carbendazim at 0.5 g/lit.

Rossette - *Groundnut rosette assistor virus*(GRAV), *Groundnut rosette virus*and *Groundnut rosette satellites*

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 mosaicmottling.Theinfectedplantsremainstuntedandproduceflowers,butonlyafewofthepegsmay develop further to nuts but no seed formation.

Symptoms

Pathogen

The disease is caused by a complex mixture of viruses viz.,*Groundnut rosette assistorvirus*(GRAV), *Ground nut rosette virus* and *Groundnutrosette satellites* is an isometric, not envelopedand28nmdiameter(reportedfromIndia)anditgivesnoovertsymptomingroundnut. *Groundnut rosette virus* is with ssRNAgenome, which becomes packaged in GRAV virious and thusdependsonitforaphidtransmission,butproducesnoovertsymptomsingroundnut.The

groundnut rosette satellites are satellite RNAsthat control the symptoms and cause the different types of rosette (chlorotic, green and mosaic).

Disease Cycle

The primary source of spread by aphid vector, *Aphis craccivora*and *A. gossipii*in a persistent manner, retained by vector but not transmitted congenitally. The virus is not transmitted by any other means like mechanical or seed or pollen. The virus can survive on the volunteer plants of groundnut and other weed hosts.

Management

- Practice clean cultivation.
- Use heavy seed rate and rogue out the infected plants periodically.
- Spray Monocrotophosor Methyl demetonat 500 ml/ha.

Groundnutbudnecrosisdisease-*Groundnutbudnecrosisvirus*(GBNV-Tospovirus) 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 rugosewith varying patterns of mottling and minute ring spots. Necrotic spots and irregularly shaped lesions develop on leaves and petioles. Stem also exhibits necrotic streaks.

ıptoms

Plant becomes stunted with short internodes and short auxillary shoots. Leaflets show reduction in size, distortion of the lamina, mosaic mottling and general chlorosis. In advanced conditions, the necrosis of buds occurs. Top bud is killed and necrosis spreads downwards. Drastic reduction in flowering and seeds produced are abnormally small and wrinkled with the dark black lesions on the testa.

Pathogen

It is caused by *Groundnut bud necrosis virus*(GBNV). The virus particles are spherical, 30 nm in diameter, enveloped, ssRNAwith multipartitegenome.

Disease cycle

The virus perpetuates in the weed hosts*viz.*, *Bidens pilosa*, *Erigonbonariensis*, *Tagetes minuta*and *Trifoliumsubterraneum*.The virusis transmittedbythrips *viz.*,*Thripspalmi*, *T. tabaci*and*Frankliniella*sp.

Management

- Adoptplantspacingof15x15cm.
- Remove and destory infected plants up to 6 weeks after sowing.
- Application of 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.

Minor diseases

Stem rot - *Sclerotium rolfsii*

Symptoms

The first symptom is the sudden drying of a branch which is completely or partially in contact with the soil. The leaves turn brown and dry but remain attached to the plant. Near soilon stems white growth of fungus mycelium is appeared. As the disease advances whitemycelium web spreads over the soil and the basal canopy of the plant. The sclerotia, the size and colour of mustard seeds, appear on the infected areas as the disease develops and spreads. The entire plant may be killed or only two or three branches may be affected. Lesions on the developing pegs can retard pod development. Infected pods are usually rotted.

Symptoms

Management

- Cultural practices such as deep' covering or burial of organic matter before planting, non-dirting cultivation by avoiding movement of soil up around the base of plants and preventing accumulation of organic debris are extremely useful in reducing the disease.
- Croprotationwithwheat,cornandsoyabeanmayminimizetheincidenceofstemrot.
- Seed treatment with Carbendazim / Thiram / Captan @ 2-3 g/kg seed.
- Seedtreatmentwith*Trichodermaviride*formulation(4g/kg)followedbyapplicationof 2.5kg *Trichoderma viride*formulation mixed with 50kg farm yard manure before sowing.

Wilt-*Fusariumoxysporum*and*F.solani*

Symptoms

Germinating seeds are attacked by the pathogens shortly before emergence. There is general tissue disintegration and the surface of the seedling is covered with sporulating mycelium. Damping off symptoms characterized by brown to dark brown Water soaked sunken lesions on the hypocotyl which later encircle the stem and extend above the soil level. Roots are also attacked, especially the apical portions. The affected seedlings become yellow and wilted. The leaves turn greyish green and the plants dry up and die. The roots and stems show internal vascular browning and discolouration. These fungi are also commonly associated with pod rot.

Management

- SeedtreatmentwithsystemicfungicideslikeCarbendazimat2g/kgseed.

Anthracnose-*Colletotrichum dematium*and *C. capsici*

Symptoms

Small water-soaked yellowish spots appear on the lower leaves which later turn into circular brown lesions with yellow margin 1 to 3 mm in diameter. In some cases lesions enlarge rapidly become irregular and cover the entire leaflet, and extend to the stipules and stems. Brownish grey lesions occur on both the surfaces of leaflets. Infection spreads to stipules, petioles and branches.

Symptoms

Disease cycle

The pathogen is seed, soil and air-borne.

Management

- Deepsummerploughing.
- Use healthy certified seeds.
- Removal of plant debris.
- Seedtreatmentwithcopperoxychlorideat3g/kgseedorcarbendazimat2g/kgseed.

Yellowmould-*Aspergillus flavus*

Symptoms

Seed and un-emerged seedlings attacked by the pathogen are rapidly shriveled and dried. Brown or black mass covered by yellow or greenish spores may be seen. Decay is most rapid when infected seeds are planted. After seedling emergence cotyledons already infected with the pathogen, show necrotic lesions with reddish brown margins. This necrosis terminates at or near thecotyledonaryaxis.Underfieldconditionsthediseasedplantsarestunted,andareoften

chlorotic.Theleafletsarereducedinsizewithpointedtips,widelyvariedinshapeand sometimes with veinal clearing.

Management

- Since the fungus is a weak parasite, agronomic practices which favour rapid germination and vigorous growth of seedling will reduce the chance of *A. flavus* infection.
- Seedtreatmentwithcarbendazimorcaptanorthiramat2g/kgseed.

Greymould- *Botrytis cinerea*

Infection is seen on leaves, stem and underground parts of the groundnut. Initially infectionoccursatgroundlevelbyalightgreyfungalrotwhichcausesdeathoftheplants. **Bacterial wilt - *Pseudomonas solanacearum***

Infectedplantsappearunhealthy,chloroticandwiltunderwaterstress.Darkbrown discolouration of xylem is seen. Grey slimy liquid ooze out of the vascular bundles.

Leaf spot -*Alternaria arachidis* and ***A. tenuissima***

Symptoms

Lesions produced by *A. arachidis* are brown in colour and irregular in shape surrounded by yellowish halos. Symptoms produced by *A. tenuissima* are characterized by blighting ofapical portions of leaflets which turn light to dark brown colour. Lesions produced by *A.alternata* are small, chlorotic, water soaked, that spread over the surface of the leaf. The lesions become necrotic and brown and are round to irregular in shape. Veins and veinlets adjacent tothe lesions become necrotic. Lesions increase in area and their central portions become pale, rapidly dry out, and disintegrate. Affected leaves show chlorosis and in severe attacks become prematurely senescent. Lesions can coalesce, give the leaf a ragged and blighted appearance.

Symptoms

Management

- Foliar application of Mancozeb (2kg/ha) or Copper oxychloride (2kg/ha) or Carbendazim (500g/ha).

Indian Peanut Clump Disease -*Peanut Clump virus*

Earlier this disease was confused with groundnut rosstte. Now it is recognized as a distinct virus causing clump disease. The leaves turn very dark and plants become severely stunted.Thediseaseissoilborneandtransmittedbyafungus,*Polymyxagraminis*.ThepHofthe soil affects transmission. It is also transmitted by seed. The virus is rod shaped, 190-245nm long x 21nm wide, not enveloped,ssRNAgenome.

Other virus diseases of minor importance occurring on groundnut are:

Peanut chlorotic streak (caused by Caulimovirus, occurs only in India), Peanut green mosaic and mottle (caused by a Potyvirus), peanut stunt (caused by Cucumovirus), groundnut chlorotic spot (caused by a Potexvirus), groundnut eye spot (caused by Potyvirus) and groundnut ringspot.

6. DiseasesofCastor

Seedlingblight- *Phytophthoraparasitica*

Symptoms

Thediseaseappearscircular,dullgreenpatchonboththesurfaceofthecotyledonleaves. It later spreads and causes rotting. The infection moves to stem and causes withering and deathof seedling. In mature plants, the infection initially appears on the young leaves andspreads to petiole and stem causing black discoloration and severe defoliation.

Dead seedling

Spot on older leaf Leaf blight symptom

Pathogen

The pathogen produces non-septate and hyaline mycelium. Sporangiophoresemerge 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 sporangiagerminate to produce abundant zoospores.The fungus also produces oosporesand chlamydosporesin adverse seasons.

FavourableConditions

- Continuousrainyweather.
- Low temperature (20-25˚C).
- Low lying and ill drained soils.

Disease cycle

The pathogen remains in the soil as chlamydospores and oospores which act as primary sourceofinfection.Thefungusalsosurvivesonotherhostslikepotato,tomato,brinjal,sesamum etc. The secondary spread takes place through wind borne sporangia.

Management

- Removeanddestroyinfectedplantresidues.
- Avoid low-lying and ill drained fields for sowing.
- Treattheseedswiththiramorcaptanat4g/kg.

Rust –*Melampsoraricini*

Symptoms

Minute, orange-yellow coloured, raised pustulesappear 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.

Powdery mass covering entire leaf

Pathogen

The pathogen produces only uredosoriin castor plants and other stages of the life cycle are unknown. Uredosporesare two kinds, one is thick walled and other is thin walled. They are elliptical to round, orange-yellow coloured and finely warty.

Disease cycle

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 airborne uredospores.

Management

- Rogue out the self-sown castor crops and other weed hosts.
- Spray Mancozeb at 2kg/ha or Propioconazole1l/ha.

Leaf blight- *Alternaria ricini*

Symptoms

Alltheaerialpartsofplantsviz.,leaves,stem,inflorescencesandcapsulesareliabletobe attacked by the pathogen. Irregular brown spots with concentric rings form initially on the leaves and covered with fungal growth. When the spots coaleasce to form big patches, premature defoliationoccurs.Thestems,inflorescencesandcapsulesarealsoshowdarkbrownlesionswith 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.

*Alternerial*eaf spot with concentric rings

Pathogen

Thepathogenproduceserectorslightlycurved,lightgreytobrownconidiophores,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.

FavourableConditions

- High atmospheric humidity (85-90 %).
- Low temperature (16-20˚C)

Disease cycle

The pathogen survives on hosts like *Jatropha pandurifolia*and *Brideliahamiltoniana.* The pathogen is externally and internally seed-borneand causes primary infection. Thesecondary infection is through air-borne conidia.

Management

- Treattheseedswithcaptanorthiramat2g/kg.
- Removethereservoirhostsperiodically.
- Spraymancozebat2kg/ha.

Brown leaf spot - *Cercosporaricinella*

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.

Spots on leaf

Pathogen

The pathogen hyphae collect beneath the epidermis and form a hymenial layer. Clusters of conidiophores emerge through stomata or epidermis. They are septate and un branched 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.

Disease cycle

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

Management

- Spraying with 1% Bordeaux mixtureor Copper oxy chloride@ 0.2%may help to bring the disease under check; but where the cultures of Eri-silk worm are maintained on castor plants, spraying would not be desirable.
- Useofresistantvarietieswouldbethemosteffectivemethodforcombatingthedisease.
- Spraying twice with Mancozeb 2g/lit or Carbendazim 500g/ha at 10-15 day interval reduces the disease incidence.
- TreattheseedwiththiramorCaptan2gm/kgseed.

Powderymildew- *Leveillulataurica*

Symptoms

It is characterized by typical mildew growth which is generally confined to the under-surface of the leaf. When the infection is severe the upper-surface is also covered by the whitish growth of the fungus. Light green patches, corresponding to the diseased areas on the under surface, are visible on the upper side especially when the leaves are held against light.

Powdery mass covering entire leaf

Management

- When weather is comparatively dry spray twice with wettable Sulphur 2g/lit at 15 daysinterval, starting from 3 months after sowing.
- Spray 1ml hexaconazole or 2ml dinocap / litre of water at fortnight intervals. The variety Jwala is resistant to this disease.

Stem rot - *Macrophominaphaseolina*

Symptoms

Small brown depressed lesions on and around nodes. Increase in size on both directionscausing2to20cmnecroticarea.Lesionsoftencoalesceandgirdlethestemcausingleafdrop.

Drying and death starts from apex and progress. Infected capsules discoloured and drop easily. Sudden wilting of plants in patches under high moisture stress coupled with high soil temperature. Plant exhibit symptoms of drought and drooping of leaves. At ground level black lesions are formed on the stem. Young leaves curl inwards with black margins and drop off later, such branches Die-back. Entire branch and top of the plant withers.

Affected plant showing drooping of leaves

Management

- Grow tolerant and resistant varieties like Jyothi, Jwala, GCH-4, DCH-30 and SHB-145.
- Avoid water logging.
- Destruction of crop debris.
- Selection of healthy seed.
- Providing irrigation at critical stages of the crop.
- Treat the seed with thiram @ 2g/kg or carbendazim at 2g/ kg seed.
- Seed treatment with*Trichoderma viride*formulation at 4g/kg of seed.
- Soil drenching with Carbendazim (1g/1 litre of water) 2-3 times at 15 days interval.

Bacterialleaf spot -*Xanthomonas campestris*pv. *ricinicola*

Symptoms

The pathogen attacks cotyledons, leaves and veins and produces few to numerous small round, water-soaked spots which later become angular and dark brown to jet black in color. The spots are generally aggregated towards the tip. At a later stage the spots become irregular in shape particularly when they coalesce and areas around such spots turn pale-brown and brittle. Bacterial ooze is observed on both the sides of the leaf which is in the form of small shining beads or fine scales.

Pustules on lower leaf surface

Management

- Field sanitation help in minimizing the yield loss as pathogen survives on seed and plant debris.
- Hotwater treatment of seed at 58˚C to 60˚C for ten minutes.
- Grow tolerant varieties.
- Spray Copper oxychloride 2kg/ha or Streptocycline100g/haorPaushamycin250g/ha.

Wilt-*Fusariumoxysporum*

Symptoms

When seedlings are attacked cotyledonary leaves turn to dull green colour, wither and die subsequently. Leaves are droop and drop off leaving behind only top leaves. Diseased plants are sickly in appearance. Wilting of plants, root degeneration, collar rot, drooping of leaves and necrosis of affected tissue and finally leading to death of plants. Necrosis of leaves starts from margins spreading to interveinal areas and finally to the whole leaf. Spilt open stem shows brownish discolouration and white cottony growth of mycelia much prominently in the pith ofthe stem.

Symptoms

Management

- Selection of disease freeseeds.
- Grow tolerant and resistant varieties like Jyothi, Jwala, GCH-4 DCH-30 and SHB 145.
- Avoidwaterlogging
- Burning of crop debris
- Greenmanuringandintercroppingwithredgram
- Treat the seeds with thiram @ 2g/ kg or carbendiazim @ 2g/ kg seed.
- Seedtreatmentwith4gof*Trichoderma viride*talcformulation.
- Multiplicationof2kgof*T.viride*formulation by mixing in 50kg farm yard manure
- Sprinklingwaterandcoveringwithpolythenesheetfor15daysandthenapplying between rows of the crops is helpful in reducing the incidence.

7. DiseasesofSesamum

Rootrotorstemrotorcharcoalrot-*Macrophominaphaseolina*(Sclerotialstage: ***Rhizoctoniabataticola*****)**

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.

Symptoms

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 shriveled andbecome black in colour. Minute pycnidia are also seen on the infected capsules and seeds. The rotten root as well as stem tissues contains a large number of minute black sclerotia. Thesclerotia may also be present on the infected pods and seeds.

Pathogen

The pathogen produces dark brown, septate mycelium showing constrictions at thehyphal junctions. The sclerotiaare minute, dark black and 110-130µm in diameter. The pycnidiaare dark brown with a prominent ostiole.The conidiaare hyaline, elliptical and single celled.

FavourableConditions

- Daytemperature of 30˚Candabove
- Prolonged drought followed by copious irrigation.

Diseasecycle

The fungus remains dormant as sclerotia in soil as well as in infected plant debris

in soil. The infected plant debris also carries 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

- Seedtreatmentwithcarbendazim+thiram(1:1)at2g/kgseed.
- Treat the seeds with*Trichoderma viride*at4g/kg.
- Applyfarmyardmanureorgreenleafmanureat10t/haorneemcake150kg/ha.Spot drench with Carbendazim at 1.0 g/litre.

Leafblight- ***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 ofthe spots are greyish brown incolour.Inseverelightingdefoliationoccurs.Darkbrownlesionscanalsobeseenonpetioles, 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 conidiophoreswhich are straight or curved. The conidia are light olive coloured with transverse and longitudinal septa. These are around 3-5 septate and conidia are borne in chain over short conidiophore.

FavourableConditions

- Low temperature (20-25˚C),
- Highrelativehumidity
- Cloudy weather.

Disease Cycle

Thefungusisseed-borneandalsosoil-borneasitremainsdormantintheinfectedplant debris.

Management

- TreattheseedswiththiramorCarbendazimat2g/kg.
- Spray Mancozeb at 2kg/ha orIprodion1L/ha.

Leaf spot -*Cercosporasesami*

Symptoms

The disease first appears on the leaves as minute water-soaked lesions, which enlarge to formroundtoirregularspotsof5-15mmdiameteronboththeleafsurface.Thespotscoalesceto 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.

Symptoms

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.

DiseaseCycle

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

Management

- Treat the seeds with Carbendazin or Thiram at 2g/kg.
- Spray with Mancozeb at 2kg/ha.

Wilt-*Fusarium oxysporum*f.sp. *sesami*

Symptoms

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

Symptoms

Pathogen

The fungus produces macroconidia, microconidiaand 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.

Disease Cycle

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

- TreattheseedswithThiramorCarbendazimat2g/kg
- Seed treatment with*Trichoderma viride*at4g/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 andaffectsbranchesandmaygirdlethestem,resultinginthedeathoftheplant.Leavesmayalso show water-soaked patches and spread till the leaves wither. Infection may be seen on flowers and capsules. Infected capsules are poorly developed with shriveled seeds.

Symptoms

Pathogen

The fungus produces non-septate, hyaline mycelium. The sporangiophoresare 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.

FavourableConditions

- Prolongedrainfall,
- Low temperature (25˚C)
- High relative humidity (above 90 per cent)

Disease Cycle

The fungus can survive in the soil through 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

- Treattheseedswithcaptanorthiramat2g/kgormetalaxyl@4g/kg.
- Avoid continuous cropping of sesamum in the same field.
- Remove and destrosy infected plant debris.

- Spray metalaxyl1kg/ha.

Powderymildew- *Erysiphecichoracearum*(Syn:*Oidium acanthospermi)*

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.Theseverallyaffectedleavesmaybetwistedandmalformed.Intheadvancedstagesof infection, the mycelial growth changes to dark or black because of development of cleistothecia.

Symptoms

Pathogen

The Pathogen produces hyaline, septate mycelium which is extophytic and sends haustoriainto the host epidermis. Conidiophoresarise 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 cleistotheciaare dark, globose with the hyaline or pale brown myceloid appendages. The asciare ovate and each ascus produces 2-3 ascospores, which are thin walled, elliptical and pale brown in colour.

FavourableConditions

- Dry humid weather.
- Lowrelativehumidity.

Disease Cycle

The Pathogen is an obligate parasiteand disease perennates through cleistothecia in the infected plant debris in soil. The ascosporesfrom 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 karathane 1L/ha repeat after 15 days.

Bacterialleafspot-

***Xanthomonascampestris*pv.*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 color. Several spots coalesce together forming irregular brown patches and cause drying of leaves. The reddish brown lesions may also occur on petioles and stem.

Symptoms

Pathogen

Thebacterium is aGram negativerod with amonotrichousflagellum.

Diseasecycle

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

Management

- Remove and burn infected plant debris.

- SprayStreptomycinsulphateoroxytetracyclinehydrochlorideorstrephocyclinat 100g/ha.

Bacterial leaf spot- *Pseudomonas sesami*

Symptoms

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

Symptoms

Pathogen

The bacterium is gram negative aerobic rod with one or more polar flagella.

Diseasecycle

The bacterium remains viable in the infected plant tissues. It is internally seedborne and secondary spread through rain splash and storms.

Management

- Keep the field free of infected plant debris.
- SpraywithStreptomycinsulphateoroxytetracyclinehydrochlorideorstreptocyclinat 100g/ha.

Phyllody- Phytoplasma

Symptoms

Thesymptomsstartswithveinclearingofleaves.Thediseasemanifestsitselfmostly duringfloweringstage,whenthefloralpartsaretransformedintogreenleafystructures,which

growprofusely.Theflowerisrenderedsterile.Theveinsofphylloidstructurearethickand prominent. The plant is stunted with reduced internodes and abnormal branching.

Symptoms

Pathogen

Itiscausedbypleomorphicmycoplasmalikebodiespresentinsievetubeofaffected plants, now designated as a phytoplasmal disease.

Diseasecycle

The pathogen has a wide host range and survives on alternate hosts like *Brassicacampestris* var. *toria,B. rapa, Cicer arietinum, Crotalaria* sp.,*Trifolium* sp.,*Arachis hypogaea*which serve as source of inoculum. The disease is transmitted by jassid, *Orosiusalbicinctus.* 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 sesame. Nymphs are incapable of transmitting the phytoplasma. Vector population is moreduring summer and less during winter months.

Management

- Removeallthereservoirandweedhosts.
- Avoidgrowingsesamumnearcotton,groundnutandgrainlegumes.
- Rogueouttheinfectedplantsperiodically.
- SprayMonocrotophosorDimethoateat500ml/hatocontrolthejassids

- Soil treatment with Thirnet 10G @ 10 kg/ha or Phorate10 G @ 11 kg/ha at the time ofsowing.

Minor disease

Anthracnose -Colletotrichum sp.

Dark brown lesions on leaf stem and capsules with black acervuliin the central portion.

8. DiseasesofCotton

Wilt - *Fusarium oxysporum*f.sp. *vasinfectum*Symptoms

Thediseaseaffectsthecropatallstages.Theearliestsymptomsappearontheseedlings 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. discoloration starts from the margin and spreads towards the midrib. The leaves loose their turgidity, gradually turn brown, droop and finally drop off.

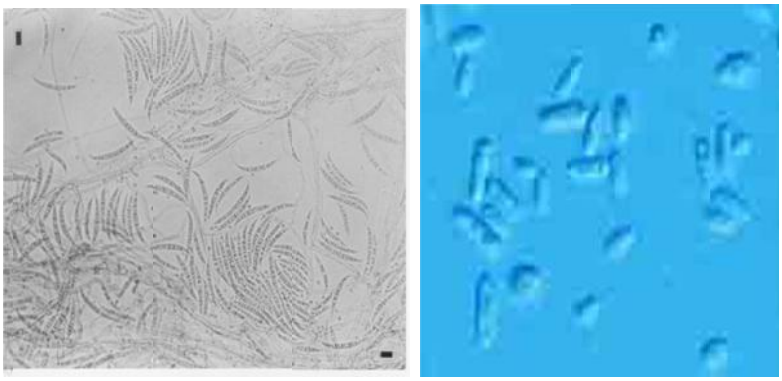
Symptoms start from the older leaves at the base, followed by younger ones towards the top, finally involving the branches and the whole plant. The defoliation or wilting may be complete leaving the stem alone standing in the field. Sometimes partial wilting occurs; where in only one portion of the plant is affected, the other remaining free. The taproot is usually stunted with less abundant laterals.

oms

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. Insevere cases, discolouration may extend throughout the plant starting from roots extending tostem,leavesandevenbolls.Intransversesection,discolouredringisseeninthewoodytissues of stem. The plants affected later in the season are stunted with fewer bolls which are very small and open before they mature.

Pathogen

Macroconidiaare1to5septate,hyaline,thinwalled,falcatewithtapperingends.The microconidiarehyaline,thinwalled,sphericalorelliptical,singleortwocelled. Chlamydosporesaredarkcolouredandthickwalled.Thefungusalsoproducesavivotoxin, Fusaricacidwhichispartiallyresponsibleforwiltingoftheplants.



FavourableConditions

- Soiltemperatureof20-30˚C
- Hotanddryperiodsfollowedbyrains
- Heavyblacksoilswithanalkalinereaction
- Increaseddosesofnitrogenandphosphaticfertilizers
- Woundscausedbynematode(*Meloidogyneincognita*)andgrubsofAshweevil (*Myllocerus pustulatus*).

Diseasecycle

The fungus can survive in soil as saprophyte for many years and chlamydospores act as restingspores.Thepathogenis bothexternallyandinternallyseed-borne.Theprimaryinfection 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

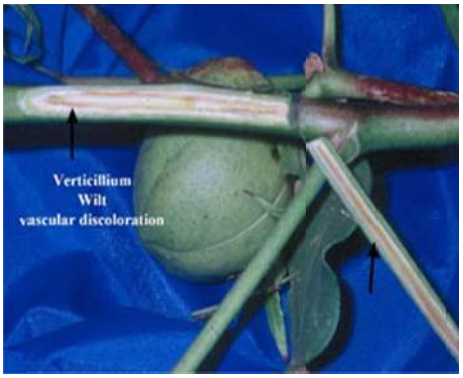
- TreattheaciddelintedseedswithCarboxinorCarbendazim at2g/kg.
- Removeandburntheinfectedplantdebrisinthesoilafterdeepsummerploughing during June-July.
- Applyincreaseddosesofpotashwithabalanceddoseofnitrogenousandphosphatic fertilizers.
- Applyheavydosesoffarmyardmanureorotherorganicmanures.Followmixed cropping with non-host plants.
- Growdiseaseresistantvarietiesof*G.hirsutum*and*G.barbadense*likeVaralakshmi, Vijay Pratap, Jayadhar and Verum.
- SpotdrenchwithCarbendazim1g/litre.

Verticilliumwilt-*Verticilliumdahliae*

Symptoms

The symptoms are seen when the crop is in squares and bolls. Plants infected at earlystagesareseverelystunted.Thefirstsymptomscanbeseenasbronzingofveins.Itisfollowed byinterveinalchlorosisand yellowingofleaves.Finallytheleavesbeginto dry, givinga scorched appearence. 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, whensplit open, show a pinkish discolouration of the woody tissue which may taper off intolongitudinal streaks in the upper parts and branches. The infected leaf also shows brown spots at the end of the petioles. The affected plants may bear a few smaller bolls with immature lint.



s

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 condiophores. The micro sclerotia are globose to oblong, measuring 48-120 X 26-45um.

FavourableConditions

- Lowtemperatureof15-20˚C,
- Lowlyingandill-drainedsoils,
- Heavysoilswithalkalinereaction
- Heavydosesofnitrogenousfertilizers.

DiseaseCycle

Thefungusalsoinfectstheotherhostslikebrinjal,chilli,tobaccoandbhendi.The fungus can survive in the infected plant debris and in soils as micro sclerotia upto 14 years. Theseedsalsocarrythemicrosclerotiaandconidiainthefuzz.Theprimaryspreadisthroughthe

micro sclerotia or conidia in the soil. The secondary spread is through the contact of diseasedroots to healthy ones and through dissemination of infected plant parts through irrigation waterand other implements.

Management

- TreatthedelintedseedswithCarboxinorCarbendazimat2g/kg.
- Removeanddestroytheinfectedplantdebrisafterdeepploughinginsummermonths (June-July).
- Applyheavydosesoffarmyandmanureorcompostat100t/ha.
- Followcroprotationbygrowingpaddyorlucerneorchrysanthemumfor2-3years.
- Spotdrenchwith0.05g/lbenomylorcarbendazim500mg/l.
- Grow disease resistant varieties like Sujatha, Suvin and CBS 156 and tolerant variety like MCU 5 WT.

Rootrot-*Rhizoctoniasolani*

Symptoms

The pathogencauses three types of symptoms viz., seedling disease, sore-shin and rootrot.Germinatingseedlingsandseedlings ofone totwoweeks oldare attackedbythe fungusat the hypocotyl and cause black lesions, girdling of stem and death of the seedling, causing large gaps 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.

Typicalrootrotsymptomappearsnormallyatthetimeofmaturityoftheplants.The most prominent symptom is sudden and complete wilting of plants in patches. Initially, all the leaves droop suddenly and die with in a day or two. The affected plants when pulled reveal the rottingofentirerootsystemexcepttaprootandfewlaterals.Thebarkoftheaffectedplant 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

Thefungalhyphaeareseptateandfairlythickandproduceblack,irregularsclerotia whichmeasure100mindiameter.

Favourableconditions

- Dryweatherfollowingheavyrains,
- Highsoiltemperature(35-39˚C),
- Cultivationoffavourablehostslikevegetables,
- Oilseedsandlegumesprecedingcotton
- Woundscausedbyashweevilgrubsandnematodes.

Diseasecycle

Thediseaseismainlysoil-borneandthepathogencansurviveinthesoilassclerotiafor severalyears.Thespreadisthroughsclerotiawhicharedisseminatedbyirrigationwater, implements,andotherculturaloperations.

Management

- Treattheseedswith*Trichodermaviride*@4g/kgofseed.
- Spotdrenchwith0.1%Carbendazim.

- Applyfarmyardmanureat10t/haorneemcakeat150Kg/ha.
- Adjust the sowing time, early sowing (First Week of April) or late sowing (Last week ofJune) so that crop escapes the high soil temperature conditions.
- Adoptintercroppingwithsorghumormothbean(*Phaseolusaconitifolius*)tolowerthe soil temperature.

Anthracnose-*Colletotrichumcapsici*

Symptoms

Thepathogeninfectstheseedlingsandproducessmallreddishcircularspotsonthe cotyledonsandprimaryleaves.Thelesionsdeveloponthecollarregion,stemmaybegirdled, causingseedlingtowiltanddie.Inmatureplants,thefungusattacksthestem,leadingtostem splittingandshreddingofbark.Themostcommonsymptomisbollspotting.Smallwater soaked, circular, reddish brown depressed spots appear on the bolls. The lint is stained to yellowor brown,becomesasolidbrittlemassoffibre.The infectedbollsceasetogrowandburstand dry up prematurely.

oms

Pathogen

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

Favourable Conditions

- Prolongedrainfallatthetimeofbollformation
- Closeplanting.

DiseaseCycle

The pathogen survives as dormant mycelium in the seed or as conidia on the Surface of seeds 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., *Aristolachiabractiata*and *Hibiscus diversifolius.*

Management

- TreatthedelintedseedswithCarbendazimorCarboxinorThiramorCaptanat2g/kg.
- Removeandburntheinfectedplantdebrisandbollsinthesoil.
- Rogueouttheweedhosts.
- Spray the crop at boll formation stage with Mancozeb 2kg or Copper oxychloride 2.5 kgor or Carbendazim 500g/ha.

GreyorAreolatemildew-*Ramulariaareola*(Sexualstage**:*Mycosphaerellaareola)***

Symptoms

Thediseaseusuallyappearsontheundersurfaceofthebottomleaveswhenthecropi nearingmaturity.Irregulartoangularpaletranslucentlesionswhichmeasure1-10mm(usually 3-4mm)developonthelowersurface,usuallyboundbyveinlets.Ontheuppersurface,the lesions appear as light green or yellow green specks.

Afrostyorwhitishgreypowderygrowth,consistingofconidiophoresofthefungus, appears onthe lower surface. When several spots coalesce, the entire leaf surface is covered bywhitetogreypowderygrowth.Whiteorgreypowderygrowthmayoccurontheuppersurface also. The infection spreads to upper leaves and entire plant may be affected. The affected leavedry up from margin, cup inward; turn yellowish brown and fall of prematurely.

s

Pathogen

The pathogen produces endophytic, septate mycelium. Conidiophores are short,hyalineand branched at the base. Conidia are borne singly or in chains at the tips ofconidiophores. The conidia are hyaline, irregularly oblong with pointed ends, sometimes rounded to flattend 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.

FavourableConditions

- Wethumidconditionsduringwintercottonseason,
- IntermittentrainsduringNorth-Eastmonsoonseason,
- Lowtemperature(20-30˚C)duringOctober-January,
- Closeplanting,excessiveapplicationofnitrogenousfertilizers,
- Veryearlysowingorverylatesowingofcotton

Diseasecycle

The pathogen 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

- Removeandburntheinfectedcropresidues.
- Rogueouttheself-sowncottonplantsduringsummermonths.
- Avoidexcessiveapplicationofnitrogenousfertilizers/manures.
- Adoptthecorrectspacingbasedonsoilconditionsandvarieties.
- SpraythecropwithCarbendazimat500g/ha,repeatafteraweek.
- GrowtheresistantvarietieslikeSujathaandVaralakshmi.

Bollrot-Fungalcomplex

It is a complex disease caused by several fungal pathogens *viz.*, *Fusarium moniliforme*, *Colletotrichum capsici*, *Aspergillus flavus*, *A. niger*, *Rhizopus nigricans*,*Nematosporanagpuri*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 and prematurely. In some cases, the rotting may be external, causingrotting 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.

s

FavourableConditions

- Heavyrainfallduringthesquareandbollformationstage,
- Woundscausedbytheinsects,
- Especiallyredcottonbug*Dysdercuscingulata*
- Closespacingandexcessivenitrogenapplication.

DiseaseCycle

Thefungisurviveintheinfectedbollsinthesoil.Theinsectsmainlyhelpinthespreadof thedisease.Thefungimaketheirentryonlythroughwoundscausedbytheinsects.The secondaryspreadofthediseaseisalsothroughair-borneconidia.

Management

- Adoptoptimumspacing.
- Applytherecommendeddosesoffertilizers.
- Spray Copper oxychloride2.5kg along with an insecticide for bollworm from 45th day at 15 days interval.
- Twoorthreespraysarenecessary.

Leafblight-*Alternariamacrospora*

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 onthe 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.

ptoms

Pathogen

Thefungusproducesdarkbrown,short,1-8septate,irregularlybendconidiophoreswith 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.

FavourableConditions

- Highhumidity.

- Intermittentrains.
- Moderatetemperatureof25-28˚C.

Diseasecycle

The pathogen survives in the dead leaves as dormant mycelium. The pathogen primarilyspreads through irrigation water. The secondary spread is mainly by airborne conidia.

Management

- Removeanddestroytheinfectedplantresidues.
- SprayMancozeb2kgorCopperoxychlorideat2kg/haattheintimationofthedisease. Four to five sprays may be given at 15 days interval.

Bacterial blight - *Xanthomonas axonopodis*pv. *malvacearum*Symptoms

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

i) Seedlingblight:

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) Angularleafspot:

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 thesurface ofleaves. Asthelesions become older, theyturntoreddishbrown colour and infection spreads to veins and veinlets.

iii) Veinblightorveinnecrosisorblackvein:

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. Theinfection also spreads from veins to petiole and cause blighting leading to defoliation.

iv) Blackarm:

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,resultinginbreakingofthe stemandhangtypicallyasdry blacktwigtogivea characteristic “black arm” symptom.

v) Squarerot/Bollrot:

On the bolls, water soaked lesions appear and turn into dark black and sunken irregularspots.Theinfectionslowlyspreadstoentirebollandsheddingoccurs.Theinfectiononmature bollsleadtoprematurebursting.Thebacteriumspreadsinsidethebollandlintgetsstained yellow because of bacterial ooze and looses its appearance and market value. The pathogen alsoinfects the seed and causes reduction in size and viability of the seeds.

Angularleafspot

Bacterialblightlesionsonleafandtheblacklegsymptomontheleafpetiole

Bollrot

Pathogen

The bacteriumis 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 µm.

FavorableConditions

- Optimumsoiltemperatureof28˚C,
- Highatmospherictemperatureof30-40˚C,
- Relativehumidityof85percent,earlysowing,
- Delayedthinning,
- Poortillage,lateirrigationand
- Potassiumdeficiencyinsoil.
- Rain followed by bright sunshine during the months of October and November are highly favorable.

DiseaseCycle

Thebacteriumsurvivesoninfected,driedplantdebrisinsoilforseveralyears.The bacteriumisalsoseed-borneandremainsintheformofslimymassonthefuzzofseedcoat.The bacteriumalsoattacksotherhostslike*Thumbergiathespesioides,Eriodendronanfructuosum* 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 sulphateovernight.
- Remove and destory the infected plant debris. Rogue out the volunteer cotton plants and weed hosts.

- Followcroprotationwithnon-hostcrops.
- Earlythinningandearlyearthingupwithpotash.
- GrowresistantvarietieslikeSujatha,1412andCRH71.
- SpraywithStreptomycinsulphate+Ttetracyclinemixture100galongwithCopperoxychlorideat 1.25 Kg/ha.

LeafCurlDisease-*Cottonleafcurlvirus*

Symptoms

Downwardandupwardcurling ofleavesandthickeningof veinsand enationon undersideofleavesarethe characteristicsymptomsofthedisease.In serveinfectionallthe leavesarecurledandgrowthretarded.Bollbearingcapacityisreduced

Pathogen

It is caused by *Cotton leaf curl virus* - a begomovirusof family geminiviridae. Thevirions are typical geminateparticles, ss circular DNA, bipartite genomewith DNA-A and DNA- B components.

DiseaseCycle

Theprimarysourceisthe viruliferouswhiteflyvector*Bemisiatabaci*.Thealternate hostsandcultivatedhostsserveasvirusreservoirsthroughoutthe year. Nottransmittedbyseed or contact.

Management

- Managementofplantingdatetoavoidpeakvectorpopulation.
- Elimination of volunteer perennial cotton and alternate hosts including malvaceous hosts like wild okra
- Use of fungus *Paecilomycesfarinosus*which parasitizes *B.tabaci*. It brings down vectorpopulation.
- Foliarapplicationofneemleafextractand1%neemoilresultedin80%reductionof virus transmission.
- Vectormanagementbyapplicationofgranularsystemicinsecticides.

Stenosis or Small leaf - PhytoplsamaSymptoms

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 canbe 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

- Rogueouttheinfectedplantsperiodically.
- Cotton varieties developed from *Gossypium hirsutum*and *G. barbadense*are found to be resistant to the disease.

Minordiseases

Leafspot-*Cercosporagossypina*

Round or irregular grayish spots with dark brown or blackish borders appear on older leaves.

Myrotheciumleafspot-*Myrotheciumroridum*

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-*Phakopsoradesmium*

Yellowishbrownraisedpustulesappearonthelowersurfaceofleaveswithrusty spores. Several pustules join to give rusty appearence to entire leaf. The sori may also develop on bolls.

Sootymould-*Capnodium*sp.

Darkspecksappearontheleavesandbolls,slowlyspreadandblackpowderygrowth covers the entire leaf area and bolls.

9. DiseasesofRedGram

Wilt-*Fusariumudum*

Symptoms

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

Pathogen

The fungus produces hyaline, septate mycelium. Microconidiaare hyaline, small, elliptical or curved, single celled or two celled. Macroconidiaare also hyaline, thin walled,linear, curved or fusoid, pointed at both ends with 3-4 septa. The fungus also poduce thick walled, spherical or oval, terminal or intercalary chlamydosporessingly or in chains of 2 to 3.

Favourableconditions

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

Disease cycle

The fungus survives in the infected stubbles in the field. The primary spread is by soil-borne chlamydospores and also by infected seed. 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 (10^6cfu/g).
- Avoidsuccessivecultivationofredgraminthesamefield.
- Croprotationwithtobacco.
- Mixed cropping with sorghum in the field.
- Grow resistant cultivars like Sharad, Jawahar, Maruthi, Malviya Arhar-2, C-11, Pusa-9,Narendra Arhar-1 and Birsa Arhar-1

Dryrootrot- *Macrophominaphaseolina*(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 occurs 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. Large number of brown dots seen on the stem portion represents the pycnidial stage of the fungus.

Symptoms

Pathogen

The fungus produces dark, brown, filamentous hyphae and constrictions are seen in hyphal branches at the junction with main hyphae. Sclerotiaare jet black, smooth, hard, minute, globose and 110-130µm in diameter. The pycnidiaare 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.

FavourableConditions

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

Disease cycle

The primary spread of the disease is by seed and soil. Secondary spread is by 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 2g/kg or pellet the seeds with*Trichodermaviride*at 4 g/kg (10^6cfu/g).
- Apply heavy doses of farm yard manure or green leaf manure like *Gliricidia maculata*at 10 t/ha or apply Neemcake at 150 kg/ha.

Powderymildew- *Leveillulataurica*

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 of 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.

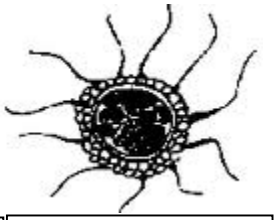
Symptoms

Pathogen

The fungus is intercellularand absorbs nutrition through haustoria. The conidiophores, which arise through stomata, are hyaline, long, non septate, slender and rarely branched and bear singleconidiumatthetip.Theconidiarehyaline,singlecelledandellipticalorclavate.The

fungus also produces black, globose cleistotheciawith simple myceloid appendages.They contain 9-20 cylindrical asci. Each ascuscontains 3-5 ascosporeswhich are also hyaline and unicellular.

Conidia and conidiophores



Cleistothecium

FavourableConditions

- Dry humid weather following rainfall.

Disease Cycle

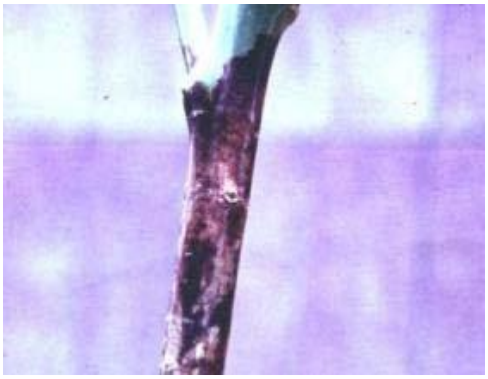
The fungus survives in the soil through cleistotheciaand ascosporesfrom asci infect the first lower most leaves near the soil level. Secondary spread is by air-borne conidia.

Management

Spray Carbendazim500g/ha or Wettable sulphur2 kg/ha at the initiation of the diseaseand repeat after 15 days.

Stemblight-*Phytophthoradrechslerif*sp.*cajani*Symptoms

Initially purple to dark brown necrotic lesions girdle the basal portion of the stem and later may occur an aerial parts. Initially lesions are small and smooth, later enlarging and slightly depressed. Infected tissues become soft and whole plant dies. In grown up plants, infection is mostly confined to basal portions of the stem. The infected bark becomes brown and the tissue softens causing the plant to collapse. In leaf, localized yellowing starts from the tip and margin andgraduallyextendstowardsthemid-rib.Thecentreofthespotslaterturnbrownandhard.The spots increase in size and cover a major portion of the lamina, leading to drying.



Symptoms

Pathogen

Fungusproduceshyaline,coenocyticmycelium.Thesporangiophoresarehyalinebearing ovateorpyriform,non-papillatesporangia.Eachsporangiumproduces8-20zoospores.Oosporesare globose, light brown, smooth and thick walled.

FavourableConditions

- Soilswithpoordrainage,
- Low lying areas,
- Heavy rain during the months of July- September
- High temperature (28-30˚C).

Disease Cycle

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

Management

- Treat the seeds withMetalaxylat 6 g/kg.
- SprayMetalaxylat500g/ha.
- Adjust the sowing time so that crop growth should not coincide with heavy rainfall.

Leaf spot -*Cercosporaindica*

Symptoms

Small, light brown coloured spots appear on leaves. The spots later become dark brown andtheinfectedportionsdropoffleavingshotholesymptoms.Whenseveralspotsjointogether, irregular necrotic blotches develop and premature defoliation occurs. In severe cases, black lesions develop on petioles and stem.

Symptoms

Pathogen

Thefungusproduceslargenumberofwhip-like,hyaline,7-9septateconidiaingroupson the conidiophores which are light to dark brown in colour.

Disease cycle

Thefungussurvivesintheinfectedplanttissues.Thediseaseisspreadbyairborne conidia.

Management

- Remove the infected plant debris and destroy.
- SprayMancozeb2kgorCarbendazim500g/hasoonaftertheappearanceofsymptom and repeat after a fortnight.

SterilityMosaicDisease(SMD)-*Pigeonpeasterilitymosaicvirus*(PPSMV) Symptoms

The Symptoms are characterized by bushy and pale green appearance of plants.The excessive vegetative growth, stunting, prominent mosaic on leaves and reduction in leaf size. Complete or partial cessation of flowering leads to sterility. Depending on genotype three types of symptoms are recognized. They are

a. Severe mosaic and sterility
b. Mild mosaic and partial sterility
c. Chlorotic ringspot without any noticeable sterility.

Light and dark green mosaic pattern on leaves

Sterilitymosaicinfectedplant(rightside)withoutflowersandpods compared to normal plant (left side)

Pathogen

Itiscausedby*Pigeonpeasterilitymosaicvirus*(PPSMV).Thevirionsareslenderhighly flexuousfilamentousvirus like particles (VLPS) of 3-10 nm diameter, a major virus specific proteins of 32kDa and 5-7 major RNA species of 0.8-6.8kb.

Disease cycle

Itisnottransmittedbyinfectioussap.Itistransmittedbyaneriophyidmite,*Aceriacajani*inasemip ersistantmanner,mitesretainingthevirus12-13hours,eggsofmitesdonot transmit. The self grownredgram plants and perennial species act as source of virus inoculums. **Management**

- Rogue out infected plants up to 40 days after sowing.
- Spray Monocrotophosat 500 ml/ha soon after appearance of the disease and if necessary, repeat after 15 days.

- Growresistantgenotypes/cultivarslikeICP7035,VR3,Purple1,DA11,DA32,ICP 6997, Bahar, BSMR 235, ICP 7198, PR 5149, ICP 8861 and Bhavanisagar 1.

Minor diseases

Seedlingblight- ***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 - ***Colletrtrichumcapsici***

Purple brown discolouration occurs mainly on pods but also on petioles, leaf veins, stems and peduncles. Pods become distorted and have black fruiting bodies.

Anthracnose-*Colletotrichum lindemuthianum* *(Glomerellacingulata)*

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 -*Alternaria alternata*

Water soaked, circular to irregular spots occur. The centre of the spot is straw coloured with raised reddish brown margins.

Haloblight- ***Pseudomonas phaseolicola***

Small brown spots appearon leaves and develop a chlorotic halo. The spots extend and form dried brown zone. Brown elongated streaks appear on petioles, stem and pods.

There are two other virus diseases reported on pigeonpea, mosaic and yellow mosaic transmitted by aphidsand whiteflies which are of sporadic occurrence only.

10. DiseasesofBlackgram

Powderymildew- *Erysiphe polygoni*

Symptoms

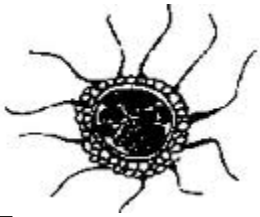
Small, irregular powdery spots appear on the upper surface of the leaves, sometimes on both the surfaces. The disease becomes severe during flowering and pod development stage. The white powdery spots completely cover the leaves, petioles, stem and even the pods. The plant assumes greyish white appearance;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

Symptoms

Pathogen

The fungus is ectophytic, spreading on the surface of the leaf, sending haustoriainto the epidermal cells. Conidiophoresarise vertically from the leaf surface, bearing conidiain short chains. Conidiaare hyaline, thin walled, elliptical or barrel shaped or cylindrical and single celled. Later in the season, cleistotheciaappear as minute, black, globose structures with myceloid appendages. Each cleistotheciumcontains 4-8 ascand each ascuscontains 3-8 ascosporeswhich are elliptical, hyaline and single celled.

Conidia and conidiophores



Cleistothecium

FavourableConditions

- Warmhumidweather.
- The disease is severe generally during late kharif and rabi seasons.

Disease cycle

The Pathogen 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

- Removeanddestroyinfectedplantdebris.
- SprayCarbendazim500gorWettablesulphur2kgorTridemorph500ml/haattheinitiation of disease and repeat 15 days later.

Anthracnose-

Colletotrichumlindemuthianum**(**Sexualstage**:*****Glomerellalindemuthianum*****)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 andcause death of the seedlings. Small angular brown lesions appear on leaves, mostly adjacent to veins, which later become greyish white centre with dark brown or reddish margin.

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

Symptoms

Pathogen

The fungus mycelium is septate, hyaline and branched. Conidiaare 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 conidiophoresare 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 ascosporeswhich are one or two celled with a central oil globule.

FavourableConditions

- Highrelativehumidity(Above90percent),
- Low temperature (15-20˚ C)
- Cool rainy days.

Disease cycle

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

- Removeanddestroyinfectedplantdebrisinsoil.
- TreattheseedswithCarbendazimat2g/kg.

- Spray Carbendazim 500g or Mancozeb 2kg/ha soon after the appearance of disease andrepeat after 15 days.

Leaf spot -*Cercosporacanescens*

Symptoms

Small, circular spots develop on the leaves with grey centre and brown margin. 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.

Symptoms

Pathogen

Thefungusproducesclustersofdarkbrownseptateconidiophores.Theconidiaare linear, hyaline, thin walled and 5-6 septate.

FavourableConditions

- Humid weather and dense plant population.

Disease cycle

The fungus survives on diseased plant debris and on seeds. The secondary spread is byair-borne conidia.

Management

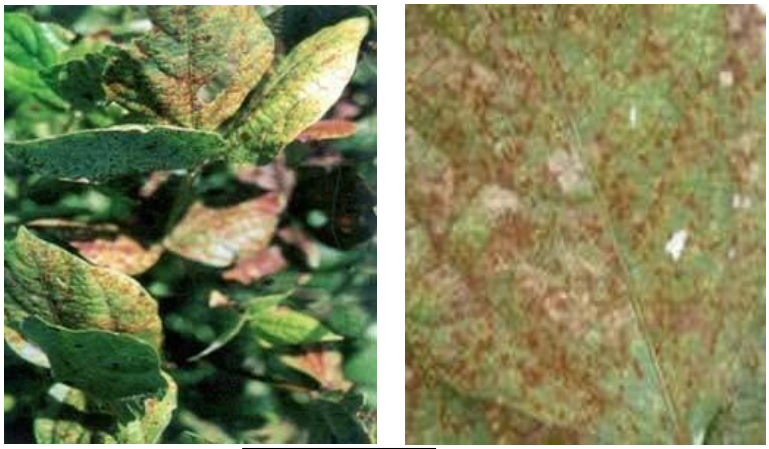
- Removeandburninfectedplantdebris.
- Spray Mancozeb at 2 kg/ha or Carbendazim at500 g/ha.

Rust-

***Uromycesphaseolitypica*(Syn:*U.appendiculatus*)Symptom**

s

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



Symptoms

Pathogen

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

FavourableConditions

- Cloudy humid weather, temperature of 21-26˚ C
- Nights with heavy dews

Mode of Spread and Survival

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

Management

- Removetheinfectedplantdebrisanddestroy.
- Spray Mancozeb2 kg or Carbendazim500 g or Propiconazole1L/ha, immediately on the set of disease and repeat after 15 days.

Dryrootrot-*Rhizoctoniabataticola*(Pycnidialstage**:*Macrophominaphaseolina*)**

Symptoms

The disease symptom starts initially with yellowing and drooping of the leaves. The leaves later fall off and the plant dies with in 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.

Symptoms

Pathogen

The fungus produces dark brown, septate mycelium with constrictions at hyphalbranches. Minute, dark, round sclerotia in abundance. The fungus also produces dark brown, globose ostiolatedpycnidiaon the host tissues. The pycnidiosporesare thin walled, hyaline, single celled and elliptical.

Favourableconditions

- Day temperature of 30˚C.
- Prolonged dry season followed by irrigation.

Disease cycle

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 spreads is through pycnidiosporeswhich are air-borne.

Management

- Treat the seeds with carbendazim + thiram at 2 g/kg (1:1 ratio) or pellet the seeds with *Trichoderma viride*at 4 g/kg (10^6cfu/g) or *Pseudonomas fluorescens* @ (10^6cfu/g) of seed.
- Applyfarmyardmanureorgreenleafmanure*(Gliricidiamaculata)*at10t/haor neemcake at 150 kg/ha.

MungbeanYellowmosaicdisease-

***Mungbeanyellowmosaicvirus*(MYMV)Symptoms**

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

Symptoms

Pathogen

It is caused by *Mungbean yellow mosaic India virus*(MYMIV) in Northen and Centralregionand*Mungbeanyellowmosaicvirus*(MYMV)inwesternandsouthernregions.Itisa

Begomovirus belonging to the family geminiviridae. Geminatevirus particles, ssDNA, bipartitegenomewith two gemonic components DNA-A and DNA-B.

Disease cycle

Transmitted by whitefly, *Bemisiatabaci*under favourable conditions. Disease spreads by feeding of plants by viruliferouswhiteflies.Summer sown crops are highly susceptible. Weed hosts viz., *Croton sparsiflorus*, *Acalypha indica*, *Eclipta alba*and other legume hosts serve as reservoir for inoculum.

Management

- Rogueoutthediseasedplantsupto40daysaftersowing.
- Removetheweedhostsperiodically.
- Increasetheseedrate(25kg/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.
- Treattheseeds with Thiomethoxam-70WS orImidacloprid-70WS @4g/kg
- Spray Thiamethoxam-25WG @ 100g or Imidacloprid17.8% SL @ 100 ml in 500 lit ofwater.

Leafcrinkledisease-*Urdbeanleafcrinklevirus*(ULCV)

Symptoms

Crinkling and curling of the tips of leaflets and increase in leaf area. Crinkling and rugosity in older leaves becomes severe and leaves thickened. Petioles as well as internodes are shortened. Infected plant gives a stunted and bushy appearance. Flowering is delayed, if inflorescence is formed, is malformed with small size flower buds and fails to open.

Pathogen

Casual organism of the disease is not yet ascertained.

Disease cycle

Presence of weed hosts like *Aristolochiabracteata*and *Digera arvensis*. Kharif season cropandcontinuouscroppingofotherlegumesserveassourceofinoculum.Thevirusisseed-

borneandprimaryinfectionoccursthroughinfectedseeds.Perhapswhitefly,*Bemisiatabaci* helps in the secondary spread. The virus is also sap transmissible.

Management

- Useincreasedseedrate(25kg/ha).
- Rogueoutthediseasedplantsatweeklyintervalupto45daysaftersowing.Cultivate seed crop during rabi season.
- Removeweedhostsperiodically.
- Spray methyl demeton on 30 and 40 days after sowing at 500 ml/ha.

Leafcurl/Necrosis-*Groundnutbudnecrosisvirus*(GBNV)

Symptoms

Upward cupping and curling of leaves with vein clearing. Infected leaves turn brittle and sometimes show vein necrosis on the under surface of the leaves, extending to the petiole. Plants affected in the early stages of growth develop top necrosis and die. Plant may produce a few small and malformed pods.

Pathogen

It is caused by *Groundnut bud necrosis virus*

Disease cycle

Thevirusistransmittedbythripsviz.,*Frankliniellaschultzii*,*Thripstabaci*and *Scirtothripsdorsalis*. The virus survives in weed hosts, tomato, petunia and Chilli.

Management

- Rogue out infected plants up to 30 days after sowing.
- Removetheweedhostswhichharbourvirusandthrips.
- Spray imidachlor at 500 ml/ha on 30 and 45 days after sowing.

Minor diseases

Ascochyta leaf spot - *Ascochyta phaseolorum*

Smallirregularspotwithgreytobrowncentreandyellowborder.Theyrapidlyenlargeto produce very large brown lesions with concentric markings.

Bacterial blight - *Xanthomonas phaseoli*

Circular,reddishbrownspotsappearonleaves,enlargetoformirregularbrownlesions. Water soaked, sunken spots with red border occur on pods.

11. DiseasesofGreengram

Powderymildew- *Erysiphe polygoni*

Symptoms

Powdery mildew is one of the widespread diseases of several legumes in green gram. White powdery patches appear on leaves and other green parts which later become dull colored. These patches gradually increase in size and become circularcoveringthelower surface also. When the infection is severe, both the surfaces of the leaves are completely covered by whitish powdery growth. Severely affected parts get shriveled and distorted. In severe infections,foliage becomes yellow causing premature defoliation. The disease also creates forced maturity of the infected plants which results in heavy yield losses.

Pathogen

The fungus is ectophytic, spreading on the surface of the leaf, sending haustoriainto the epidermal cells. Conidiophoresarise vertically from the leaf surface, bearing conidia in short chains. Conidia are hyaline, thinwalled, elliptical or barrel shaped or cylindrical and singlecelled. Later in the season, cleistotheciaappear as minute, black, globose structures with myceloid appendages. Each cleistothecium contains 4-8 asci and each ascuscontains 3-8 ascosporeswhich are elliptical, hyaline and single celled.

FavourableConditions

- The pathogen has a wide host range and survives in oidial form on various hosts in off-season.
- Secondary spread is through air-borne oidia produced in the season

Disease Cycle

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

Management

- Useresistantvarieties

- Theseedsmustbesownearlyinthemonthof Junetoavoidearlyincidenceofthedisease on the crop.
- .SprayCarbendazim500gorWettablesulphur1.5kgorTridemorph500ml/haatthe initiation of disease and repeat 15 days later.

Anthracnose -*Colletotrichum lindemuthianum*- (Sexual stage:***Glomerellalindemuthianum)*

Symptoms

The disease appears on all aerial part parts and at any stage of plant growth. Circular, black, sunken spots with dark center and bright red orange margins on leaves and pods. In severe infections, the affected parts wither off. Seedlings get blighted due to infection soon after seed germination.

Pathogen

The Disease appears on fungus mycelium is septate, hyaline and branched. Conidiaare 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 conidiophoresare 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.

FavourableConditions

- The disease is more sever in cool and wet seasons.

Disease cycle

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

- Hotwatertreatmentat54ºfor10min.
- Use disease free seed.
- Followcroprotation
- Removeanddestroyinfectedplantdebrisinsoil.
- TreattheseedswithCarbendazimat2g/kg.

- Spray Carbendazim 500g or Mancozeb 2kg/ha soon after the appearance of disease andrepeat after 15 days.

Leaf spot -*Cercosporacanescens*

Symptoms

Thisisanimportantdiseaseofgreengramandisusuallyoccursinasevereform,causing heavy losses in yield. Spots produced are small, numerous in numbers with pale brown centreand reddish brown margin. Similar spots also occur on branches and pods. Under favourable environmentalconditions,severeleafspottinganddefoliationoccursatthetimeoffloweringand pod formation.

Pathogen

Thefungusproducesclustersofdarkbrownseptateconidiophores.Theconidiaare linear, hyaline, thin walled and 5-6 septate.

Favourableconditions

- Highhumidityfavoursdiseasedevelopment.

Disease cycle

The fungus survives on diseased plant debris and on seeds. The secondary spread is byair-borne conidia.

Management

- Cultivateresistantvarieties.
- Intercropthemoongwithtallgrowingcerealsandmillets.
- Followcleancultivation.
- Use disease free seed.
- Maintainlowcroppopulationdensityandwiderowplanting.
- Thecrudeextractsofcassava,garlic,andzingerareappliedforcontrollingthedisease effectively.
- Mulching reduces the disease incidence resulting in increaseyield.
- Spray Mancozeb 2kg/ha or Carbendazim500 g/ha.

Rust-*Uromyces phaseolitypica*(Syn:*U. appendiculatus*)

Symptoms

The disease appears as circular reddish brown pustules which appear more commonly on the underside of the leaves, less abundant on pods and sparingly on stems. When leaves are severely infected, both the surfaces are fully covered by rust pustules.Shriveling followed by defoliation resulting in yield losses.

Pathogen

It is autoecious,long cycle rust and all the spore stages occur on the same host. The uredosporesare unicellular, globose or ellipsoid, yellowish brown with echinulations. The teliosporesare globose or elliptical, unicellular, pedicellate, chestnut brown in colour with warty papillae at the top. Yellow colouredpycniaappear on the upper surface of leaves. Orange coloured cupulate aeciadevelop later on the lower surface of leaves. The aeciosporesare unicellular and elliptical.

FavourableConditions

- Cloudyhumidweather,
- Temperature of 21-26˚C
- Nights with heavy dews.

Disease Cycle

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

Management

- Removetheinfectedplantdebrisanddestroy.
- SprayMancozeb12kgorCarbendazim500gorPropiconazole1L/hakg/ha,immediately on the set of disease and repeat after 15 days.
- Use tolerant varieties.

Dryrootrot- *Rhizoctonia bataticola*(Pycnidial stage: *Macrophominaphaseolina)*

Symptoms

The disease symptom starts initially with yellowing and drooping of the leaves. The leaves later fall off and the plant dies with in week. Dark brown lesions are seen on the stem at groundlevelandbarkshowsshreddingsymptom.Theaffectedplantscanbeeasilypulledout

leavingdried,rottenrootportionsintheground.Therottentissuesofstemandrootcontaina large number of black minute sclerotia.

Pathogen

The fungus produces dark brown, septate mycelium with constrictions at hyphalbranches. Minute, dark, round sclerotia in abundance. The fungus also produces dark brown, globose ostiolated pycnidia on the host tissues. The pycnidiosporesare thin walled, hyaline, single celled and elliptical.

Favourableconditions

- Daytemperature of 30˚C.
- Prolonged dry season followed by irrigation.

Disease cycle

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 air-borne pycnidiospores.

Management

- TreattheseedswithCarbendazim+Thiramat2g/kgorpelletttheseedswith *Trichoderma viride*at 4 g/kg or*Pseudonomas fluorescens*@ 10g/kg of seed.
- Apply farm yard manure or green leaf manure *(Gliricidia maculate)* at 10 t/ha or neemcake at 150 kg/ha.

Yellowmosaicdisease-*Mungbeanyellowmosaicvirus*(MYMV) Symptoms

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

Pathogen

It is caused by Mungbean yellow mosaic India virus (MYMIV) in Northen and Central region and *Mungbean yellow mosaic virus* (MYMV) in western and southern regions. It is a Begomovirus belonging to the family geminiviridae. Germinate virus particles, ssDNA, bipartite genome with two gemonic components DNA-A and DNA-B.

Disease cycle

Transmitted by whitefly, *Bemisiatabaci*under favourable conditions. Disease spreads by feeding of plants by viruliferouswhiteflies. Summer sown crops are highly susceptible. Weed hosts viz., *Croton sparsiflorus*, *Acalypha indica*, *Eclipta alba*and other legume hosts serve as reservoir for inoculum.

Management

- Rogueoutthediseasedplantsupto40daysaftersowing.
- Removetheweedhostsperiodically.
- Increasetheseedrate(25kg/ha).
- Grow resistant green gram variety like Pant Moong-3, Pusa Vishal, Basanti, ML-5, ML-337, PDM-54 and Samrat.
- Cultivatethecropduringrabiseason.
- 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.
- Treat the seeds with Thiomethoxam-70WS or Imidacloprid-70WS @4g/kg
- Spray Thiamethoxam-25WG @ 100g or Imidacloprid 17.8% SL @ 100 ml in 500 lit ofwater.

Leafcrinkledisease-*Urdbeanleafcrinklevirus*(ULCV)

Symptoms

Crinkling and rugosity in older leaves becomes severe and leaves thickened. Crinkling and curling of the tips of leaflets are seen. Petioles as well as internodes are shortened. 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.

Pathogen

Casualorganismofthediseaseisnotyetascertainedworkisinprogressindifferent laboratories.

Disease Cycle

Presence of weed hosts like *Aristolochiabracteata*and *Digera arvensis.* Kharif seasoncropandcontinuouscroppingofotherlegumesserveassourceofinoculum.Thevirusisseed-

borneandprimaryinfectionoccursthroughinfectedseeds.Perhapswhitefly,*Bemisiatabaci* helps in the secondary spread. The virus is also sap transmissible.

Management

- Useincreasedseedrate(25kg/ha).
- Rogueoutthediseasedplantsatweeklyintervalupto45daysaftersowing.Cultivate seed crop during rabi season.
- Removeweedhostsperiodically.
- Spray Methyldemetonon 30 and 40 days after sowing at 500 ml/ha.

Leafcurl/Necrosis-*Groundnutbudnecrosisvirus*

Symptoms

Upward cupping and curling of leaves with vein clearing. 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. Plant may produce a few small and malformed pods.

Pathogen

Caused by groundnut bud necrosis virus

Disease Cycle

Thevirusistransmittedbythripsviz.,*Frankliniellaschultzii*,*Thripstabaci*and *Scirtothrips dorsalis*. The virus survives in weed hosts, tomato, petunia and Chilli.

Management

- Rogue out infected plants up to 30 days after sowing.
- Removetheweedhostswhichharbourvirusandthrips.
- Spray Imidachlor at 500 ml/ha on 30 and 45 days after sowing.

Minor diseases

Ascochyta leaf spot - *Ascochyta phaseolorum*

Smallirregularspotwithgreytobrowncentreandyellowborder.Theyrapidlyenlargeto produce very large brown lesions with concentric markings.

Bacterial blight- *Xanthomonas phaseoli*

Circular,reddishbrownspotsappearonleaves,enlargetoformirregularbrownlesions. Water soaked, sunken spots with red border occur on pods.

12. DiseasesofSoybean

Dryrootrot- *Macrophominaphaseolina*

Symptoms

The disease symptom starts initially with yellowing and drooping of the leaves. The leaves later fall off and the plant dies with in 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.

Symptoms

Pathogen

The fungus produces dark brown, septate mycelium with constrictions at hyphal branches. Minute, dark, round sclerotiain abundance. The fungus also produces dark brown, globose ostiolatedpycnidiaon the host tissues. The pycnidiosporesare thin walled, hyaline, single celled and elliptical

Favourableconditions

- Daytemperature of 30˚C
- Prolonged dry season followed by irrigation.

Disease cycle

The fungus survives in the infected debris and also as facultative parasite in soil. Theprimaryspreadisthroughseed-borneandsoil-bornesclerotia.Thesecondaryspread

isthroughseed-borneandsoil-bornesclerotia.Thesecondaryspreadsisthrough pycnidiospores which are air-borne.

Management

- TreattheseedswithCarbendazimorThiramat2g/kgorpelletttheseedswith *Trichoderma viride*at 4 g/kg or*Pseudonomas fluorescens*@ 10g/kg of seed.
- Apply farm yard manure or green leaf manure *(Gliricidia maculata)* at 10 t/ha or neem cake at 150 kg/ha.

Wilt-*Fusariumoxysporumf.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.

Symptoms

Pathogen

The fungus produces falcate shaped macroconidiawhich are 4-5 septate, thin walled and hyaline. The microconidiaare single celled hyaline and oblong or oval. The chlamydosporesare also produced in abundance.

Favourableconditions

Temperatureof20-25˚C and moist humid weather.

Disease cycle

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

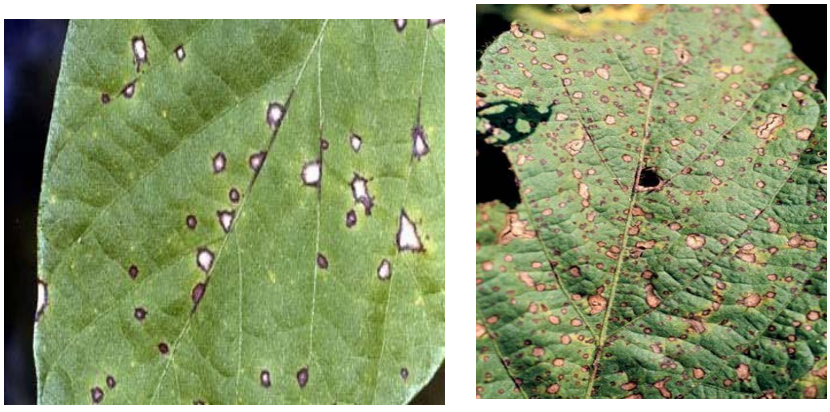
Management

- TreattheseedswithCarbendazimorThiramat2g/kgortreattheseedswith *Trichoderma viride*at 4 g/kg.
- Spot drenching with Carbendazim at 0.5 g/litre.

Leaf spot -*Cercosporasojana*

Symptoms

Lighttodarkgrayorbrownareasvaryingfromspeckstolargeblotchesappearon seeds. The disease primarily affects foliage, but, stems, pods and seeds may also be infected. Leaf lesions are circular or angular, at first brown then light brown to ash grey with dark margins. The leaf spot may coalesce to form larger spots. When lesions are numerous the leaves wither and drop prematurely. Lesions on pods are circular to elongate, light sunken and reddish brown.



Symptoms

Favourableconditions

- Fungus survives in infected seeds and in debris.
- Warm, humid weather favor disease incidence

Management

- Useresistantvarieties.
- Usehealthyorcertifiedseeds.
- Rotate soybean with cereals.
- Completelyremoveplantresiduebycleanploughingthefieldsoonafterharvest.
- Destroy last years infected stubble.
- SeedtreatmentwithThiram+Carbendazium(1:1)@2g/kgseed.
- SprayMancozeb@2g/LorCarbenzadium(500mg/L).

Mosai-Soybeanmosaicvirus(SMV)

Symptoms

Diseased plants are usually stunted with distorted (puckered, crinkled, ruffled, narrow) leaves. Pods become fewer and smaller seeds. Infected seeds get mottled and deformed. Infected seeds fail to germinate or they produce diseased seedlings.

Symptoms

Pathogen

Itiscausedby*Soybeanmosaicvirus*-apotyvirus.Flexuousparticles750- 900nm long, ss RNA genome

.

Disease cycle

Soybean mosaic virus is seed borne. The SMV can be transmitted through sap, 32 aphid species are involved in transmission.

Favorable conditions

- Temperaturearound18^{o}C
- Humidweather.

Management

- Deepsummerploughing.
- Useresistantortolerantvarieties.
- Usehealthy/certifiedseeds.
- Keep the field free from weeds.
- Rogueoutinfectedplantsandburnthem
- Pre-sowing soil application ofPhorate@10kg/ha.
- Two foliar sprays of Thiamethoxam25 WG @ 100 g/ha or Methyl demeton800 ml/ha at 30 and 45 days after sowing.