

## Lecture 6 & 7

### Diseases of Sorghum / Jowar

#### Major diseases

1. Grain smut/Kernel smut / Covered smut / Short smut: *Sphacelotheca sorghi*
2. Loose smut/ kernel smut : *Sphacelotheca cruenta*
3. Long smut : *Tolyposporium ehrenbergii*
4. Head smut : *Sphacelotheca reiliana*
5. Downy Mildew : *Peronosclerospora sorghi*
6. Leaf blight : *Exerohilum turcicum* (Syn: *Helminthosporium turcicum*)
7. Rectangular Leaf spot : *Cercospora sorghi*
8. Anthracnose and red rot : *Colletotrichum graminicolum*
9. Rust : *Puccinia purpurea*
10. Ergot or Sugary disease : *Sphacelia sorghi*
11. Charcoal rot / Stalk rot / Hollow stem: *Macrophomina phaseolina*
12. Phanerogamic parasite : *Striga asiatica* and *Striga densiflora*

#### Bacterial diseases

13. Bacterial leaf Blotch : *Xanthomonas campestris* p.var. *rubrisorghii*
14. Bacterial leaf Stripe : *Pseudomonas syringae* p. var. *sorghicola*

#### 1. Grain smut / Kernel smut / Covered smut / Short smut: *Sphacelotheca sorghi*

Most extensive disease and cause damage to grain. Disease is found both in rainfed and irrigated crops and estimated loss is 25%.

#### Symptoms

Individual healthy grains are replaced by smut sori which can be localized at a particular part of head or occur over the entire inflorescence. Smutted grains are larger than normal and the sori are oval or cylindrical with a dirty grey colour and are covered with a tough creamy skin (peridium) which often persists unbroken upto threshing. Ratoon crops exhibit higher incidence of disease.

#### Disease Cycle

Spores are borne on the surface of the grains and they germinate with the seed, infect the seedling and establish systemic infection and develop along with meristematic tissue of the host. At the time of flowering, fungal hyphae gets converted into spores, replacing ovary with the sori. At the time of harvest, the healthy grains will get contaminated with smut spores. These spores remain dormant on the seed for long periods until the next season. 'Hay Fever' in humans is caused due to allergic reaction of smut spores which is accompanied with sneezing, cold, itching, rhinitis, watery eyes etc.

## **2. Loose smut/ Kernel smut: *Sphacelotheca cruenta***

### **Symptoms**

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 much earlier than the healthy. The glumes are hypertrophied and the earhead gives a loose appearance than healthy. Sorus is covered by a membrane which ruptures very early, exposing the spores even as the head emerges from the sheath. Size of the sorus varies with variety of the host.

## **3. Long smut: *Tolyposporium ehrenbergii***

### **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). 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.

## **4. Head smut: *Sphacelotheca reiliana***

### **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 coloured filaments which are the vascular bundles of the infected head. Sometimes smaller sori develop on the leaves & lower part of the peduncle.

### **Management for all smuts**

- Grow resistant varieties – CSH7R, CSH-5, SPV-245, SPV-138, RSV-1-R against grain smut and the local variety ‘Irungu’ is resistant to Long smut
- Follow crop rotation.
- Collect smutted ear heads in cloth bags and bury in soil or destroy by dipping in boiling water
- Early sowing of the crop
- Use disease free seeds.
- Immerse seed in 0.5% formalin for 2h followed by drying.
- Dipping in 0.5-3.0% copper sulphate for 5 min and drying
- Hot water treatment *i.e.*, soaking in water at 55°C for 15 min.
- Solar treatment - Soak seeds in cold water for 4 -10h & drain and spread in sun for 10-20h
- Treat seeds with Captan / Thiram / Sulphur @ 4 g/kg seed or carboxin (Vitavax) @ 2g /Kg seed

### Differences between various smut diseases of sorghum

Sl.No.	Characters	Grain smut	Loose smut	Long smut	Head smut
1.	Causal organism	<i>Sphacelotheca sorghi</i>	<i>S. cruenta</i>	<i>Tolyposporium ehrenbergii</i>	<i>S. reiliana</i>
2.	Symptom	Apparent only at grain formation. Healthy grains replaced by smut sori. Sori are larger than normal grains. All or most of the grains are smutted	Affected plants stunted. More no. of tillers & flowering is earlier. All spikelets of infected ear are malformed & hypertrophied. The sorus replace pistil and stamen. Affected ear appears leafy and leathery.	Few grains in an ear are smutted & are scattered here & there. Sorus will be covered by a thick whitish yellow membrane. Sorus is larger than the other smuts.	Entire head replaced by large sori which is covered by whitish grey membrane. It ruptures before head emerges from boot leaf to expose a mass of brown smut spores. Spores embedded in long, thin, dark coloured filaments which are the vascular bundles of the infected head.
3.	Sori	Small 5-15x 3-5mm	Small 3-18x 6-8mm	Long 40x 6-8mm	Very long 7.5-10x 2.5-5cm
4.	Columella	Short	long	Absent but 8-10 vascular strands present	Absent but network of vascular tissue present
5.	Smut spore	Single, smooth walled, round to oval, olive brown 5-9µm diameter	Single, spherical / elliptical, dark brown spore wall pitted , 5-10 µm diameter	In balls, globose or angular, brownish green, spore wall warty, 12-16 µm diameter	Loosely bound in balls, spherical, dull brown , minutely papillate, 10-16 µm diameter
6.	Viability of spores	Viability of spores over 10 years	Viability of spores about 4 years	Viability of spores about 2 years	Viability of spores upto 2 years

7.	In culture	Yeast like growth with sporidia	In colonies with sporidia and resting spores 40x50 in diameter	In colonies with masses of sporidia	In colonies germ tubes and sporidia
8.	Spread	Externally seed borne	Externally seed borne	Air borne	Soil & Seed borne

## 5. Downy Mildew: *Peronosclerospora sorghi*

### Symptoms

Fungus invades growing points of young plants, either through oospore or conidial infection. Leaf surface exhibit green to yellow discolouration. Abundant downy white growth is produced on the lower surface of the leaves, which consists of sporangiophores and sporangia. Normally 3-4 leaves develop chlorotic patches. Subsequent leaves show complete bleaching of the leaf tissue in streaks or stripes. Later these leaves turn necrotic and interveinal tissues disintegrate, releasing resting spores (oospores) which are linearly arranged and leaving the vascular bundles loosely connected to give typical shredded leaf symptom. Occasionally green ear symptom is observed whereby the floral parts are converted into green leafy structures.

### Pathogen

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

### Favourable Conditions

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

### Disease Cycle

Primary infection is by means of oospores which persist in soil for 5-10 years and germinate to initiate systemic infection. Secondary spread is by air-borne sporangia. Presence of mycelium of the fungus in the seeds is also a source of infection. The disease has been known to occur through a collateral host, *Heteropogon contortus* on which the fungus perpetuates in the host. Oospores either fall to soil or are wind blown. Conidia are formed at night in large numbers. Optimum temperature for production is 20-23°C.

## Management

- Crop rotation with other crops viz., pulses and oilseeds.
- Avoid the secondary spread of the disease by roguing out infected plants atleast upto 45 DAS since wind plays a major role in the secondary spread of the disease.
- Grow moderately resistant varieties like Co25 and Co26.
- Seed treatment with metalaxyl at 6 g/kg of seed.
- Spray metalaxyl 500 g or mancozeb 2 kg or Ziram 1 kg or Zineb 1kg/ha.

## 6. Leaf blight: *Exerohilum turcicum* (Syn: *Helminthosporium turcicum* /*Drechslera turcicum*)

### Symptoms

Pathogen causes seed rot and seedling blight of sorghum. The disease appears as small narrow elongated spots in initial stage and in due course they extend along the length of the leaf. On older plants, the typical symptoms are long elliptical necrotic lesions, straw coloured in the centre with dark margins. The straw coloured centre becomes darker during sporulation. The lesions can be several cms 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 infected lesion. Conidiophores emerge through stomata and are simple, olivaceous, septate and geniculate. Conidia are olivaceous brown, 3-8 septate and thick walled.

### Favourable Conditions

- Cool moist weather
- High humidity (> 90 %)
- High rainfall.

### Disease cycle

The pathogen is found to persist in the infected plant debris. Seed borne conidia are responsible for seedling infection. Secondary spread is through wind-borne conidia.

### Management

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

## 7. Rectangular Leaf spot: *Cercospora sorghi*

### Symptoms

The symptoms appear as small leaf spots which enlarge to become rectangular lesions (which can be 5-15 mm long by 2 to 5 mm wide) on the leaf and leaf sheath. Usually the lower leaves are first attacked. The lesions are typical dark red to purplish with 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 hyaline, thin walled, 2-13 celled and long obclavate.

### Favourable Conditions

- Cool moist weather.
- High humidity (> 90 %)
- High rainfall

### Disease cycle

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

### Management

- Use disease free seeds.
- Treat the seed with Captan or Thiram at 4 g/kg seed
- Spray Mancozeb 2 kg /ha

## 8. Anthracnose and red rot: *Colletotrichum graminicolum*

### Symptoms

Fungus causes both leaf spot (anthracnose) and stalk rot (red rot). The disease appears as small red coloured spots on both surfaces of the leaf. The centre of the spot is white in colour encircled by red, purple or brown margin. Numerous small black dots like acervuli are seen on 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 marbled appearance.

### Pathogen

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

## Favourable Conditions

- Continuous rain
- Temperature of 28-30°C
- High humidity

## Disease cycle

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

## Management

- Treat the seeds with Captan or Thiram at 4 g/kg
- Spray the crop with Mancozeb 2 kg/ha

### Chief characters of three major leaf disease of sorghum

Sl.No.	Characters	Leaf Blight	Leaf spot	Anthracnose
1.	Pathogen	<i>Exerohilum turcicum</i>	<i>Cercospora sorghi</i>	<i>Colletotrichum graminicolum</i>
2.	Symptom	Spots are long, spindle shaped, several cm long and about 1 cm broad, straw coloured at the centre	Spots are rectangular or irregular bound by veins, red or dark brown coloured, 5-15 mm x 3-5mm depressed	Spots Are elliptical to spindle shaped with whitish centre and coloured margin, dark dots at the centre, 2-4x 1-2mm
3.	Conidiophores	Arise single or in groups through stomata. Conidiophores are long, septate, olivaceous, 150-250 X 7-9µ	Clusters of conidiophores arising through stomata. Conidiophores are long, septate, brown, 40-120 X 2.5-7.5 µ	Acervuli with setae arising through epidermis. Conidiophores are short, single celled and colourless
4.	Conidia	Spindle shaped, olivaceous brown, 3-8 septate, 45-132 X 15x 25 µ	Hyaline, septate, 2-3 celled, obclavate, 30-132 X 3-8 µ	Hyaline, single celled, falcate, vacuolated, 21-32 X 3-7 µ
5.	Spread	Air borne & to some extent seed borne	Air borne & through collateral hosts	Seed borne & air borne

## 9. Rust: *Puccinia purpurea*

### Symptoms

Fungus affects the crop at all stages of growth but more when the plant is 2 months old. Initial symptoms appear as purple, tan or red small flecks on lower leaves. (Pustules (uredosori) appear on both surfaces of leaf as purplish reddish brown spots which rupture to release reddish powdery masses of uredospores. Teliopores develop later on the lower surface of the leaves sometimes in the old uredosori or in teliosori, which are darker and longer than the uredosori. The pustules may also occur on the leaf sheaths and on the stalks of inflorescence. Plants remain stunted and remain unhealthy.

### Pathogen

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

### Favourable Conditions

- Low temperature of 10 - 12°C favours teliospore germination.
- A spell of rainy weather favours the onset of the disease.

### Disease cycle

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

### Management (Refer Wheat)

- Remove the alternate host *Oxalis corniculata*.
- Follow crop rotation
- Follow field sanitation
- Use certified seeds
- Avoid excess dose of nitrogenous fertilizers.
- Avoid late sowing
- Spray Zineb @ 2.5 kg/ha / Propiconazole @ 0.1 %.
- Seed treatment with Plantvax / Vitavax @ 2g / Kg seed / Vitavax Power (carboxin + Thiram) @ 3g / Kg seed
- Foliar application of Vitavax / Plantvax @ 500g / 500l/ ha / carbendazim 0.1% / mancozeb at 3 gm/l.

## 10. Ergot or Sugary disease: *Sphacelia sorghi*

Disease is severe in some parts of India especially in hybrid varieties.



## Symptoms

The disease is confined to individual spikelets. The first symptom is the secretion of honey dew from infected florets which attracts insects and helps in spread of the disease. Under favourable conditions, long, straight or curved, cream to light brown, hard sclerotia develop. Often the honey dew is colonised by *Cerebella sorghivulgaris* which gives the head a blackened appearance.

## Pathogen

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

## Favourable Conditions

- High rainfall and high humidity during flowering season.
- Cool night temperature and cloudy weather aggravate the disease.

## Disease Cycle

Primary source of infection is through germination of sclerotia which release ascospores that infect ovary. Secondary spread takes place through air and insect-borne conidia. Rain splashes also help in spreading the disease.

## Management

- Adjust the date of sowing so that the crop does not flower during September- October when high rainfall and high humidity favour the disease.
- Spray any one of the following fungicides viz., Mancozeb 2 kg/ha (or) Carbendazim at 500 g/ha at emergence of ear head (5-10 % flowering stage) followed by a spray at 50 % flowering and repeat the spray after a week, if necessary.

## 11. Charcoal rot / Stalk rot / Hollow stem: *Macrophomina phaseolina*

### Symptoms

Fungus causes seedling blight and stalk rot in older plants. Infected stalk splits longitudinally into a mass of fibre and tissues are severely weakened. Black sclerotial bodies are seen on infected tissues. Sometimes pycnidia measure 150-200 µm diameter. Fungus is soil borne and can survive saprophytically on crop residues.

### 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.
- Treat seeds with *T. viride* @ 4g/ Kg seed
- Treat seeds with Carbendazim @ 2 g/kg/ Captan/ Thiram @ 4g/Kg

## 12. Head mould/Grain mould/Head blight

More than 32 genera of fungi were found to occur on the grains of sorghum.

### Symptoms

If rains occur during the flowering and grain filling stages, severe grain moulding occurs. The most frequently occurring genera are *Fusarium*, *Curvularia*, *Alternaria*, *Aspergillus* and *Phoma*. *Fusarium semitectum* 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.

### Favourable Conditions

- Long wet weather following flowering favours grain mould development.
- Compact ear heads are highly susceptible.

### Disease cycle

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

### Management

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

## 13. Phanerogamic parasite: *Striga asiatica* and *Striga densiflora*

### Symptoms

It is a partial root parasite and occurs mainly in rainfed sorghum. It is a small plant with bright green leaves, grows upto a height of 15-30 cm. Plants occur in clusters of 10-20/host plant. *S. asiatica* produces red to pink flowers while, *S. densiflora* produces white flowers. Each fruit contains minute seeds in abundance which survives in the soil for several years. Root exudates of sorghum stimulate the seeds of the parasite to germinate. The parasite then slowly attaches to the root of the host by haustoria and 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.

### Management

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