

2. Maize

(*Zea mays* Linn., Family: Poaceae)

1. Stalk Rot of Maize:

Stalk rots are caused by several fungi and bacteria which affects the plants near maturity. Losses from stalk rot vary region to region and are estimated 10 – 20 %. Losses are caused either by poor filling of the cobs or due to lodging of affected plants. The following pathogens are associated with stalk rot of maize.

Symptoms:

- Stalk rot and ear rot are the two important phases of the disease.
- In stalk rot, symptoms appear after a few weeks of pollination as premature dying of lower leaves which turn into dull grey appearance.
- The internodes become soft and appear tan to brown from outside and pink or reddish inside.
- The pith is completely rotten and the stalk may lodge.
- Plants may die if harvesting is delayed. In ear rot, ears may rot completely and a pinkish mold can be seen between ear and husks.

Pathogens: *Gibberella zeae*; *Diplodia zeae*; *Fusarium species* and *Colletotrichum graminicola* are the major pathogens involved in the rot complex but *G. zeae* dominates in the complex. The fungus produces ascospores in perithecia, mycelium, or chlamydospores in infected plant debris. *G. zeae* also produces mycotoxins which are toxic to human and animals.

Bacterial Pathogens: *Pseudomonas avenae* sub-sp. *avenae* Manns, *Enterobacter dissolvens* (Rosen) Brenner et al. = *Erwinia dissolvens* (Rosen) Burkholder, *Erwinia carotovora* sub-sp. *carotovora* (Jones) Bergey et al. = *E. chrysanthemi* pv. *Zae* (Sabet) Victoria et al.

Fungal Pathogens : *Colletotrichum graminicola* (Ces.) G.W. Wils., Teleomorph: *Glomerella graminicola* (Politis), *G. tucumenensis* (Speg.) Arx & E. Muller., *Physoderma maydis* (Miyabe) Miyabe, *Diplodia maydis* (Berk.) Sacc., *Fusarium moniliforme* J. Sheld var. *subglutinans* Wollenweb & Reinking, *Gibbrella zeae* (Schwein) Petch. (Anamorph: *Fusarium graminearum* Schwabe, *Setophalaria turcica* (Luttrell) K.J. Leonard & E.G.Suggs (Anamorph : *Exserohilum turcicum* (Pass.) K.J. Leonard & E.G. Suggs = *Helminthosporium turcicum* Pass., *Pythium aphanidermatum* (Edson) Fitzp., *Rhizoctonia solani* Kuhn. = *R. zeae* Voorhees = *R. solani* sub sp. *Sasakii*, *Cochliobolus heterostrophus* (Drechs.) Drechs. Anamorph: *Bipolaris maydis* (Nisikado & Miyake) = *Helminthosporium maydis* (Nisikado & Miyake). *Fusarium spp.*, *Mucor sp.*, *Spicaria spp.* & *Rhopoglyphus zeae* Pat.

Disease Cycle: The pathogens survive in soil from one growing season to another. The spores are blown off by wind into the base of leaf sheath and cause infection either by directly penetrating into the host or through wounds caused by insects such as stem borer. Conidia are produced on infected plant parts and serve as secondary inoculum. The disease is favoured by wet weather near or after silking. Higher plant density, high nitrogen and low potash doses and early maturity of hybrids also favour the disease.

Disease Management:

Cultural Practices: low plant density, proper fertility practices, insect control and timely harvesting, Use balanced fertilizer, Minimize all crop stresses, Use proper plant population (lower plant populations).

Chemical Practices:

- Seed treatment with captan and thiabendazole.
- Foliar spray of Carbendazim @ 0.1% or Chlorothalonil @0.3%.
- Use hybrids that are resistant to other stalk rot diseases.
- Control insects.
- The preventive measures for disease management are use of resistant varieties
- Use of disease resistance varieties, i.e. Hybrids Ganga Safed-2, DHM 103.
- Sanitation- removal of infected crop residues.
- Avoid water logging and poor drainage.
- Avoid excessive irrigation
- Avoid injury to plant parts.
- Three application of bleaching powder (10%) @ 16.5 kg/ha at the time of sowing, earthing up and tusseling stage

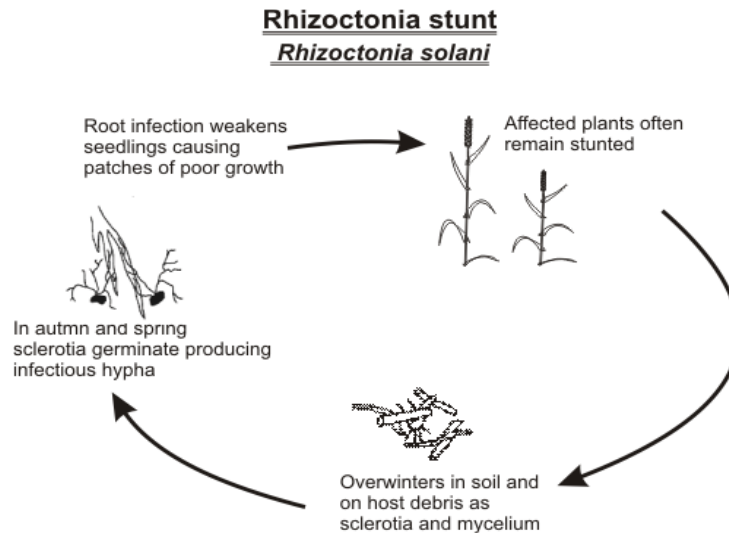
2. Leaf Blights of Maize:

S.N.	Name of disease	Causal organism
1.	Seed and seedling blights	(Aspergillus, Rhizoctonia, Nigrospora, Pythium, Fusarium, Acremonium, Penicillium, Sclerotium, etc.) Symptoms –These diseases are prevalent in temperate areas where soil temperatures are low (below 13°C) during planting time. These diseases pose a serious problem in temperate areas by reducing plant stand. But they do not pose a serious threat in the major tropical environments of India because of rapid emergence of seedlings.
2.	Banded leaf and sheath blight – J&K, HP, Sikkim, Punjab, Haryana, Rajasthan, MP, Delhi, UP, Bihar and North Eastern States.	(Rhizoctonia solani f. sp. sasakii) Symptoms – Characteristic symptoms include concentric bands and rings on infected leaves and sheaths that are discolored, brown, tan or grey in color. The disease develops on leaves and sheaths and can spread to the ears causing ear rot. Dull white to brown sclerotial formation is there on affected plant parts
3.	Turcicum leaf blight Distribution:J&K,H.P.,Sikkim,W.B.,Meghalaya,Tripura,Assam,U.P., Uttaranchal, Bihar, M.P., Gujrat, Karnataka, T. Nadu.	Northern maize leaf blight (Exserohilum turcicum) Symptoms:- Lesions are elliptical and tan in color, developing distinct dark areas as the fungus sporulates. Lesions typically first appear on lower leaves and spread upwards.Under severe infection, lesions may coalesce, blighting the entire leaf. Favourable conditions: High humidity and low temperatures (18-27°C) prevail during the growing season of the host.
4.	Maydis leaf blight: J&K, HP, Sikkim, Meghalaya, Punjab, Haryana, Rajasthan, Delhi, UP, Bihar, MP,	Southern maize leaf blight [Bipolaris maydis (Drechslera maydis)] Symptoms: Young lesions are small and diamond shaped. As they mature, they elongate. Lesions may coalesce, producing a complete “burning” of large areas of the leaves. They vary in size and shape among inbreds and hybrids with

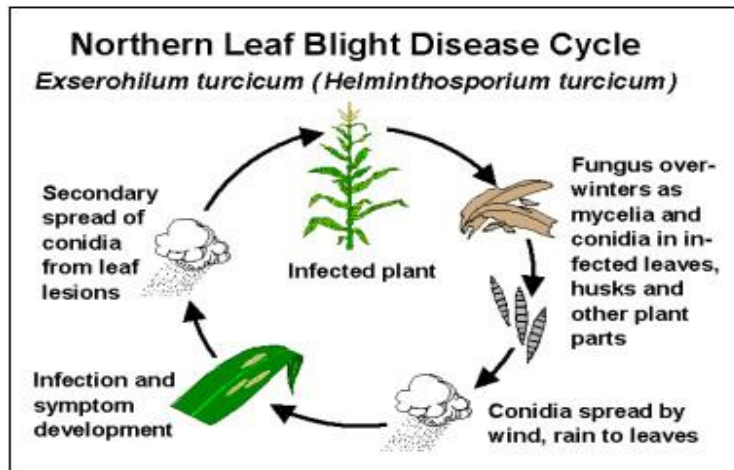
	Gujrat, Maharashtra, AP, Karnataka, TN.	different genetic background. Race 'O' produced tan, elongated (2-6x 3-22 mm) lesion between the veins with limited margins, with buff to brown borders, usually attacks only leaves. Favourable conditions: The disease is prevalent in hot, humid, maize-growing areas. The fungus requires temperatures (20-32 ⁰ C) for infection.
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Disease Cycles:

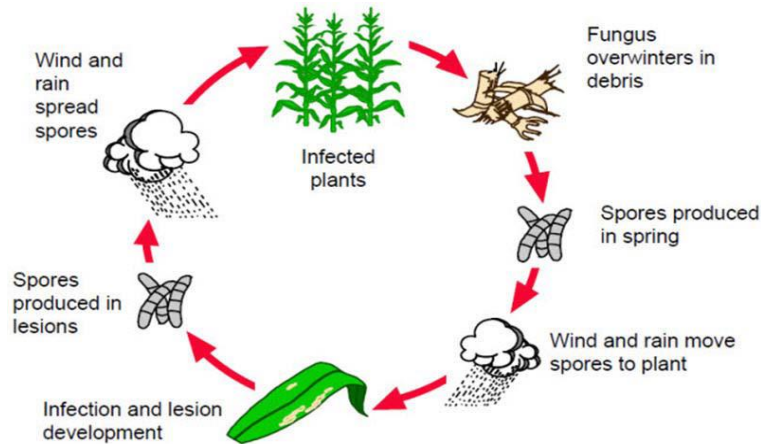
Banded leaf and sheath blight



Northern maize leaf blight



Southern maize leaf blight



Disease Management:

Host resistance

- Lack of resistant commercial varieties.
- Available tolerant germplasm should be cultivated.

Biological control

- Trichoderma bioformulations-through seed dressing and soil application

Cultural control

- Stripping of 2-3 lower leaves.
- Composting of hardwood.
- Fields should be well drained prior to planting.
- Seeds should be planted on raised beds

Chemical control

- Spraying with Zineb/Maneb @ 2 gm/liter at 8-10 days interval or Validamycin (Sheathmar-3) @ 2-3 ml/liter or Carbendazim @ 2gm/litre on the 30-40 days old crop.

3. Downy Mildews of Maize: Downey mildews are found worldwide but they cause serious diseases in Asia and Africa on maize and other grain crops. These diseases cause considerable losses to the yield under favourable conditions of fungal growth. These diseases cause severe damage to hybrid maize like Ganga-3 etc. Several mildews are known as mentioned below:

Symptoms:

- The symptoms appear on younger leaves as white or light green stripes which soon become white or light yellow on most of the leaves of affected plants.
- The sporangia develop on branched sporangiophores which emerge in groups from the plant tissues through stomata.
- A white mat of the fungal growth can be seen on the lower or both the surfaces of leaves during wet weather.
- The stem may also be affected if infection occurs during early stages of plant growth.
- Downy mildew of Maize is characterized by local lesions and systemic infection.
- All Peronosclerospora spp. induce both local and systemic infection.

- Chlorosis, white stripes/streaks, stunting with downy fungal growth on both leaf surfaces are the characteristic symptoms.
- Severe infection also incites blotching. Systemic infection can induce malformation of tassels, ears and other plant parts.
- Wilting generally starts from the top leaves; Leaves become dull green, eventually loose colour and become dry.

S.No.	Name of disease	Causal organism
1.	Brown stripe mildew	<i>Sclephthora rayssiae</i> var. <i>zeae</i> Kenneth et al. Symptoms: causes leaf lesions only. Lesions are initially interveinal and appear as chlorotic, brownish or reddish stripes on the leaves
2.	Philippine downy mildew	<i>Peronosclerospora philippinensis</i> Symptoms: Young plants and seeds may be infected systemically. Malformation of vegetative or floral tissues.
3.	Crazi top downy mildew	<i>Sclephthora macrospora</i> = <i>Sclerospora macrospora</i> Sacc.
4.	Green ear downy mildew	<i>Sclerospora graminicola</i> (Sacc) J. Schrot
5.	Spontaneum downy mildew	<i>Peronosclerospora spontanea</i> = <i>Sclerospora spontanea</i>
6.	Sorghum downy mildew	<i>Peronospora sorghi</i> = <i>Sclerospora sorghi</i>
7.	Sugarcane downy mildew	<i>Peronosclerospora sacchari</i> = <i>Sclerospora sacchari</i>

Pathogens: *Sclerophthora rayssiae*, *Peronosclerospora maydis*; *P. philippinensis*; *P. sorghi* and *P. sacchari* are commonly distributed downy mildew pathogens. These pathogens belong to the group Oomycetes and family peronosporaceae. The first two pathogen attacks maize but the rest two are the pathogens of sorghum and sugarcane respectively but also infect maize.

The *S. rayssiae* produces sporangia at the tips of sporangiophores at their branches. Sporangia are white in colour in the beginning but turn to greyish light brown later. The sporangia germinate by protruding a germ tube and finally produce zoospores at higher temperature. The *P. philippinensis* fungus produces numerous hyaline, thin walled, ellipsoidal conidia on dichotomously branched conidiophores.

Disease Cycle: Downey mildews are **soil and seed borne** in nature. The fungus perpetuates in the form of oospores in the seed or soil or plant debris or sporangia on collateral hosts. The Oospores present in soil serve as source of primary infection. Secondary infection is about by sporangia producing zoospores formed on the lower surface of infected leaves.

Disease Management:

- The control of mildew diseases is difficult.
- General sanitation-The eradication of collateral and wild hosts along with maize debris.
- Seed treatment with Metalaxyl (Apron XL 35 ES 3WS) @ 2.5g/kg gives better protection.
- Use of resistant varieties like– Comp. A-9, Indimyt 345, EH-43861, KH-526, AH-36 DMR 1, DMR 5 and Ganga 11.
- Foliar spray of Mancozeb 2g/ltr or Ridomil MZ at 2g/ltr is recommended.