Lecture No. 4 & 5
Diseases of Maize

Major diseases

1. Downy mildew/Crazy top/ Green ear

   Sorghum downy mildew : *Peronosclerospora sorghi*
   Philippine downy mildew: *Peronosclerospora philippinensis*
   Crazy top : *Sclerophthora macrospora*

2. Northern Corn Leaf blight (NCLB): *Exserohilum turcicum* (asexual stage)
   *Setosphaeria turcica* (perfect stage)

3. Southern Corn leaf blight (SCLB) : *Bipolaris maydis* (*Cochliobolous heterostrophus* - perfect)
4. Rust : *Puccinia sorghi*
5. Head smut : *Sphacelotheca reiliana*
6. Common smut : *Ustilago maydis*
7. Charcoal rot : *Macrophomina phaseolina* (*Rhizoctonia bataticola*)

Minor diseases

1. Bacterial Stalk rot/ Shoot & Ear rot : *Erwinia dissolvens* / *Erwinia carotovora* sp. *zeae*
2. Mosaic : Maize mosaic potyvirus
3. Brown spot : *Physoderma maydis*
4. Soft rot : *Pythium* sp.

Major Diseases

1. Downy mildew/Crazy top/ Green ear

   Sorghum downy mildew : *Peronosclerospora sorghi*
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   Crazy top : *Sclerophthora macrospora*

First reported by Venkatarayan in 1947 in Karnataka (Mysore) where the incidence occurred in 1930. Sporadic infection observed in both early & late sown crops.

**Symptoms:** The most characteristic symptom is the development of chlorotic streaks on 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. Proliferation of axillary buds on the stalk of tassel and the cobs is common (Crazy top).

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

**Favourable Conditions**

- Low temperature (21-33°C)
- High relative humidity (90 per cent) and drizzling.
- Young plants are highly susceptible
- Zinc deficiency disposes plants to infection

**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 sporangia. Some species are also seed borne.

At the onset of growing season, at soil temperature >20°C, oospores in the soil germinate in response to root exudates from susceptible maize seedlings. The germ tube infects the roots of maize plants causing systemic infection which includes extensive chlorosis and stunted growth. If the pathogen is seed borne, whole plants show symptoms. Oospores are reported to survive in nature for upto 10 years. Once the fungus has colonised host tissue, sporangiophores emerge from stomata and produce sporangia which are wind and rain splash disseminated and initiate secondary infections. Sporangia are always produced in the night. They are fragile and cannot be disseminated more than a few 100 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. Initial symptoms of disease i.e., chlorotic specks and streaks parallel to veins occur within 3 days. As the crop approaches senescence, oospores are produced in large numbers.

**Management**

- Deep ploughing
- Crop rotation with pulses
- Rogue out infected plants
- Eradication of collateral and wild hosts
- Grow resistant varieties and hybrids viz. CO1, COH1, COH2, DMR 1, DMR 5 and Ganga 11
- Treat seeds with metalaxyl at 4-6g/kg
- Spray crop with metalaxyl + mancozeb @ 2g/l on 20th day after sowing

2. **Northern Corn Leaf blight (NCLB): Exserohilum turcicum (Setosphaeria turcica - perfect stage)**

Earlier known to be caused by *Helminthosporium maydis* (Syn: *H. turcicum*) (*Cochliobolous heterostrophus*-perfect stage / teleomorph)

**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 which are cigar shaped and are straw to greyish 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.

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

**Favourable conditions**

- Optimum temperature for germination of conidia is 8-27°C provided with free water on 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**

- Balanced fertilizer application based on soil test. Do not apply excessive nitrogen.
- Crop rotation with soyabean or other non host crops
- Treat the seeds with Captan or Thiram @ 4 g/kg.
- Spray Mancozeb 2 Kg/ha or Captan / Zineb @ 0.3% during the pollination period itself

**3. Southern corn leaf blight: Bipolaris maydis (Cochliobolous heterostrophus- perfect)**

There are three races of *B. maydis*: Race O, Race C and Race T. SCLB symptoms vary depending on the infectious pathogen's race. Race T is infectious to corn plants with the Texas male sterile cytoplasm (cms-T cytoplasm maize) and this vulnerability was the cause of the United States SCLB epidemic of 1969-1970. Maize with normal cytoplasm (N) is susceptible to Race O which produces O toxin. Maize with Texas male sterile cytoplasm (T-cms) plants have gene T-urf 13 which is susceptible to Race T producing T-toxin which was found in most of maize growing areas of USA. Corn plants with T-cms cytoplasm have maternally inherited the gene T-urf 13, which encodes for a protein component of the inner mitochondrial membrane. T-toxin acts on this portion of the mitochondria. Maize with cytoplasm male sterile C (C-cms)- currently found only in China is susceptible to Race C producing C-toxin.

**Symptoms:** Lesions appear on leaf ranging from minute specks to spots of one half inch wide and one and one-half inches in length. They are oblong, parallel-sided, and tan to greyish in colour. A purplish to brown border may appear on the lesions depending on the genetic background of the plant. Early and severe infections in susceptible plants predisposes them to stalk rots.

**Favourable conditions:** SCLB is favoured by warm temperature of 20-32°C and high humidity.

**Disease cycle:** The fungus overwinters in corn debris as spores or mycelium. Spores are spread by wind or splashing water to growing plants. After infection and colonization, sporulation from these primary lesions serve as the source for secondary spread and infections, as long as weather conditions are favourable for disease development and living tissues are present. The disease cycle may repeat every few days under ideal conditions.
Management

- Balanced fertilizer application based on soil test. Do not apply excessive nitrogen.
- Crop rotation with soyabean or other non host crops
- Treat the seeds with Captan or Thiram @ 4 g/kg.
- Spray Mancozeb 2 Kg/ha or Captan / Zineb @ 0.3% during the pollination period from 14 days before tasseling to 21 days after tasseling

Difference between Northern corn leaf blight (NCLB) and Southern corn leaf blight (SCLB)

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Northern corn leaf blight</th>
<th>Southern corn leaf blight</th>
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<tbody>
<tr>
<td>1.</td>
<td>Caused by <em>Exserohilum turcicum</em> (<em>Setosphaeria turcica</em> - perfect stage). Earlier known as <em>Helminthosporium turcicum</em>. There are many races or strains of the fungus</td>
<td>Caused by <em>Bipolaris maydis</em> (<em>Cochliobolous heterostrophus</em> – teleomorph / sexual / perfect stage)</td>
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<td>2.</td>
<td>Long, elliptical lesions that are typically cigar shaped. Lesions may be as large as ¾ inch in width and 2 inches in length. The disease progresses upward until, in severe cases, nearly all of the leaves are infected.</td>
<td>Leaf lesions ranging from minute specks to spots of one half inch wide and one &amp; one-half inches in length. They are oblong, parallel-sided, and tan to greyish in colour. A purplish to brown border may appear on the lesions. Early and severe infections in susceptible plants predisposes them to stalk rots.</td>
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<td>3.</td>
<td>NCLB favoured by moderate temperature (18-29°C) high humidity and heavy dew during the growing season</td>
<td>SCLB favoured by warm temperature (20-32°C) and high humidity</td>
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<td>4.</td>
<td>NCLB overwinters in corn debris. Conidia (spores) can be wind blown over long distances. Water splashing can also cause lower leaf infections and result in seedling blighting where continuous corn is planted</td>
<td>Fungus overwinters in corn debris as spores or mycelium. Spores are spread by wind or splashing water to growing plants. After infection and colonization, sporulation from these primary lesions serves as the source for secondary spread and infections as long as weather conditions are favourable for disease development and living tissues are present. The disease cycle may repeat every few days under ideal conditions.</td>
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<td>5.</td>
<td>Although the spores are easily disseminated by winds, rotating to soybeans or another non host crop helps reduce disease levels. Foliar fungicides are also helpful in seed production</td>
<td>Crop rotation is especially suggested where no till is used or where heavy crop residues are found. Since this fungus</td>
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fields where susceptible inbreds are planted. Applications should be made as for SCLB during the pollination period. Maintaining high balanced fertility based upon a soil test is also helpful. Do not apply excessive nitrogen since this may increase infection levels. Overwinters on debris, planting of corn into such residues may result in earlier infection and poor seedling performance. Foliar fungicides are useful in seed production fields. For optimal control, it is important to control foliar disease during the period from 14 days before tasseling to 21 days after tasseling.

4. Rust: *Puccinia sorghi*

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

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

**Favourable Conditions**

- Cool temperature and high relative humidity.

**Disease cycle:** Primary source of inoculum is uredospores surviving on alternate hosts *viz.*, *Oxalis corniculata* and *Euchlaena mexicana*.

**Management**

- Remove alternate hosts.
- Spray Mancozeb at 2-2.5g/l / Bavistin @ 1g/l as soon as first symptoms are observed and it can be repeated at 10 days interval till flowering.

5. Head smut: *Sphacelotheca reiliana*

**Symptoms:** Symptoms are usually noticed on the cob and tassel where fungus affects pistillate & staminate inflorescence forming tumours & the floral parts are covered by black powdery mass of smut spores. Large smut sori replace the tassel and the ear. Sometimes the tassel is partially or wholly converted into smut sorus. The smuttedplants are stunted produce little yield and remain greener than that of the rest of the plants.

**Pathogen:** Smut spores are produced in large numbers which are reddish brown to black, thick walled, finely spined & spherical.
Favourable Conditions

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

**Disease cycle:** Smut spores retain its viability for two years. Fungus is externally seed borne and soil-borne. Primary source of infection is through soil-borne chlamydomos. Spores germinate and enter the seedlings & they grow along with the apical tissues producing sorus at the time of flowering.

**Management**

- Field sanitation
- Crop rotation with pulses
- Growing resistant varieties
- Treat the seeds with Captan or Thiram @ 4 g/kg.

6. Common smut / Smut: *Ustilago maydis*

**Symptoms:** Pathogen causes galls on ears, axillary bus, tassels, stalks & rarely on leaves Epidermal tissues of the galls are dull white or grey bulged from the surface & is shiny. It ruptures & exposes black powdery mass of spores. These spores are spherical, brown I colour. Infection occurs through wounds or through natural openings & it is through air borne conidia.

**Management**

- Field sanitation
- Grow resistant varieties

7. Charcoal rot: *Macrophomina phaseolina (Rhizoctonia bataticola)*

**Symptoms:** Affected plants exhibit wilting symptoms. The stalk of the infected plants can be recognized by greyish streak. The pith becomes shredded and greyish black minute sclerotia develop on the vascular bundles. Shredding of the interior of the stalk often causes stalks to break in the region of the crown. The crown region of the infected plant becomes dark in colour. Shredding of root bark and disintegration of root system are the common features.

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

**Favourable Conditions**

- High temperature and low soil moisture (drought)

**Disease cycle:** The fungus has a wide host range, attacking sorghum, pearlmillet, fingermillet and pulses. It survives for more than 16 years in infected plant debris. The primary source of infection is through soil-borne sclerotia.

**Management**

- Field sanitation
- Long crop rotation with crops that are not natural host of the fungus.
• Irrigate the crops at the time of earhead emergence to maturity.
• Grow disease tolerant varieties \textit{viz.}, SN-65, SWS-8029, Diva, Zenit, DHM 103, Ganga Safed - 2 and avoid sowing of susceptible varieties like DHM 105
• Treat seeds with Carbendazim @ 2 g/kg/ Captan / Thiram @ 4g/Kg

\textbf{Minor diseases}

1. \textbf{Bacterial Stalk rot: Erwinia dissolvens}

\textbf{Symptoms:} The basal internodes develop soft rot and give a water soaked appearance. A mild sweetfermenting odour accompanies such rotting. Leaves some time show signs of wilting and affected plants topple down in few days. Ears and stem may also show rot. They fail to develop further and the ears hang down simply from the plant.

\textbf{Disease cycle:} Borer insects play a significant role in initiation of the disease. The organism is soil borne and makes its entry through wounds and injuries on the host surface. Organism survives saprophytically on debris of infected materials and serves as primary source of inoculum in the next season.

\textbf{Management}

• Use of disease resistance varieties; while no absolute resistance has been identified so far, Hybrids Ganga Safed-2, DHM 103, show significantly less disease incidence than other hybrids.
• Avoid waterlogging and poor drainage.

2. \textbf{Mosaic: Maize mosaic potyvirus}

\textbf{Symptoms:} Symptoms appear as chlorotic spots, which gradually turn into stripes covering entire leafblade. 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 tassels tend to be normal in late infection.

\textbf{Disease cycle:} It is transmitted by leaf hopper vector, \textit{Perigrimus maidis} / \textit{Rhopalosiphum maidis}

3. \textbf{Brown spot: Physoderma maydis}

Water soaked lesions, which are oval, later turn into light green and finally brown.