Major Diseases

1. Fusarium Wilt: *Fusarium oxysporum* f. sp. *vasinfectum*
2. Verticillium wilt: *Verticillium dahliae*
3. Root rot: *Rhizoctonia solani*
4. Anthracnose: *Colletotrichum capsici*
5. Grey /Areolate mildew: *Ramularia areola* (sexual stage: *Mycospharella areola*)
6. Boll rot: Fungal complex
7. Leaf blight: *Alternaria macrospora*
8. Bacterial blight: *Xanthomonas axonopodis* pv. *malvacearum*
9. Leaf curl disease: *Cotton leaf curl virus*
10. Stenosis / Small leaf: *Phytoplasma*

Minor diseases

11. Leaf spot: *Cercospora gossypina*
12. Myrothecium leaf spot: *Myrothecium roridum*
13. Rust: *Phakopsora desmium*
14. Sooty mould: *Capnodium* sp.

1. Fusarium Wilt: *Fusarium oxysporum* f. sp. *vasinfectum*

**Symptoms:** Disease affects the crop at all stages. On seedlings symptoms appear on the cotyledons which turn yellow and then brown. Base of petiole shows brown ring followed by wilting and drying of the seedlings. In young and grown up plants, the first symptom is marginal yellowing of edges of leaves and spreads towards the midrib. Leaves lose their turgidity, gradually turn brown, droop and finally drop off.

In older plants, symptoms start at the base, followed by younger ones towards the top, finally involving the branches and the whole plant. Severe wilting and defoliation occur where the stem alone remains in the field. Sometimes partial wilting occurs; wherein only one portion of the plant is affected, the other remains free. Taproot is usually stunted with less abundant laterals. Browning or blackening of vascular tissues is the other important symptom where black streaks or stripes may be seen extending upwards to the branches, leaves, bolls and downwards to lateral roots. Also a discoloured ring is seen in the woody tissues of stem. Plants affected later in the season are stunted with fewer bolls which are very small and open before they mature.

**Pathogen:** Macroconidia with 1-5 septa, hyaline, thin walled, falcate with tapering ends. Microconidia are hyaline, thin walled, spherical or elliptical, single or two celled. Chlamydospores are dark coloured and thick walled. Fungus also produces a vivotoxin fusaric acid which is partially responsible for wilting of the plants.
**Favourable Conditions:**

- Soil temperature of 20-30°C
- Hot and dry periods followed by rains
- Heavy black soils with an alkaline reaction
- Increased dose of nitrogen and phosphatic fertilizers
- Wounds caused by nematode (*Meloidogyne incognita*) and grubs of Ash weevil (*Myllocerus pustulatus*)

**Disease cycle:** Fungus can survive in soil as saprophyte for many years and chlamydospores act as resting pores. Pathogen is both externally and internally seed-borne. Primary infection is mainly from dormant hyphae and chlamydospores in the soil. Secondary spread is through conidia and chlamydospores which are disseminated by wind and irrigation water.

**Management**

- Treat the acid delinted seeds with carboxin or carbendazim at 2 g/kg.
- Remove and burn the infected plant debris in the soil after deep summer ploughing during June-July
- Apply increased doses of potash with a balanced dose of nitrogenous and phosphatic fertilizers
- Apply heavy doses of FYM or other organic manures
- Follow mixed cropping with non-host plants.
- Grow disease resistant varieties of *G. hirsutum* and *G. barbadense* like Varalakshmi, Vijay Pratap, Jayadhar and Verum.
- Spot drench with carbendazim 1g/litre.

**2. Verticillium wilt: Verticillium dahliae**

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

**Pathogen:** Fungus produces hyaline, septate mycelium and two types of spores. Conidia are single celled, hyaline, spherical to oval, borne singly on verticillate conidiospores. Microsclerotia are globose to oblong.
**Favourable condition**

- Low temperature of 15-20°C
- Low lying and ill-drained soils
- Heavy soils with alkaline reaction
- Heavy doses of nitrogenous fertilizers

**Disease cycle:** Fungus also infects other hosts like brinjal, chilli, tobacco and bhindi. Fungus can survive in infected plant debris and in soils as micro sclerotia upto 14 years. Seeds also carry micro sclerotia and conidia in the fuzz. Primary spread is through micro sclerotia or conidia in the soil. Secondary spread is through contact of diseased roots to healthy ones and through dissemination of infected plant parts through irrigation water and other implements.

**Management**

- Treat the delinted seeds with carboxin or carbendazim at 2g/kg
- Remove and destroy infected plant debris after deep ploughing in summer months (June-July)
- Apply heavy doses of FYM or compost at 100 t/ha
- Follow crop rotation by growing paddy or lucerne or chrysanthemum for 2-3 years
- Spot drench with benomyl (0.05g/l) or carbendazim (1g/l)
- Grow disease with resistant varieties like Sujatha, Suvin and CBS 156 and tolerant variety like MCU 5WT

3. **Root rot: Rhizoctonia solani**

**Symptoms:** Pathogen causes three types of symptoms viz., seedling disease, sore shin and root rot. Germinating seedlings of 1-2 week old are attacked by the fungus at the hypocotyl and cause black lesion, girdling of stem and death of the seedling, causing large gaps in the field. In sore-shin stage (4 - 6 weeks old plants), dark reddish brown cankers are formed on the stems near the soil surface, later turning dark black and plant breaks at the collar region leading to drying of the leaves and subsequently the entire plant.

Typical root rot symptom appears normally at the time of maturity of plants. Most prominent symptom is sudden and complete wilting of plants in patches. Initially, all the leaves droop suddenly and die within a day or two. Affected plants when pulled reveal the rotting of entire root system except tap root and few laterals. Bark of the affected plants 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:** Fungal hyphae septate, fairly thick, produce black, irregular sclerotia
Favourable conditions

- Dry weather following heavy rains
- High soil temperature (35-39°C)
- Cultivation of favourable hosts like vegetables
- Cultivation of oil seeds and legumes
- Wounds caused by ash weevil grubs and nematodes

**Disease cycle:** Disease is mainly soil borne and pathogen can survive in soil as sclerotia for several years. Spread is through sclerotia which are disseminated by irrigation water, implements and other cultural operations.

**Management**

- Treat the seeds with *Trichoderma* @ 4g/ kg of seed
- Spot drench with 0.1% carbendazim
- Apply FYM @ 10 t/ ha or neemcake @ 150 kg/ha
- Adjust sowing time, early sowing (1st week of April) or late sowing (last week of June) so that the crop escapes soil temperature conditions
- Adopt intercropping with sorghum or moth bean (*Phaseolus aconitifolius*) to lower the soil temperature.

4. Anthracnose: *Colletotrichum capsici*

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

**Pathogen:** Pathogen forms large number of acervuli on the infected parts. Conidiophores are slightly curved and club shaped. Conidia are hyaline and falcate, borne single on the conidiophores. Numerous black coloured and thick walled setae are also produced in acervulus.

**Favourable Conditions**

- Prolonged RF at the time of boll formation
- Close planting

**Disease cycle:** Pathogen survives as dormant mycelium in the seed or as conidia on the surface of seeds for about an year. Pathogen also perpetuates on rotten bolls & other plant debris in the soil. Secondary spread is by air borne conidia. Pathogen also survives in weed host *viz.*, *Aristolochia bracteata* & *Hibiscus diversifolius*.
Management:

- Treat the delinted seeds with carbendazim/ carboxin / Thiram / Captan @ 2g/ kg
- Remove and burn infected plant debris and bolls in the soil
- Rogue out weed hosts
- Spray crop at boll formation stage with mancozeb 2 kg/ CoC 2.5 kg/ carbendazim 1g/l

5. Grey or Areolate mildew: *Ramularia areola* (sexual stage: *Mycospharella areola*)

**Symptoms:** Disease usually appear on under surface of bottom leaves when the crop is nearing maturity. Irregular to angular pale translucent lesions (1-10mm) develop on the lower surface usually bound by veinlets. On the upper surface, the lesions appears as light green to yellow green specks. A frosty or white grey powdery growth, consisting of conidiophores of the fungus, appears on both upper and lower surface. Infection spreads to upper leaves and entire plant may be affected. Affected leaves dry up from margin, cup inward, turn yellowish brown and fall prematurely.

**Pathogen:** Pathogen produces endophytic, septate mycelium. Conidiophores are short, hyaline and branched at the base. Conidia are borne singly or in chains at the tips of conidiophores. Conidia are hyaline, irregularly oblong with pointed ends, sometimes round to flat ends, unicellular or 1-3 septate. The perfect stage of the fungus produces perithecia containing many asci. Ascospores hyaline and usually two celled.

**Favourable Conditions**

- Wet humid conditions during winter season
- Intermittent rains during North-East monsoon season
- Low temperature (20-30˚C) during Oct-Jan
- Close planting
- Excessive application of nitrogenous fertilizers
- Very early sowing or very late sowing

**Disease cycle:** 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. Primary infection is through conidia from infected plant debris and secondary spread is through wind, rain splash, irrigation water and implements.

**Management**

- Remove and burn infected crop residues
- Rogue out self-sown cotton plants during summer months
- Avoid excessive application of nitrogenous fertilizers/manures
- Adopt correct spacing based on soil conditions and varieties
- Spray the crop with carbendazim at 1g/l & repeat after a week
- Grow resistant varieties like Sujatha and Varalakshmi
6. **Boll rot**: Fungal complex

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

**Symptoms**: Initially 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. Bolls never burst open and fall off prematurely. In some cases, the rotting may be external, causing rotting of the pericarp leaving the internal tissues free. On the affected bolls, a large number of fruiting bodies of fungi are observed depending upon the nature of the fungi involved.

**Favourable Conditions**

- Heavy rainfall during square and boll formation stage
- Wounds caused by the insects especially red cotton bug, *Dysdercus cingulata*
- Close spacing and excessive nitrogen application

**Disease cycle**: Fungi survive in the infected bolls in the soil. Insects mainly help in the spread of the disease. The fungi make their entry only through wounds caused by the insects. The secondary spread of the disease is also through air borne conidia.

**Management**

- Adopt optimum spacing
- Apply the recommended doses of fertilizers
- Spray copper oxychloride 2.5 kg/ha along with an insecticide against bollworm from 45th day at 15 days interval twice or thrice

7. **Leaf blight**: *Alternaria macrospora*

**Symptoms**: Disease may occur in all stages but more severe when plants are 45-60 days old. Small, pale brown, irregular or round spots may appear on leaves. Each spot has a central lesion surrounded by concentric rings. Several spots coalesce together to form blighted areas. Affected leaves become brittle and fall off. Sometimes stem lesions are also seen. In severe cases, spots may appear on bracts and bolls.

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

**Favourable Conditions**

- High humidity
- Intermittent rains
- Moderate temperature of 25-28°C
Disease cycle: Pathogen survives on dead leaves as dormant mycelium. Pathogen primarily spreads through irrigation water and secondary spread is mainly by airborne conidia.

Management

- Remove and destroy infected plant residues.
- Spray mancozeb 2 kg or copper oxychloride at 2kg/ha on symptom appearance
- Four to five sprays may be given at 15 days interval

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

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

iii) **Vein blight / Vein necrosis / Black vein:** Blackening of veins and veinlets occur giving a typical ‘blightening’ appearance. On the lower surface of the leaf, bacterial ooze are formed as crusts or scales. Affected leaves become crinkled and twisted inward and show withering. Infection also spreads from veins to petiole and cause blightening leading to defoliation

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

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

**Pathogen:** Bacteria - short rod with a single polar flagellum, Gram negative, non spore forming.

**Favourable Conditions**

- Optimum soil temperature
- High atmospheric temperature of 30°C – 40°C
- Relative humidity of 85 per cent, early sowing
- Delayed thinning
• Poor tillage, late irrigation and
• Potassium deficiency in soil
• Rain followed by bright sunshine during the months of October and November are highly favourable

**Disease cycle:** Bacterium survives on infected, dried plant debris in soil for several years. Bacterium is also seed-borne and remains in the form of slimy mass on the fuzz of seed coat. Bacterium also attacks other hosts like *Thumbergia thespesioides*, *Eridendron anfruosum* and *Jatropha curcus*. Primary infection starts mainly from the seed-borne bacterium. Secondary spread of the bacteria may be through wind, windblown 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 1000ppm Streptomycin sulphate overnight
• Remove and destroy infected plant debris.
• Rouge out volunteer cotton plants and weed hosts
• Follow crop rotation with non-host crops
• Early thinning and early earthing up with potash
• Grow resistant varieties like Sujatha, 1412 and CRH 71.
• Spray with streptomycin sulphate + tetracycline mixture 100g along with copper oxychloride at 1.25 Kg/ha

**9. Leaf curl disease: Cotton leaf curl virus**

**Symptoms:** Downward and upward curling of leaves, thickening of veins and enation on underside of leaves are the characteristic symptoms of the disease. In severe infection growth retards. Boll bearing capacity is reduced.

**Pathogen:** It is a Begomovirus belonging to family Geminiviridae. The virions are typical geminate particles with ss circular DNA.

**Disease Cycle:** Primary source is the viruliferous whitefly vector *Bemisia tabaci*. Alternate hosts and cultivated hosts also serve as virus reservoirs throughout the year. It is not transmitted by seed or contact.

**Management**

• Adjust planting date to avoid peak vector population
• Elimination of volunteer perennial cotton and alternate hosts including malvaceous hosts like wild okra
• Use of fungus *Paecilomyces farinosus* which parasitizes *B.tabaci* which brings down vector population.
• Foliar application of neem leaf extract and 1% neem oil resulted in 80% reduction of virus transmission.
• Vector management by application of granular systemic insecticides.

10. **Stenosis / Small leaf**: Phytoplasm

**Symptoms**: Disease appears when plants are 2-3 months old and affected plants are stunted. Numerous extremely small leaves occur in cluster and dormant buds are stimulated resulting in profuse vegetative growth. Leaves turn disfigured and variously lobed. Flowers remain small with abortive ovary. Large number of flower buds and young seeds are developed. Root system is poorly developed and can be easily pulled out. Sometimes, disease affects only the base of the plant, resulting in formation of clump of short branches which bear small and deformed leaves. The mode of transmission of disease and the role of vector are unknown.

**Management**

• Rogue out infected plants periodically.

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

**Minor diseases**

11. **Leaf spot**: *Cercospora gossypina*

**Symptoms**: Round or irregular greyish spots with dark brown or blackish borders appear on older leaves.

12. **Myrothecium leaf spot**: *Myrothecium roridum*

**Symptoms**: Reddish spots of 0.5 mm- 1 cm diameter may appear near the margins of the leaves. Affected portions fall off leaving irregular shot holes on leaves.

13. **Rust**: *Phakopsora desmium*

**Symptoms**: Yellowish brown raised pustules appear on lower surface of leaves with rusty spores. Several pustules join to give rusty appearance to entire leaf. The sori may also develop on bolls.

14. **Sooty mould**: *Capnodium* sp.

**Symptoms**: Dark specks appear on the leaves and bolls, slowly spread and black powdery growth covers the entire leaf area and bolls.