

## MANGO

### 1.0 POWDERY MILDEW (*Oidium mangiferae* Berth.)

**Symptoms:** Wefts of white mycelium on leaves, inflorescences and fruits develop. Later the whole surface of the infected parts is covered with a powdery coating. The fungus is ectophytic, remaining mostly on the surface. The affected fruits do not grow in size and may drop before attaining pea size (Fig. 1a, Fig. 1b).

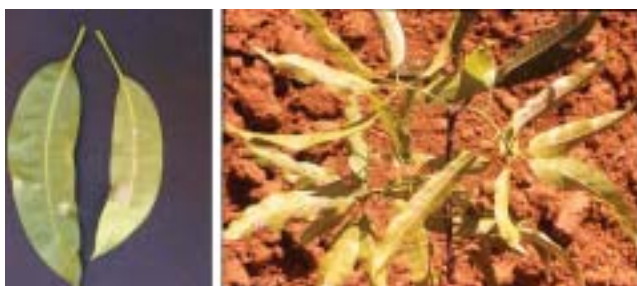


Fig. 1a. Mango: Powdery mildew leaf infection



Fig. 1b. Mango: Powdery mildew: Panicle infection

**Epidemiology:** Warm temperature with heavy morning dew and cloudy weather favour the disease development. The minimum, optimum and maximum temperature for conidia germination are to be 9, 22 and 30.5 °C, respectively.

**Management:** Sprays of wettable sulfur (Sulfex or Wettsulf 0.2 %) or sulfur dusts provide reasonable control of powdery mildew, but it should be avoided during sunny, warm conditions as may cause phytotoxicity (burn) to flowers and young fruit where sprays are applied. Systemic fungicides namely Tridimefon (Bayleton 0.1%) or Dinocap (Karathane 0.1%) or Tridemorph (Calixin 0.1%) or Myclobutanil

(Systhane 0.1%) or Fenarimol (Rubigan 0.05%) or Flusilazole (Punch 0.05%) provide excellent control when the first spray is given at the disease appearance and subsequently three more sprays at 15 days interval should be applied.

### 2.0 ANTHRACNOSE (*Colletotrichum gloeosporioides* (Penz.) Penz. & Sacc.)

**Symptoms:** The disease results in leaf spot, blossom blight, wither tip, twig blight and fruit rot symptoms. Young leaves when infected wither and dry up. At times when only the edges of the leaves are affected, their margins darken, dry up, and may fall out, giving the leaf a ragged appearance. The disease causes the wither tip of young tender twigs. It also results in die-back which appears as blackening of growing tips. The affected branches ultimately dry and infection keeps on penetrating down.

On fruits, infection starts from the blossoming period until the fruits are more than half grown. The spots appear near the stem end as small brown areas that enlarge rapidly and become black. These may form streaks running down from the stem end. The affected areas are sunken and usually crack. The decay is confined to the skin of the fruit except in late stages when it penetrates the flesh in shallow areas. The unripe mature fruits carry the quiescent infection from the field that leads to rotting in the storage during ripening.



Fig. 2a. Mango: anthracnose – foliage infection



Fig. 2b. Mango: anthracnose – Blossom & Immature fruit infection



Fig. 2c Mango: anthracnose – Mature fruit infection

Healthy fruits develop infection after coming in contact with diseased fruit (Fig. 2a, Fig. 2b, Fig. 2c).

**Epidemiology:** The inoculum survives in dried leaves, defoliated branches and mummified flowers and flower brackets. The temperature in the range of 10 - 30 °C

and the R.H in the range of 95 - 97% are highly congenial for infection and subsequent disease development. Rain drops spread the inoculum in the field.

**Management:** The anthracnose could be effectively managed by four pre harvest sprayings with Carbendazim (0.1%) / Thiophanate methyl (0.1%) / Prochloraz (0.1%) or Chlorothalonil (0.2%) at 14 days interval, when the fruits begin to attain pea nut size. Such pre- harvest treated fruits must be further subjected to hot water treatment at 52 °C for ten minutes. This provides very effective control of the rot under storage.

### 3.0 BLOSSOM BLIGHT (*C. gloeosporoides*, *Alternaria alternata*, *Pestalotiopsis mangiferae*)

**Symptoms:** Brownish black spots appear on the foliage. The blossom appear blighted from the bud swelling stage and whole blossom turn into the black thick mass of the tissue. Panicle doesn't develop fully and result in heavy crop loss or total destruction (Fig. 3).



Fig. 3. Mango: Blossom blight

**Management:** Four applications of Carbendazim (Bavistin 0.1%) or Thiophanate methyl (Topsin M or Roko 0.1%) along with Zineb (Indofil Z-78 0.2%) or Chlorothalonil (Kavach 0.2% or Propineb (Anrtacol 0.2%) or Mancozeb (Inofil Dithane M 45 0.2%). or application of Carbendazim + Iprodion (Quintal 0.2%) at 14 days interval when the fruits begin to attain pea nut size.

#### 4.0 STEM END ROT (*Lasiodiplodia theobromae* syn. (*Botryodiplodia theobromae* Pat.)

**Symptoms:** Epicarp turns dark around the base of the pedicel in the initial stage. Subsequently the affected area enlarges to form a circular black patch which extends rapidly under humid atmosphere and turns the whole fruit completely black with in two or three days. The pulp of the diseased fruits becomes brown and somewhat soft (Fig. 4).



Fig. 4. Mango Stem end rot

**Control measures:** Careful harvesting and subsequent handling of the fruits to avoid any injury is very important. Pre harvest application of Carbendazim (Bavistin 0.1%) or Thiophanate methyl (Topsin M or Roko 0.1%), or Chlorothalonil (Kavach 0.2%) spraying in the field and then fruits should be harvested with 1-2" pedicle attached which should be subjected to hot water treatment (52 °C for 10 minutes). Dipping of mangoes in six per cent Borax solution at 43 °C for 3 minutes also reduces the disease incidence.

#### 5.0 DIE-BACK (*Botryodiplodia theobromae* Pat. & *Colletotrichum gloeosporioides* Penz.)

**Symptoms:** Drying of twigs and branches followed by complete defoliation, which gives the tree an appearance of scorching by fire. Discoloration and darkening of the bark occurs some distance from the tip of the twigs. The dark area advances and young green leaves start withering first at the base and then extending outwards

along the vein. The affected leaves turn brown and its margins roll upward. At this stage, the twig or branch dies, leaves shrivel and fall. This may be accompanied by exudation of gum. The infected twigs show internal discoloration. The association of a beetle (*Xyleborus affinis*) has also known to increase the disease incidence (Fig. 5).



Fig. 5. Mango: Die back

**Epidemiology:** Relative humidity above 80%, temperature range of 25 to 31.5 °C and rains help in the disease development.

**Management:** Regular pruning and destruction of affected twigs or branches and application of Copperoxychloride (Blitox or Fytolon 0.2%) soon after the pruning. Sprays of Carbendazim (Bavistin 0.1%) or Thiophanate methyl (Topsin M or Roko 0.1%) or Chlorothalonil (Kavach 0.2%) at fortnightly interval during rainy season are important for the control. Proper insecticides are also to be sprayed to control the beetle.

#### 6.0 LEAF BLIGHT (*Macrophomina mangiferae*, other pathogens include: *Pestalotiopsis mangiferae* (Grey blight) *Phoma glomerata* (Phoma blight) *Phoma* sp. (Twig blight and fruit rot)

**Symptoms:** Mostly infection is noticed on foliage. Yellow, pin headed spots appear on the leaves and twigs of the affected plants that enlarge and discolouring surrounding tissues is noticed. Spots become dark brown with slightly raised, brown purplish margins and turns into ashy colour. On stem elliptic lesions are produced and latter girdling is noticed. On fruits water soaked, circular lesions are produced which enlarge and cause rot (Fig. 6).





Fig. 6. Mango: Leaf Blight

**Epidemiology:** High relative humidity and prolong rains favour the disease.

**Management:** Maintain a good field sanitation. Spraying of Burgundy mixture (Copper sulfate + Sodium Carbonate 0.1%) or Lime Sulphur (Calcium hydroxide + Sulphur) or Mancozeb (Indofil Dithane M 45 0.2%) or Zineb (Indofil Dithane Z-78 (0.2%) or Propineb (Antracol (0.2%) have also been found to be effective.

### 7.0 BLACK BANDED DISEASE (*Rhinocladium corticolum* Masee)

**Symptoms:** Dark, black velvety growth observed on twigs, stem and branches that is most conspicuous at the nodes or branching point. In severe cases, similar symptoms observed on leaves which are just black layer of the fungus (Fig. 7).



Fig. 7. Mango : Black banded disease

**Management:** Removal of black growth by scrubbing, application of Bordeaux or Copper oxychloride paste (Blitox or Fytolon) and spraying of Bordeaux mixture (1%) or Copper oxychloride (Blitox or Fytolon 0.3%) helps in management of the disease.

### 8.0 RED RUST (*Cephaleuros mycoides* Karst)

**Symptoms:** The disease results due to an alga which is both parasitic and epiphytic in nature. The initial greenish-grey velvety spots develop that later on turn reddish-brown. When infection is severe the bark becomes thickened, the twigs get enlarged and remain stunted and the foliage becomes sparse which finally dries up. The algal spots are circular to irregular in shape, slightly elevated, roughly 2mm in diameter though in some cases it may be as much as 1 cm (Fig. 8).



Fig. 8. Mango: Red rust

**Management:** Application of Bordeaux mixture (6:6:100) or Copper oxychloride (Blitox or Fytolon 0.2%) or Lime Sulphur (Calcium hydroxide + Sulphur 0.2%) is recommended.

### 9.0 MANGO MALFORMATION (*Fusarium moniliforme* var *subglutinans* Sheldon) [Physiological disorders, acarological involvement and virus nature have also been postulated]

**Symptoms:** Two types of symptoms namely, 'Floral' malformation and 'Vegetative' malformation or 'Bunchy top' or 'Witches broom' are manifested on the diseased plants. The flowering panicles instead of emerging as normal turn into a compact mass of flowers that is very hard and not soft like normal panicle. Individual flower is greatly enlarged and has a large disc. The inflorescence gets hypertrophied. The percentage of bisexual flowers in malformed panicles is very low. In

'Bunchy top' compact leaves are formed in a bunch at the apex of shoot or in the leaf axil. A similar bunch consisting of small rudiments crowded together on short shootlets is seen in 'Vegetative malformation'. Vegetative malformation is more pronounced in young seedlings and seedling trees. The malformed heads dry up in black masses and persist on the trees for a long time (Fig. 9a).



Fig. 9a. Mango Malformation

**Management:** Use of disease free planting material and regular prophylactic applications of insecticides and fungicides can keep the orchards healthy. In areas with less than 5-10 percent infection, diseased plants should be destroyed. Pruning of diseased parts 15-20 cm below the apparently healthy portions followed by the spraying of Carbendazim (Bavistin 0.1%) or Captan (Captaf 0.2%) is effective. Spray of Naphthalene acetic acid (Planofix 100-200 ppm) has managed the disease. Partial control of malformation has been achieved by spraying the Mangiferin - Zn ++ and Mangiferin-Cu++ with chelates.

### 10.0 BLACK MOULD ROT (*Aspergillus niger* Van Teigh.)

**Symptoms:** The pathogen infects fruits through injury or wounds. The affected fruits show yellowing of base and development of irregular, hazy, grayish spots that coalesce into dark brown or black lesions. The mesocarp of the rotten area becomes depressed and soft (Fig. 9b).

**Management:** Careful harvesting and subsequent handling of the fruits to avoid any injury is very important. Pre harvest application of Carbendazim (Bavistin 0.1%) or Thiophanate methyl (Topsin M or Roko 0.1%) or Chlorothalonil (Kavach 0.2%) spraying



Fig. 9b. Mango: Black mould rot

in the field and then fruits should be subjected to hot water treatment (52 °C for 10 minutes).

### 11.0 Bacterial canker (*Xanthomonas campestris* pv. *mangifera indicae*)

**Symptom:** The disease attack leaves, petioles, stems and fruits. On the leaf lamina the disease first appear as small water-soaked irregular spots, which later increase in size, turn dark brown to black in colour and are surrounded by chlorotic haloes. The spots become angular in due course and result in cankerous raised lesions. Severe infections cause defoliation of leaves. On twigs, fresh lesions are water soaked which become raised and dark brown to black later. On fruits, it starts as water soaked lesions gradually developing into cankers, which are raised or flat and vary from brown to black in colour. In advance stages cracks are formed on cankers.

#### Management:

1. Introduction of disease from other orchards should be avoided.
2. Regular pruning must be followed and infected materials must be discarded.
3. Disease free shoots should be selected for grafting.
4. Spraying of Copper oxychloride (0.3%) + Streptocycline (300 ppm) is recommended.

## 2. BANANA

### 1.0 PANAMA DISEASE (*Fusarium oxysporum* f. sp. *cubense* Wollen of Rein)

**Symptoms:** Panama disease is a soil borne disease. The pathogen enters the host through the roots. Entry is facilitated by root damage such as that caused by the nematode, the fungus grows and blocks the vascular system causing the plant to wilt. The nematode *Radopholus similis* infected plants show characteristic yellowing of leaf blades which develops as a band along the margin and spreads towards midrib. The leaves wilt, the petiole buckles and the leaf hangs between the pseudo stem and the middle of lamina even it is still green. All leaves eventually collapse where the petiole joins the pseudo stem and dies. Often the emerging heart leaf is affected. The pseudo stem soon gets surrounded by the appearance of daughter suckers. At times it may show the longitudinal splitting of the outer leaf bases above the soil level. When an affected rhizome is cut transversely, the infestation is seen localized in the vascular strands. Individual strands appear yellow, red or brown dots and



Fig. 10a. Banana: Panama disease – Foliar symptoms



Fig. 10b. Banana: Panama disease – Pseudo stem splitting



Fig. 10c. Banana: Panama disease – Infected corm

streaks. The cut stem smells like rotten fish (Fig. 10a, 10b, 10c).

**Epidemiology:** The fungus is known to survive for long periods in the field. Survival is influenced by soil moisture, soil texture and pH. Liming of soil reduces the survival period to two months. The Indian strain of pathogen could survive water stagnation for a month.

**Management:** Control of disease is difficult and expensive. Eradication of the infected stool and liming of infested pits after chopping of plant parts is found to give only partial control. Flooding of infested areas from 6 months to 2 years has been reported to give satisfactory results. Use of Carbendazim (Bavistin) as



capsule application in the rhizome has been reported to be the most effective. However dipping of suckers in Carbendazim (Bavistin 0.1%) solution before planting followed by bimonthly drenching of Carbendazim (Bavistin 0.1%) from 6 months of planting onwards provides a good control. The cultivation of resistant variety (Grand Naine) is advocated.

## 2.0 LEAF SPOT OR SIGATOKA DISEASE (*Cercospora musace. Zimm syn. M. musicola*)

**Symptoms:** Small pale lesions or greenish streak develop on the leaves which become clearly visible on both the leaf surfaces parallel to the leaf veins. Some of these develop to form characteristic spots which increase in size to form dark, brownish to black linear oblong areas. Center of the spots eventually dries out, turns light grey, but a narrow dark brown or black border persists giving mature spot in ‘eye spot’ appearance. A plant infected by sigatoka has a characteristic ‘scorched’ appearance due to distinct spots on the leaves or light brown dried leaf tissues, where several spots are coalesced. In severe cases the petiole collapses and the leaf hangs down from the pseudo stem. Bunch on the plant with severe disease never matures (Fig. 11).



Fig. 11. Banana: Sigatoka

**Epidemiology:** Disease spreads very fast during rainy season. Weak plants are easily infected and badly attacked. Heavy spread of sigatoka and heavy ascospores infection are favoured by warm (23-25 °C) rainy or humid weather. Below 21 °C there is a marked decline in infection even if other conditions are favourable.

**Management:** Good agronomic practices including improved drainage, weed control, removal of suckers and correct spacing help in reducing the disease incidence. Removal and destruction of infected leaves is recommended. Spraying of Bordeaux mixture 1% plus linseed oil 2% or Thiophanate methyl (Topsin – M or Roko 0.1%) or Prochloraz (0.1%) or Tridemorph (Calixin 0.1%) are quite effective.

## 3.0 LEAF SPOT (*Cordana musae (Zimm.) Von Hohn.*)

**Symptoms:** Pale brown or yellow oval spots are formed on the leaf surface. Within the central necrotic area of spots, a delicate concentric zonation surrounded by a yellow halo can be observed. The spots usually occur near the leaf margins or near the tearing areas of the leaves or on the other mechanically damaged parts. On the underneath of such spots greyish brown coloration without clear borders are observed (Fig. 12).



Fig. 12. Banana: Cordana leaf spot

**Management:** Application of oil and water emulsion containing Maneb (Dithane M 45 0.2%) or Carbendazim (Bavistin 0.1%) provide a very good control of the disease.

#### **4.0 DEIGHTONIELLA LEAF AND FRUIT SPOT** (*Deightonella torulosa* (Syd.)

**Symptoms:** The disease appears as black spot on leaf, fruit tip discolouration or black tip and fruit spot (speckle). Round, pin point, black spots on the main veins of the lamina in the proximity to the leaf margin appear. Gradually these spots increase in size but remain separated from the normal green leaf tissue by a narrow, yellow peripheral band. The large spots dry in the center with pale brown areas extend to the edge of the leaf blade.

In fruits, tip turn blackish below the perianth and advances along the fruit. The infected tissue may not have regular outlines which get surrounded by a narrow, grey or yellowish margin (Fig. 13).



Fig. 13. Banana: *Deightonella* Fruit Spot

**Epidemiology:** Spores of the fungus can be trapped during June to November particularly during wet spells. Infection requires dew or rain water and is more severe during wet weather.

**Management:** Sanitation of plantation and good drainage is important for reducing the disease pressure.

The affected leaves and fruits should be collected and destroyed. Dead sheath and leaves around the bunch should be removed. Trash should be cleared before the rains. Spraying with Bordeaux mixture (4:4.50) or Mancozeb (Indofil Dithane M 45 0.2%) or Chlorothalonil (Kavach 0.2%) or Propineb (Antracol 0.2%) can control the disease.

#### **5.0 ANTHRACNOSE** (*Colletotrichum gloeosporioides* (Penz.) Penz. & Sacc.)

**Symptoms:** Disease attacks the plants at all stages of their development. On leaves, dark brown spots with grayish centre appear during monsoon seasons whereas small black circular specks on the flowers, skin and distal ends of banana hands develop which do not grow further. Infection on the banana usually starts during the development of the fruit but remains quiescent until the fruit ripens. Dark brown to black sunken spots appear on the fruits. In the center, pink spore mass is seen. A tip rot may develop and can rot the entire fruit but the pulp is usually not affected unless the fruit is overripe (Fig. 14).



Fig. 14. Banana: Anthracnose

**Epidemiology:** Disease development is severe at 30 - 35 °C with the humidity ranging between 85.7 to 100%, whereas it is restricted during the cold as well as hot and dry months.

**Management:** Three to four pre harvest spraying with Carbendazim (Bavistin 0.1%) or Thiophanate methyl (Topsin M or Roko 0.1%) or Difenaconazole (Score 0.05%) or Chlorothalonil (Kavach 0.2%) at 15 days intervals is quite effective for disease control.



## 6.0 STEM END ROT (*Botryodiplodia theobromae* (Pat.)

**Symptoms:** The infection originates in or immediately below the decayed perianth, stems end or styler end causing a progressive brownish black discolouration. The skin becomes black, soft and wrinkled and the pulp turns rapidly into black watery mass (Fig. 15).

**Epidemiology:** Maximum damage to fruits occurs at 25-30 °C and humidity above 80%.



Fig. 15. Banana: Stem end

**Management:** Proper field sanitation, avoiding any delay before cooling and shorter transit time help to control the disease. Three to four pre harvest spraying with Carbendazim (Bavistin 0.1%) or Thiophanate methyl (Topsin M or Roko 0.1%) or Prochloraz (0.1%) or Chlorothalonil (Kavach 0.2%) at 15 days intervals results in good control.

## 7.0 CIGAR END ROT (*Verticillium theobromae* (Turc.) Masonet Hughes)

**Symptoms:** Infection generally begins from the tip of the finger and slowly spreads backwards resulting in grey colour of the skin. Necrosis spreads a short way up the finger and the necrotic tissue becomes corrugated and covered with grayish white fungal hyphae

resembling ash at the end of a cigar. The pulp turns rapidly into black watery mass (Fig. 16).

**Management:** Manual removal of floral remains;



Fig. 16. Banana: Cigar end rot

Spraying of Chlorothalonil (Kavach 0.2%) or Thiophanate methyl (Topsin M or Roko 0.1%) or copper oxychloride (Blitox – 50 or Fytolon 0.2%) are effective against the disease.

## 8.0 RHIZOME ROT OR TIP OVER DISEASE (*Erwinia carotovora* pv. *carotovora*, *E. chrysanthemi*)

**Symptom:** The parts of the affected plants above the ground wilt and dry out progressively starting from the outermost leaves (Fig. 17a). The root system and the collar are attacked by rot which first causes browning of the pith and, in the end, decay of all the tissues occur (Fig. 17b). At this point they emanate an awful smell. As the epidemic progresses plants die on certain spots in the field and large blanks occur in the crop.



Fig. 17a. Tip over disease in Banana



Fig. 17b. Rhizome rot in Banana

### Management:

1. Dipping rhizome in Bavistin (1.0%) + Streptocycline (300 ppm) + Copper oxychloride (0.3%) for 15 to 20 minutes before planting.
2. Soil drenching with streptocycline (300ppm) + Copper oxychloride (0.3%) or bleaching powder 2g/L water at 10 – 15 days interval.
3. 2–3 sprays of Streptocycline (300 ppm) + Copper oxychloride (0.3%) at 15 days interval is recommended.

### 9.0 BANANA BUNCHY TOP (*Banana bunchy top virus*)

**Symptoms:** Symptoms of bunchy top are distinctive and plants can become infected at any stage of growth (Fig. 18a). The leaves are rosette and small with very chlorotic margins that tend to turn necrotic. Dark green streaks are usually evident in the leaves and pseudostem



Fig. 18a. Banana bunchy top virus (BBTV)



Fig. 18b. Streaks on stem and leaves due to BBTV

(Fig. 18b). Successive leaves become shorter and narrower and often have chlorotic, upturned margins. The leaves become brittle and erect, giving the plant a bunched appearance. Once infected, plants rarely produce a bunch and do not fruit in subsequent years. When infected late in the growing cycle, they may fruit, but the bunch stalk and fruits are small and distorted.

**Cause and Spread:** *Banana bunchy top virus* (BBTV) causes banana bunchy top disease, which is isometric virus of 18-20nm in diameter, belongs to genus Babuvirus of the family Nanoviridae. The virus possesses a multicomponent genome, consists of at least six circular ssDNA components each 1000 to 1100 nucleotides long. BBTV is transmitted by *Pentalonia nigronervosa* (Fig. 18c) in a circulative, non-



Fig. 18c. Banana Aphid vector of BBTV

propagative manner. The virus also transmitted through vegetative planting material such as suckers and micro propagated plants but not by mechanical inoculation.

Spread of the virus over long distance is by infected planting material, and it is by this means that new plantings in isolated areas usually become infected. Dissemination over short distance from these foci is by the banana aphid.

**Management practices:** Only virus free suckers or micro propagated plants should be used to establish new plantations. BBrMV infected plants should be destroyed immediately upon detection because the aphid vectors pose a continuing threat in the presence of perennial sources of infection. Disease spread by aphids in the field can be prevented or limited with preventive systemic insecticides.

## 10.0 BANANA BRACT MOSAIC DISEASE (*Banana bract mosaic virus*)

**Symptoms:** Mosaic patterns on bracts are diagnostic and distinct from symptoms caused by all other known viruses of banana. Mosaic patterns, stripes and spindle shaped streaks may also be visible on the pseudostem when the outer leaf sheaths are removed and may be seen on the petioles and mid ribs (Fig. 19a,b). The



a. Symptoms on plant



b. Symptoms on Bract

Fig. 19. *Banana bract mosaic virus (BBrMV)*

color of symptoms depends on host pigmentation, and can vary from chlorotic or yellow, through red, brown and even black pigmentations is seen. Suckering also suppressed, and suckers that do emerge are distorted and leaves become brittle and crinkled. Spindle shaped streaks on bract is the most common symptom.

**Cause and Spread:** *Banana bract mosaic virus (BBrMV)* causes bract mosaic disease of banana, which is flexuous virus particle of 660-760 X12nm and virus particles consists of positive –sense ssRNA. BBrMV is a potyvirus belonging to Potyviridae. Both serological and nucleic acid based assays are now available for BBrMV detection. BBrMV is transmitted by at least three species of aphids: *Aphis gossypii*, *Rhopalosiphum maidis* and *Pentalonia nigronervosa* in a non-persistent manner. (Fig. 19c). The virus mainly spread in the field through infected plant material and it is not transmitted by mechanical inoculation.



Fig. 19c. *Banana Aphid - vector of BBrMV*

**Management practices:** The use of virus indexed, disease free planting material is the best method of control. Rouging and sanitation of early-infected plants is also important. Disease spread by aphids in the field



can be prevented or limited with preventive systemic insecticides.

### **11.0 BANANA CHLOROSIS OR INFECTIOUS CHLOROSIS, HEART ROT AND MOSAIC DISEASE (*Cucumber mosaic virus*)**

**Symptoms:** Symptoms are affected by environmental changes and are dependant on the strain of CMV. Although infected leaves may be symptom less, they typically have chlorotic stripes, stippling or line patterns, or a more general mosaic. Fruits may be distorted and display chlorotic streaks or a mosaic (Fig. 20a, b). At temperature below 24 °C, symptoms are often more severe and may include heart rot. Several strains of the virus can cause leaf distortion and necrosis. In the past, symptoms were often confused with those caused by BSV.



a. Chlorotic streaks

b. Mosaic symptoms

Fig. 20. *Cucumber mosaic virus* symptoms (CMV)

**Cause and Spread:** This disease is caused by cucumber mosaic virus belongs to genus cucumovirus. The virus has a tripartite ssRNA genome encapsulated in isometric virions 28-30 nm in diameter. A satellite RNA is encapsulated with some isolates, and is responsible for symptom attenuation. CMV is transmitted in a non-persistent manner by at least 75 aphid species and often is seed transmitted in other hosts. Although CMV can be sap transmitted experimentally,

this probably is not important in the field. Weeds or nearby crop plants are the primary sources of inoculum, and spread from banana to banana appears to be less common. The spread mainly occurs through infected planting material.

**Management practices:** Alternative hosts should be removed form within and around banana plantings. Growing bananas next to non hosts instead of susceptible vegetable crops. Rouging infected banana plants in plantations is advisable, as it eliminates these plants as potential sources of infection. Most aphid vectors do not colonize bananas, but large transient populations of inefficient species can still result in the transmission of CMV to banana. Insecticides are unlikely to be effective in controlling the disease in banana because these non colonizing species can transmit the virus after feeding for a few seconds. A combination of rouging and insecticides has been reported to give good control in commercial plantations, but probably may not be cost effective. Rouging alone has given adequate control. It is important that planting material must be sourced form virus free sources. Tissue cultured plantlets should also be protected from infection in nurseries during the acclimatization phase.

### **12.0 BANANA STREAK DISEASE (*Banana streak virus*)**

**Symptoms:** Symptoms expression is very variable, and is influenced by virus strain, host cultivar and physiology and the environmental conditions. The most common symptoms are continuous or discontinuous chlorotic streaks running parallel to the leaf veins, and range from prominent to very sparsely distributed (Fig. 21a, b). The streaks darken over time and may become brown or black. In some cases, spindle-shaped lesions or chlorotic

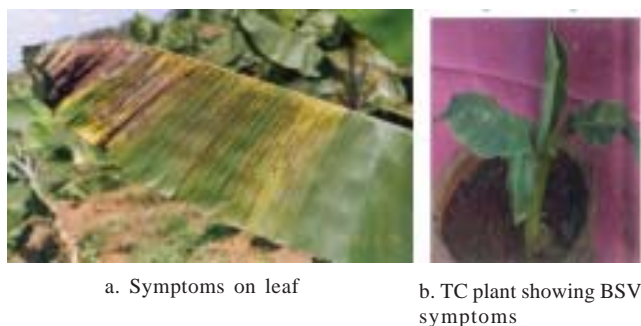


Fig. 21. *Banana Streak virus (BSV)*

blotches occur. a range of other symptoms are sometimes associated with the disease, including splitting of the pseudostem, heart rot, leaf and pseudostem streaks, aberrant bunch emergence and altered leaf phyllotaxy. Young, infected, suckers usually display few, if any, symptoms. Symptom expression is sporadic over time, and not all leaves on an infected plant may display symptoms. Similarly, not all infected plants in a stand will have symptoms at the same time. Lower temperature, or possible temperature fluctuations, has been correlated with symptom expression. However, the developmental stage of the plant may also be important, as the proportion of plants with symptoms was shown to increase progressively during each cropping cycle. Streak can deform fruit and bunches, lengthen the cropping cycle and reduce bunch size, and fruit number, size and quality. Yield depression increases through successive cropping cycles, and is more apparent under suboptimal growth conditions. Reported losses have ranged from 6 to 45%.

**Cause and Spread:** *Banana streak virus* is a

bacilliform virion of size 130-150X30nm. It has a double stranded (ds) DNA genome of 7.4 kbp and replicates *via* reverse transcription. Isolates of BSV are highly heterogeneous, and induce a range of symptoms. They also differ serologically and genomically. Sequences of BSV are integrated into the genomes of *Musa* and *Ensete*. These sequences are very variable and probably include many dead and partial inserts of a number of virus strains.

BSV is transmitted in a semi-persistent manner by the mealy bugs *Planococcus citri* (Risso), *Saccharicoccus sacchari* (Cockerell) and possible other species. Field spread of BSV is slow and appears to be of limited significance in most locations. However, this may not be the case in some commercial plantations of Cavendish cultivars, where BSV is a serious problem. The major means of spread is in vegetative planting material. The virus is neither mechanically transmissible nor soil borne. Although there is some evidence that BSV is seed transmitted, this finding is not now accepted as integration of BSV in the host genome has now been recognized.

**Management practices:** The use of virus-free planting material is crucial since the virus is spread primarily by vegetative propagation. However, the selection of suitable planting material is hampered by the difficulties in visually diagnosing BSV infection and in identifying such a heterogeneous virus with diagnostic assays so visual inspections should be conducted on all leaves and on a number of occasions during the cropping cycle.

### 3. CITRUS

#### 1.0 Diseases caused by *Phytophthora* spp.

Among the different pathogenic species of *Phytophthora*, reported from the citrus growing areas world wide. *P. citrophthera* (R.E Sm & E.H Sm) Leonian, *P. nicotianae* (Bred a deltaan) and *P. palmivora* (E. Butler) have been a serious threat to the citrus plants in the country.

**Symptoms:** *Phytophthora* species causes root rot, foot rot or collar rot or stump rot, crown rot, gummosis, leaf fall and brown rot diseases in citrus (Fig. 22a).

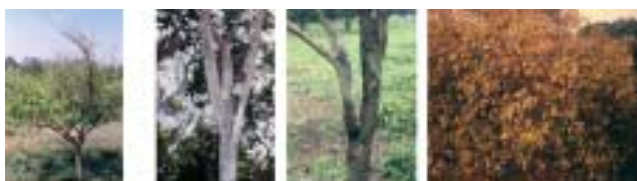


Fig. 22a. Citrus diseases caused by *Phytophthora*

**i) Root rot:** Infection of *Phytophthora* species causes the rotting of the feeder roots due to which plants are starved of the nutrients, resulting in pale green foliage with yellowing of mid rib of leaves. When infection is severe it moves to main lateral roots through the feeder roots and develops 'bird-eye-spot' on big roots or causes complete rotting of relatively smaller roots. Quite often the rotting of the main tap roots are observed and the root system remains restricted to a shallow depth. Such plants show early wilting symptoms during drought period that is marked with no flushing and excessive flowering followed by poor fruit set on irrigation.

**ii) Foot rot or Stump rot:** Wherever rootstock is susceptible, the root near the collar region is infected and the infection is generally extend to the bark on the trunk, resulting in its permanent damage. The plant vigour is adversely affected leading to slow mortality of the

plant. Whenever complete girdling of the trunk is developed, plant dies abruptly.

**iii) Gummosis:** Oozing of a gummy substance from the bark of above ground plant parts is noticed on physiologically active plants. At times girdling of branches occur which leads to then complete death, resulting in poor yields.

**iv) Leaf fall and fruit rot:** Infection of *Phytophthora* leads to the blighting of foliage along with appearance of brownish patches. Leaves normally drop off. This is of a common occurrence in nursery where leaves near the ground are infected. Complete drop off of foliage and fruits lacks occurs due to the infection and trees look barren. Such infections spread fast and usually with in 2-3 days. Thousands of plants are destroyed causing complete loss of standing crops. Fruits develop brown decay and fallen fruits emit a characteristic odour (Fig. 22b).

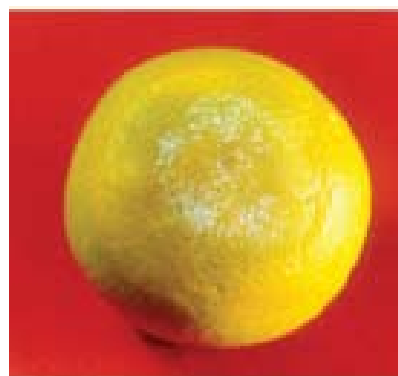


Fig. 22b. Citrus *Phytophthora* fruit rot

**v) Nursery infection:** In addition to collar rot caused by the infection of *Rhizoctonia solani*, pre and post emergency damping off of root stock seedlings due to *Phytophthora* infection results in serious losses in nursery.



**Epidemiology:** *Phytophthora* inhabit soil and is a water loving fungus. It survives in soil through small thick walled spores (chlamydospores) and oospores, which can tolerate dry summer conditions. With onset of monsoon and in optimum temperature (25 - 32 °C), flooding or excessive irrigation, these spores germinate to produce sporangium and zoospores. These zoospores swim in water and are attracted to root tips and wounds to cause infection. A new generation of sporangia is formed within 24 hrs of their entrance in tissue and again liberates the zoospores to initiate new infection. This cycle repeats so for soil remains saturated and their reservoir of inoculum accumulates.

**Management of *Phytophthora* diseases: An integrated approach involving**

- (i) the use of resistant rootstocks.
- (ii) following appropriate cultural practices.
- (iii) application of chemicals as prophylactic and/or therapeutic measures.
- (iv) Bio-control tactics is a must.

**Resistant rootstocks: Trifoliolate orange (*Poncirus trifoliata* (L.) and sour orange**

(*C. aurantium* L.) are the most important sources of *Phytophthora* resistance, while trifoliolate hybrids such as citranges (*C. sinensis* (L.) Osbeck X *P. trifoliata*) and citrumelos (*P. trifoliata* X *C. paradisi* Macf) are tolerant to resistant. But in India, Trifoliates and their hybrids have shown poor compatibility with mandarins, high susceptibility to root rots caused by basidiomycetes such as *Armilaria* spp. and poor drought resistance in rainfed areas. Therefore, these are not very popular rootstocks. Rangpur lime (*C. lemonia* Osbeck) and Cleopatra mandarin (*C. reshni* Hort.) are *Phytophthora* tolerant. These rootstocks are more vigorous and drought tolerant.

**Improved cultural practices:** Plants should be selected from *Phytophthora*, free certified nurseries and with high budding (above 9" heights) while planting care should be taken to keep bud union as high as possible, so that irrigation water should not touch the rootstock-scion union. Soil should be kept well drained and flood irrigation and stagnation of water for longer period in the basin should be avoided. Injuries to trunk and root system by farm operations should also be avoided. During monsoon, drip circles need to be kept weed free. New shoots that emerge on main trunk during monsoon and growth of moss on tree branches and on main trunk should be removed periodically. Enarching and earthing up can save the mortality of high yielding plants after getting infected with severe root rot or stump rot.

**Chemical control:** Various systemic and non-systemic fungicides have been recommended as pre - and post-monsoon treatments. Sprays of Bordeaux mixture alone or in combination with 0.5% zinc sulphate; Bordeaux pasting (4: 4: 40) or Chaubatia pasting is effective to control stump rot and gummosis. Among other non-systemic fungicides Captaf (Foltaf 0.2%), Captan (Captaf 0.2%), Chlorothalonil (Kavach 0.2%), Copper oxychloride (Blitox 0.3%) have also been reported to be effective as spray and drenching for the control of leaf fall and stump rot respectively.

Among new generation systemic fungicides, formulation of Metalaxyl with Mancozeb (Ridomil MZ 0.25%) as spray or drenching and Phosetyl-Al (0.3%) as spray on Coorg mandarin showed good control of root rot, stump rot and gummosis. Phosphonic acid based fungicides namely Akomin and Phytoalexin - 84 as 0.3% sprays were also equally effective.

**Organic amendments and biological control:** Application of FYM, poultry manure, coffee waste



(husk and pulped fruit skin) reduced *Phytophthora* populations and increased *Trichoderma* populations in soil in Kodagu. *T. harzianum* has shown promising potential as antagonist to *Phytophthora* infections in Coorg.

Thus, for integrated disease management for *Phytophthora* in high rainfall areas, the most effective strategy would be as follows: Use of disease tolerant, vigorous and drought tolerant rootstocks such as Rangpur lime or Cleopatra mandarin.

- (i) Maintaining tree trunks free of new shoots or mass growth.
- (ii) Maintaining drip circle well drained, free of weeds or green manuring crop during monsoon. Use of chemical control methods that support biological control e.g. Metalaxyl or Phosetyl-Al that are not lethal to *Trichoderma sp.* which is antagonist to *Phytophthora*.

## **2.0 TWIG BLIGHT (*Colletotrichum gloeosporioides* in association with *Fusarium spp* and *Lasidiplodia thebromae*)**

**Symptoms:** Disease is characterized by three types of symptoms such as wilting of foliage, die-back and post emergence decline of water shoots. Initially, the foliage of diseased plant appear dull followed by wilting. Canopy is ultimately invaded and gradually the leaves roll lightly; loose turgidity and drop. Die back sets in after the leaves are shed. The diseased trees are retarded and become dwarf and fail to develop. This type of disease to citrus fruits are more commonly found in acid lime, whereas in mandarin and sweet oranges, it comes in stages and the incidence is low.

**Management:** Pulverisation of soil, proper manuring, maintenance of the humidity and soil texture also contributes to control the disease. Pruning followed by

spraying Carbendazim (Bavistin (0.1%) 2 to 3 times at monthly intervals is also effective.

## **3.0 ALTERNARIA LEAF SPOT & FRUIT ROT (*Alternaria citri* Ellis and Pierce). It is important foliage disease in the nursery particularly on rough lemon and Rangpur lime.**

**Symptoms:** Regular to irregular, light to dark brown necrotic lesions surrounded by chlorotic halo develop along the margin following infection of young leaves which may cover larger portion of leaf lamina. Severe attacks leads to the leaf dwarfing and drop. Disease also attacks fruit where most conspicuous symptom appears a few weeks after colour breaking stage. Affected fruits develop an orange colour prematurely with light brown to blackish discolouration of the rind near the styler end. Internal symptoms consist of a brown to greenish black discolouration and disorganization of the core is clearer at the stem end. Affected fruits ultimately shed.

**Management:** Spraying of fungicides namely Copper oxychloride (Blitox or Fytolon 0.3%) or Zineb (Indofil Dithane - Z78 0.3%) or Chlorothalonil (Kavach 0.2%) give a very effective control. Infected fruits may be collected and destroyed.

## **4.0 POWDERY MILDEW (*Acrosporium tingitanium* (Carter) Swr.)**

**Symptoms:** All the aerial parts of the plant are attacked. The disease is characterized by a whitish mealy powdery growth on young leaves and twigs, which covers the entire leaf and young greening shoots. Even the small fruits also infected, such fruits get shrink and mummified. The affected leaves become distorted. The powdery coverage of foliage and twigs leads to leaf drop and die-back. The affected fruits drop off prematurely and the yield is reduced. Damp mornings with a few hours

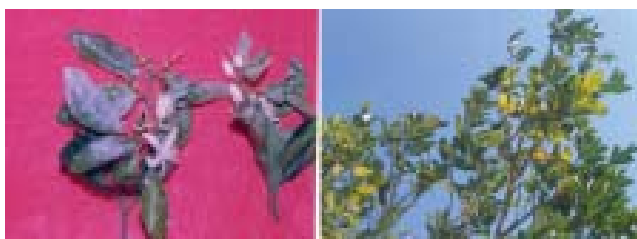


Fig. 23. Citrus Powdery mildew

of sunshine favour, onset of the disease. After infection, the fungus leaves purple ting in mature leaves (Fig. 23).

**Management:** The disease is easily controlled by dusting the foliage with finely powdered sulphur or spraying wettable sulphur, formulations such as Sulfex (0.25%). Spraying with Bitertanol (Baycor 0.2%), Tridemorph (Calixin 0.01%), Tradimefon (Bayleton 0.1%), Dinocap (Karathane 0.1%) and Benzimidazoles (Bavistin 0.1% or Topsin M 0.1%) have provided good control of the disease.

### 5.0 Scab (*Elsinoe fawcetti* Bitancourt)

It is one of the common diseases of sour orange, rough lemon and tangelo and mostly prevalent in the nursery. It is also recorded in sweet oranges in Karnataka.

**Symptoms:** On leaves small, semi translucent dots appear usually on the underside of young leaf that becomes well defined pustule. The lesions mostly appear simply on one side of leaf. A few days later, these projection develop a cream to yellow-orange color at the tips. The opposite surface corresponding to warty growth shows a circular pink to red depression; severely attacked leaves became distorted and occasionally shed prematurely. The lesions may also appear on shoots tender twigs, blossom pedicels and buttons. Water sprouts of trees and the stem of nursery plants develop scab lesions similar to those on leaves. Heavily infected fruits may drop shortly after being attacked. The lesions on fruit have corky projections, which often break into scabs and the fully formed scab lesions are raised and

are buff to pink to drab in colour (Fig 24).



Fig. 24. Citrus Scab

**Management:** Post-monsoon spray of Bordeaux mixture (1%) and application of systemic benzimidazole fungicides such as Carbendazim (Bavistin 0.1%) or Thiophanate methyl (Topsin M or Roko 0.1%) and non-systemic fungicide Captafol (Foltaf 0.2%) are effective for controlling the disease. In nurseries, sprinkler irrigation should be avoided.

### 6.0 ANTHRACNOSE (*C. gloeosporioides* (Penz.) Penz. & Sacc.)

The disease manifest in various types of symptoms. In recent years the decline in production of lime has been attributed due to wither tip, leaf spot and fruit rot, all are caused by *Colletotrichum gloeosporioides* Penz.

**Symptoms:** Anthracnose attacks the young leaves, shoots, blossoms and fruits of small acid limes. Young foliage and blossoms are blighted and distinct lesions formed on leaves and fruits. Affected fruits frequently drop prematurely. Wither tip is characterized by shedding of leaves and die-back of twigs. Leaves show light green spots that turn brown on dead twigs thereafter black dot like acervuli appear in concentric rings. The stem end of immature fruits results in fruit drop. In severe cases branches show die-back and trees dies in



a few years. Dead parts of the twigs develop silvery grey appearance (Fig. 25).



Fig. 25. *Citrus Anthracnose*

**Management:** For the control of the disease dead twigs should be pruned and destroyed. Cut ends should be protected by Bordeaux paste. Such trees should be sprayed with Carbendazim (Bavistin 0.1%) or Thiophanate methyl (Topsin M or Roko 0.1%) three times after pruning at fortnightly interval.

### **7.0 PINK DISEASE** (*Pellicularia salmenicolor* and *Corticium salmonicolor* Berk.)

**Symptoms:** The disease appears after or during rains. It is characterized with growth of pink coloured mycelium around the infected trunk or bark of the tree. The infected tissue of bark is killed and pathogen further invades into the wood to impede the functioning of vascular tissue.

**Management:** The diseased portion of the tree should be removed and the cut end and scrapped portions of the plants should be pasted with Copper fungicides / Bordeaux paste.

### **8.0 BACTERIAL CANKER** (*Xanthomonas axonopodis* pv. *Citri*)

**Symptom:** Oily looking 2 - 10 mm circular spots will appear on leaves usually on the abaxial surface. Later, both epidermal surfaces may become ruptured by tissue hyperplasia induced by the pathogen. On leaves, stems,

thorns and fruit, circular lesions become raised and blister-like, growing into white or yellow spongy pustules (Fig. 26). These pustules then darken and thicken into a light tan to brown corky canker, which is rough to the touch. On stems, pustules may coalesce to split the epidermis along the stem length, and occasionally girdling of young stems may occur. Older lesions on leaves and fruit tend to have more elevated margins and are at times surrounded by a yellow chlorotic halo and a sunken center. Sunken craters are especially noticeable on fruits, but the lesions do not penetrate far into the rind. Defoliation and premature abscission of affected fruit occurs on heavily infected trees.



Fig. 26. *Bacterial canker on citrus*

- Management:**
1. Spraying of Streptocycline (300-500ppm) – 6 sprays at 30 days interval is recommended.
  2. Spraying of Streptocycline 0.03% + Copper oxychloride 0.3% 2-3 sprays at 15 days interval (or)
  3. Spraying Bordeaux mixture (1.0%) 3-4 sprays in a year is effective for the control of the disease.
  4. Two prunings along with 4 sprays of Copper oxychloride (0.3%) is recommended.

### **9.0 CITRUS TRISTEZA DISEASE** (*Citrus Tristeza virus*)

**Symptoms:** Tristeza, known as ‘quick decline’ is the

most destructive disease of citrus and has a worldwide distribution. Citrus tristeza virus (CTV) causes different symptoms on citrus plants depending on the virus strain, the variety of citrus, and the scion rootstock combination. In India, various strains of CTV, generally referred to as seedling yellows (CTV-SY), tristeza (CTV-T), stem pitting (CTV-SP), and a mild type, have been widespread for many years. Any of these strains may exist in a citrus plant, or they may occur together, as a complex.

**Quick Decline:** Sweet orange, mandarin (including Satsuma, Ponkan and grapefruit cultivars are affected by this disease when grown on sour orange, pumelo, or lemon rootstock (but not rough lemon rootstock). The causal virus is either CTV-SY or CTV-T. When the adult tree of such a combination is affected, it turns yellow and wilts rapidly, and dies within a few years (Fig. 27).

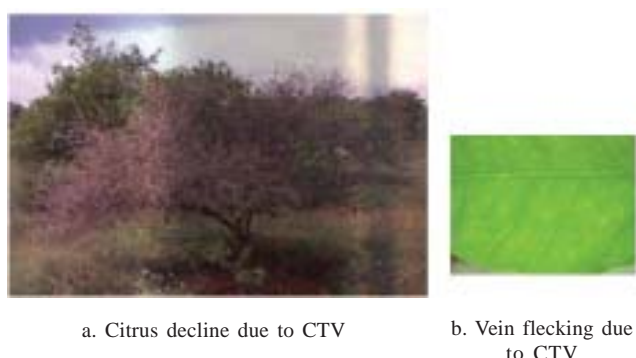


Fig. 27. CTV symptoms on acid lime

**Seedling Yellows:** Self-rooted trees of sour orange and lemon are affected by this disease after being infected with CTV-SY. These trees become yellow and die back.

**Stem Pitting Disease:** Most varieties of citrus are affected by stem pitting disease, even if they are grafted onto a rootstock resistant to tristeza. Grapefruit, sweet orange are all susceptible, although many varieties of mandarin are resistant. Susceptible plants develop a

large number of pits on both their trunks and their stems. Affected trees become dwarfed and show less vigor, and occasionally die back. As a result, although there is profuse flowering, the trees bear only poor crops of small sized or irregularly shaped fruit. Some cultivars develop rind-oil spots, or brown spots with gumming on the fruit. The causal virus is a severe strain of CTV-SP (Fig. 28).



Fig. 28. Severe Stem-Pits on the Trunk

**Cause and Spread:** Caused by *Citrus Tristeza virus* belonging to genus *Closterovirus* of the family *Closteroviridae*. The causal virus is a flexuous and thread-like rod, 2,000 nm in length and 15 n in width. The virus particles are located in the phloem of the host plant, and disturb its transportation systems. Mexican lime (*Citrus aurantifolia*), also known as West Indian lime or Key lime, is the best indicator of tristeza virus infection. The citrus brown aphid, *Toxoptera citricida* Kirkaldy, is the most effective vector (Fig. 29). Melon aphid *Aphis gossypii* Glover is also an important vector where *T. citricida* is not established. However, the level



Fig. 28. Citrus Aphid – Vector of CTV

of transmission from the melon aphid is. *Aphis citricola* and *Toxoptera aurantii* have also been shown to be potential vectors of CTV in some countries, but their efficiency is very low.

**Management practices:** The certification of budstock, and the use of resistant rootstock, is the primary counter-measures in controlling the disease. The production of virus-free trees by shoot-tip grafting or heat treatment is very important. If it is possible to keep the field permanently free of CTV, the planting of virus-free trees is practical. If the tree is grafted onto resistant rootstock, such as trifoliate orange or mandarin, it recovers immediately after grafting.

### 10.0 CITRUS MOSAIC DISEASE (*Citrus yellow mosaic virus*)

**Symptoms:** The most characteristic symptoms of the disease are yellow mosaic of the leaves and yellow flecking along the veins. And involves stunting, chlorosis and uniformly distributed leaf mosaic, followed by a leathery texture of mature leaves. The characteristic symptoms due to mosaic in field-infected orange and pummelo are bright yellow mottling of the leaves and yellow flecking along the veins (Fig. 30). Variable symptoms develop on graft-inoculated *Citrus* spp. in the glasshouse. It is possible that some of the field symptoms earlier described could have been due to



a. Citrus mosaic leaf symptom

b. Citrus mosaic fruit symptom

Fig. 30. *Citrus yellow mosaic virus*

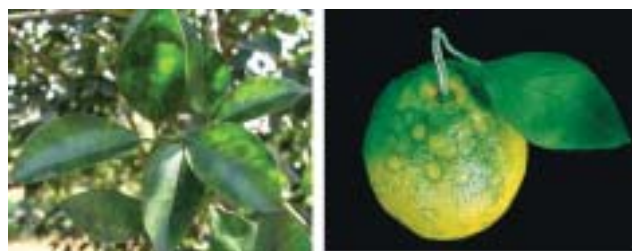
other causes, or to mixed infections with other viruses which are quite common in orchard trees in India. Trees affected by this disease not only produce significantly less fruit, but fruit from such trees also produce less juice and ascorbic acid.

**Cause and Spread:** Citrus yellow mosaic virus has non-enveloped bacilliform particles, 30 x 150 nm, located in the cytoplasm, typical of badnavirus. The virus genome is a double stranded DNA belonging to Retroviridae. The virus was transmitted by bud, bark and leaf grafting. The disease is not transmitted through soil, sap and tools. Seed transmission was noted to an extent of 1.2%. It was also mechanically transmitted to *Citrus decumana*, Satgudi sweet orange and pummelo. It was transmitted in nature through citrus mealy bugs .

**Management practices:** Use of healthy bud wood is the only method of control.

### 11.0 CITRUS RING SPOT DISEASE (*Indian ring spot virus*)

**Symptoms:** Citrus ring spot disease is widely distributed in India and affects the fruit quality of Kinnow mandarins. The field symptoms include formation of distinct rings ranging from 0.2-2 mm in diameter, with green tissue in the center (Fig. 31). Blisters on the twigs and leaves are also associated with the disease. When challenge inoculated Sweet oranges and Grape fruits show leaf patterns. On grown up plants the symptoms tend to disappear as the air temperature increases.



a. Leaf Symptoms

b. Fruit Symptoms

Fig 31. Citrus Ring spot Disease



**Cause and Spread:** This disease is caused by *Indian ring spot virus* belongs to genus *Mandarivirus* of the family *Flexiviridae*. The virus particles are approximately 650 x 15 nm in size with clearly visible cross banding. This is transmitted through seed and grafting.

**Management practices:** Citrus ring spot is disseminated in infected bud wood. Use of healthy bud wood and crop sanitation is the best method of control.

## 12.0 CITRUS YELLOW-CORKY VEIN DISEASE (*Hop stunt viroid*)

**Symptoms:** The disease first reported from the citrus orchards of Andhra Pradesh. The initial disease symptoms are the yellowing of midrib and lateral veins. After 30 days of incubation, distinct corking of midrib on the underside of affected leaves occur (Fig 32A). Consequently, the leaves curl presumably owing to the collapse of the midrib. The fruits will be reduced size and will have less juice.



a. Leaf symptoms



b. Fruit symptoms

Fig. 32a. Citrus Yellow Corky-vein

**Cause and Spread:** This disease is caused by Hop stunt viroid. Viroids are low molecular weight, infectious, non-encapsidated, self-replicating, circular, single-stranded RNA molecules (246–463 nt) without any functional ORFs. The disease is transmitted from sweet orange to sweet orange by bud or leaf grafting. This

viroid can be artificially transmitted to acid lime, Rangpur lime, Jamberi and Troyer citrange.

**Management practices:** Citrus viroids are disseminated in infected bud wood. Use of healthy bud wood and crop sanitation is the best method of control.

## 13.0 CITRUS EXOCORTIS DISEASE (*Citrus exocortis viroid*)

**Symptoms:** The disease is characterized by drying of narrow strips of outer bark, tending to separate from the inner live bark and slowly peeling off as it withers. These symptoms are seen below the bud union on the rootstock portion of susceptible stocks such as trifoliolate orange or Rangpur lime (Fig. 32b). Affected trees show lack of vigor resulting in dwarfing. The affected rootstock portion overgrows the scion.



Fig. 32b. Citrus Exocortis

**Cause and Spread:** This disease is caused by Exocortis viroid. Viroids are low molecular weight, infectious, non-encapsidated, self-replicating, circular, single-stranded RNA molecules (246–463 nt) without any functional ORFs. The disease is transmitted by grafting and Rangpur lime is used as indicator plant.

**Management practices:** Citrus viroids are disseminated in infected bud wood. Use of healthy bud wood and crop sanitation is the best method of control.

## 14.0 CITRUS GREENING (or) HUANGLONGBING DISEASE

**Symptoms:** Citrus greening, also called Huanglongbing

or yellow dragon disease, is one of the more serious diseases of citrus. An infected tree produces fruit that is unsuitable for sale as fresh fruit or for juice. Citrus plants infected by the citrus greening bacteria may not show symptoms for years following infection. Initial symptoms frequently include the appearance of yellow shoots on a tree. As the bacteria move within the tree, the entire canopy progressively develops a yellow color.

The most characteristic symptoms of citrus greening are a blotchy leaf mottle and vein yellowing that develop on leaves attached to shoots showing the overall yellow appearance. These foliar symptoms may superficially resemble a zinc deficiency although the green and yellow contrast is not as vivid with greening as it is with zinc deficiency or another disease, citrus variegated chlorosis (Fig. 33). Leaves with citrus greening have a mottled appearance that differs from nutrition (Fig. 34). Fruit from diseased trees are small, often misshapen, and typically some green color remains on ripened fruit. On Mandarin orange, fruit may develop an uneven ripening such that they appear half orange and half yellow. This symptom is the origin of the common name “greening.” Yields are almost non-existent, and remaining fruit is rendered worthless due to small size, poor color, and bad taste. The only definitive method of diagnosis of trees suspected of infection by citrus greening pathogens is by analysis of DNA.



Fig. 33. Citrus Greening Disease

**Cause and Spread:** The disease is known to be caused by phloem limited bacteria *Candidatus Liberibacter asiaticus*, *L. africanus* and *L. americanum*. The disease is primarily spread by two species of psyllids



a. similar to nutrient deficiency      b. Citrus greening vector

Fig. 34. Citrus Greening Disease & Vector

The Asian citrus psyllid, *Diaphorina citri* and the African citrus psyllid, *Trioza erythrae*, There are three strains of the bacteria, an Asian, an African version, and a recently described American strain discovered in Brazil. Adult Asian citrus psyllids are small, about the size of aphids (2.5 mm), resemble small cicadas and prefer to feed on leaves and stems of citrus and closely related Rutaceae. They have mottled brown wings, characteristically sit at an angle to the shoot or leaf on which they feed and will jump when disturbed. Eggs are bright yellow and deposited on young leaves. The Asian citrus psyllid is most likely to be found on new shoots, and the population increases during periods of active plant growth. It is capable of building to large numbers on one of its preferred hosts, the ornamental plant Orange Jessamine (*Murraya paniculata*).

**Management practices:** Other than tree removal, there is no effective control once a tree is infected and there is no known cure for the disease. Infected trees may produce misshapen, unmarketable and bitter fruit. Citrus greening reduces the quantity and quality of citrus fruits, eventually rendering infected trees useless. In areas of world affected by citrus greening the average productive lifespan of citrus trees has dropped from 50 or more years to 15 or less. The trees in the orchards usually die 3-5 years after becoming infected and require removal and replanting. The certification of budstock, is the primary counter-measures in controlling the disease. The production of CGB free trees by shoot-

tip grafting or heat treatment is very important. If it is possible to keep the field permanently free of CGB, the planting of virus-free trees is practical.

### **15.0 CITRUS WITCHES BROOM (*Phytoplasma aurantifolia*)**

**Symptoms:** Symptoms of the disease include appearance of small chlorotic leaves, highly proliferating shoots and shortened internodes. Leaves drop prematurely and infected branches would have distorted twigs characteristic of witches' broom symptoms (Fig. 35). In advanced stages, infected branches show die-back symptoms. The disease was successfully

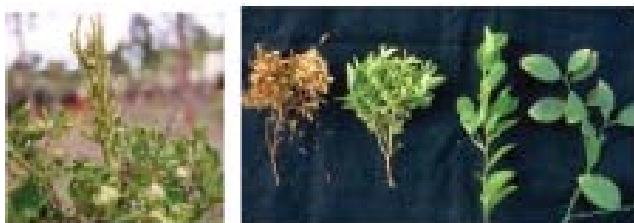


Fig. 35. *Citrus Witches broom disease*

transmitted from infected acid lime to periwinkle plants and vice-versa by dodder. A bright yellowish-green fluorescence was observed in the phloem sieve elements of diseased periwinkle stem tissue when stained with DAPI.

**Cause and Spread:** Citrus Witches Broom is caused by a Phytoplasma. The disease in nature is known to be transmitted by leaf hoppers and artificially through dodder and grafting. The natural host range of WBDL includes *Citrus aurantifolia*, *C. medica*, *C. limetta*, *C. lemon* and *C. jambhiri*, sweet lime (*Citrus limettioides*) among non rutaceous plant hosts, periwinkle (*Catharanthus roseus*) was found to be infected naturally.

**Management practices:** Use of healthy bud wood is the only method of control.

## 4. GRAPES

### 1.0 DOWNY MILDEW (*Plasmopara viticola* (Berk. & Curt.) Berl. & Det.)

**Symptoms:** The disease may appear on any succulent organ of the vine, but the fungus infects mainly the leaves causing small, greenish-yellow, oily irregular spots mostly on the upper surface with downy white growths on the corresponding lower surface. The spots enlarge, merge together and tissues are traversed by reddish lines. The affected area becomes brown and brittle. The white colour of the fruiting mass on the undersurface becomes dirty grey. The infection at times spreads on young shoots, tendrils, leaf petioles and inflorescence causing their eventual drying. The affected shoots turn dark brown and become brittle and stunted. The downy fruiting masses may also appear on the infected flowers and young fruit clusters. The affected clusters wilt and die. Young berries are most susceptible to the infection from their setting until attain 5 – 6 mm in diameter. Infected berries stop growing, become harden, turn dull bluish green and then brown. These wither and start falling from the clusters (Fig. 36a, 36b).



**INFECTED FOLIAGE**

Fig. 36a. Downy mildew of grapes -Foliar infection



Fig 36b. Downy mildew of grape: panicle & berry infection

**Epidemiology:** Temperature in the range of 17-32 °C and the relative humidity above 48% is most favorable and the disease spread rapidly when rains are frequent coupled with cloudy weather. The sporangia are short lived and do not survive exposure to sunlight above 30 °C.

**Management:** Field sanitation is most important aspect to contain the disease development; Fallen leaves and twigs should be collected and burnt. Free circulation of air should be ensured by proper spacing and pruning. A regular and systematic fungicidal spraying schedule is a must to manage the disease. Application of Bordeaux mixture (1%) and 3 - 5 application of copper oxychloride (0.3%) is recommended but the 4 - 6 applications of Metalaxyl + mancozeb (Ridomil MZ 0.2%) or Fosetyl Al (Alliette 0.3%) or Fosetyl Al (Alliette 0.2%) + Propineb (Anracol 0.2%) or Mefenoxam (Ridomil Gold 0.3%) or Dimethomorph (Acrobat 0.08%) + Mancozeb (Indofil Dithane-M 45 0.2%) or Cymoxanil + Mancozeb (Curzate 0.2%) at 10 days interval are very effective for the control of disease. First spray: after vine attaining three leaf stage.



## 2.0 ANTHRACNOSE (*Elsinoe ampelina* Shear.)

**Symptoms:** The pathogen can infect all the green parts of the vine including berries. On leaves small irregular lesions are formed which turn grayish white in the centre with dark border; cankers (scars) are formed on the petioles and veins of leaves get twisted and deformed. The necrotic tissue eventually drops out off the lesion, leaving a “shot-hole” appearance. Cankers or scars are also produced on shoots. They first appear as more or less elliptical small brown spots which enlarge and become depressed at the centre. The lesions on canes are elongated, sunken, dark brown with dark purple raised margins. Blossom when infected fail to set fruits or the berries. The spots on berries are initially light brown and as they grow in size, turn grey at the centre surrounded by reddish or purple margins. The well known “bird eye” spots are produced on berries. Effected young berries shriveled or may be killed.



Fig. 37. Grape Anthracnose

Severely attacked berries may crack exposing the seeds (Fig. 37).

**Epidemiology:** Mycelium of the pathogen surviving with cankerous cane forms conidia which can penetrate the unwounded shoots, leaves, petioles, tendrils and fruit stems. The heavy rains and disease incidence are positively correlated. Warm and wet weather prevailing during July to November month is most favorable for the disease.

**Management:** Pruned plant parts should be removed from the orchard and destroyed. Vines should be trained such that the splashes of wet soil during rainy season should not reach foliage, canes and branches. Ground level canes and branches should be removed. The vines should be sprayed with Chlorothalonil (Kavach 0.2%) or Bitertanol (Baycor 0.2%) or Thiophanate methyl (Topsin M or Roko 0.1%) or Difenconazole (Score 0.05%) at 10-15 days interval. Number of sprays depend upon the prevailing weather conditions and may vary from 4 and 6 in case of systemic and contact fungicide, respectively.

## 3.0 POWDERY MILDEW (*Uncinula necator* (Schw.) Burr.)

**Symptoms:** The powdery mildew is observed on all the green parts of the vine viz. leaves, canes, tendrils, inflorescence and berries. Highly discrete scattered blemishes, dull green in colour develop on the upper surface of lamina at the onset of the disease. These symptoms are usually followed by varying degrees of blistering of the middle part of the lamina and crinkling of the margin. The crinkled region exhibit small yellowish or brownish necrotic spots when viewed against light. During congenial weather the lamina blemish expands, become prominent and covering upper and lower surfaces with white and grey colour powdery felt, respectively. The affected leaves curl up, become

twisted; young expanding leaves when infected become distorted and stunted. Petioles become brittle and may break; green shoots develop dark brown to black patches. In case of early attack cane fails to mature and fruits may not develop. At times, young shoots completely wither; inflorescence are partially infected and get covered with a light grayish white felt resulting in flowers to dry up and drop off. Fruits are susceptible to powdery mildew attack from the time of setting to ripening and injury caused to fruits is responsible for great economic losses. After setting, young berries (2-3 mm dia.) on getting infection develop oil ash green coloration and soon covered with powdery coating comprising of conidial fructifications. Infected berries dry up and fall. At ripening stage the berries stop swelling, turn rusty, dry or rot depending upon weather (Fig. 38).



Fig. 38. Grape: Powdery mildew of grapes: Infected berries & bunch

**Epidemiology:** The fungus survives in the form of conidia or mycelium that remains alive in the sheltered areas in the shoots. Secondary spread is through the air borne conidia. Cleistothecia are believed to carry the mildew from season to season wherever they are formed. In North Indian climatic conditions during the months of October and November and then February - April are ideal for the development of the disease, whereas, in Bangalore weather conditions during September to February are congenial for the disease development.

**Management:** Planting site should be well drained and with proper air circulation. Training of bunches, pruning and removal of foliage covering the fruit bunches should be practice regularly. Spraying with wettable sulphur (0.2%) when atmospheric temperature is not above 30 °C; Four applications of Tridimefon (Bayleton 0.1%) or Myclobutanil (Systhane 0.05%) or Dinocap (Karathane 0.03%) or Fenarimol (Rubigan 0.03%) or Hexaconazole (Contaf 0.1%) or Propiconazole (Tilt 0.025%) or Azoxystrobin (Amistar 0.125%) provides effective control of the disease. First spray: At the appearance of disease.

#### 4.0 DEAD ARM (*Phomopsis viticola* Sacc.)

**Symptoms:** Small angular spots having yellowish margins and dark centers appear on the leaves, stems, canes and flower clusters. These spots grow further to form large brown patches on the canes which may enlarge and kill the buds. When disease is severe, it penetrates the woody parts and kills the water conducting tissues resulting in to the death of branch. Pathogenic association of other fungi namely *Pestalotiopsis viticola*, *Guignardia bidwelli*, *Greenaria uvicola* and *Botryodiplodia theobromae* with the branches also results the similar symptoms. All these fungi also infect leaves, berries and rachis and cause typical symptoms (Fig. 39).



Fig. 39. Grape: Dead Arm

**Epidemiology:** The pathogens overwinter in dead canes or partially infected canes, arms and at the points of leaflets left out on the vines left out after pruning. The spores disseminate from old diseased parts to the young tissues by rains or dripping fog. The used pruning knife, wind borne spores and even the insects visiting the vines also spreads the pathogens.

**Management:** The dead canes or arms and spurs should be pruned up to the region below the infected portions. The pruned material should be collected and destroyed and pruned canes should be pasted with Bordeaux paste or Copper oxychloride (Blitox-50 or Fytolon) immediately after pruning. The vines should be sprayed with Bordeaux mixture (5:5:50) followed by Chlorothalonil (Kavach 0.2%) or Zineb (Indofil Dithane Z -78 0.2%) or Propineb (Antracol 0.2%) or Carbendazim (Bavistin 0.1%) or Iprodion + Carbendazim (Quintal 0.2%) at fortnightly intervals till the canes become hard.

## 5.0 GREENARIA FRUIT ROT AND LEAF SPOT (*Greenaria uvicola* Berk. & Curt.)

**Symptoms:** The disease infects leaves, petioles, canes and berries. Both young and old leaves get infected in the field. The infected leaves initially develop black regular to irregular spots, producing greasy black veinal necrosis. At later stages the infection spreads further covering leaf lamina on either side of the vein. Such spots are surrounded by yellow halo that subsequently develop concentric rings with irregular dark water soaked margins. On petiole and tendrils the infection develops as water soaked spot extending into entire surface. Young canes become light brown initially and later turn black and fail to grow further; leaves loose turgidity and show wilting symptoms and if they are bearing fruits, bunches also show wilting and later on berries drop giving a barren look to such vines. The fungus attacks

berries at all their stages of development. The young green berries if get infected, shrivel, turn black and become mummified, whereas on mature berries light brown circular areas develop. Infection of bunch stalk or rachis get infected to the wilting of bunches. Such infected berries get detached if wet weather prevails (Fig. 40).



Fig. 40. Grape: *Greenaria* leaf & fruit spot

**Epidemiology:** Warm humid weather during July to October and January to February, Temp between 25-30 °C with surface free moisture is congenial for disease.

**Management:** Affected canes should be removed during pruning and destroyed. During early stage of bunch development loosening of bunches using suitable plant regulator should be practiced. Vines should be sprayed with Propineb (Antracol 0.2%) or Thiophanate methyl (Topsin M 0.1%) or Difenoconazole (Score 0.005%) or Tricyclazole (Beam 0.2%).

## 6.0 BLACK ROT (*Guignardia bidwelli* (Ell.) Viala and Ravaz)

**Symptoms:** All the new growth on the vine is subjected to attack during growing season. On the leaf necrotic, reddish circular spots develop on the thin part of leaf blade those subsequently turn brownish and surrounded by black margin. The centre of the spots remains reddish brown to greenish tan minute black dots arranged in a ring near the outer edge of the brown portion. On the shoots depressed, purple to black and elliptical to



elongate lesions appear. Similar lesions may also appear on tendrils, leaf petiole, leaf vein and flower stalk. With the growth of the cane bark may split along the long axis of the lesion. Dark black fruiting bodies develop in these lesions. On the berries the spots produce a bird's eye spot. The lesions are not visible until the berries are half grown. Berries shrink, wrinkled and become mummified (Fig. 41).



Fig. 41. Grape: Black rot

**Epidemiology:** Infection takes place only when there is an extended period of rain and cloudy or foggy weather prevails. Rains followed by foggy weather for 2 or 3 days are necessary for infection. 6 and 12 hrs of wetness at 26.5 °C and 32 °C, respectively is most conducive for the disease development.

**Management:** Mummies left out on vines should be collected and destroyed. Cultivation practices must allow free circulation of air and rapid drying of leaves. The black rot can be controlled by spraying protective fungicides such as Mancozeb (Indofil Dithane M 45 0.2%) or Propineb (Antracol 0.2%) or curative fungicides such as Thiophanate methyl (Topsin M or Roko 0.1%) or Difenoconazole (Score 0.05%) or Tricyclazole (Beam 0.2%) or Hexaconazole (Contaf 0.1%) or Bitertanol (Baycor 0.2%) applied at noticing the infection.

## 7.0 ALTERNARIA LEAF BLIGHT & FRUIT ROT (*Alternaria alternata* (Fr.) Keissl.)

**Symptoms:** Infects all the aerial parts like leaves, flowers, berries and canes. On the leaves dark brown

concentric rings are produced which enlarge; leaves become blighted and later fall off. Dark purplish spots are noticed on the young canes which failed to mature. Berries show depressed elliptical purplish lesions and such berries fail to ripe. Necrosis of pedicel is also common.

**Management:** Spray the vines with Zineb (Indofil Dithane Z 78 0.2%) or Ziram (Cuman L 0.4%) or Propineb (Antracol 0.2%) or Chlorothalonil (Kavach 0.2%).

## 8.0 RUST (*Phakospora euveitii* Y.Ono)

**Symptoms:** Rust is a very serious disease that hampers the successful and remunerative cultivation of the Grape var. Bangalore Blue. It appears in the form of small yellowish pustules containing uredia produced on the abaxial surface of the leaves. Pustules coalesce and cover large portion of the leaves. On adaxial surface brown necrotic spots develop opposite the uredial pustule, giving rusty appearance on matured leaves. The infection results in severe defoliation and vines had only short shoots and nodes resulting in great loss in yield (Fig. 42).



Fig. 42. Grape: Rust



**Management:** Three sprays with Propiconazole (Tilt 0.1%) or Chlorothalonil (0.2%) or Hexaconazole (Contaf 0.1%) or Bitertanol (Baycor 0.1%) at fifteen days intervals have been recommended for the control of rust. First spray: at the appearance of disease.

## **9.0 GRAPEVINE BACTERIAL CANKER** *(Xanthomonas campestris pv. viticola)*

**Symptom:** Bacterium infects all the aerial parts of vine. Initial symptoms appear as small water soaked lesions surrounded by a yellow halo in the lower surface of leaf. These lesions enlarge (2 to 5mm) in due course and become angular and cankerous. Often these lesions coalesce and form large patches (Fig. 43). Severely



Fig. 43. Grape wine Bacterial canker

infected leaves give blight appearance and firmly attached to the cane even after complete drying. Lesions were brown to black elongated (0.5 to 8 cm) and cankerous on petioles and canes. In advance stages of infection stunting, cracking and irregular growth of canes were also observed. Lesions on bunch and berries were brown to black. Cankorous and severely infected berries were small and shriveled.

### **Management:**

1. Changing pruning dates - Prune after second week of October (Early winter pruning from July to second week of September are highly vulnerable).
2. Excess Nitrogen application should be avoided.
3. Spray Copper oxychloride (0.3%) & Bordeaux mixture (1.0%).
4. Use of Resistant varieties.

## 5. PAPAYA

### 1.0 STEM ROT OR FOOT ROT (*Phytophthora* spp., *Phythium aphanidrmatum*, *Rhizoctonia solani*)

**Symptoms:** The disease is characterized as water-soaked patches on the stem at ground level, which enlarge and girdle base of the stem. The affected tissues turn brown than black and rot. The terminal leaves turn yellow, wilt and drop. Fruits if formed also shrivel and drop off. The entire plant topples and dies because of the disintegration of parenchymatous tissue. The internal tissues look like a honey cob. The affected roots deteriorate and loose attachment with the soil (Fig. 44).



Fig. 44. Papaya stem rot or foot rot

**Epidemiology:** Under suitable conditions the disease is able to destroy the entire plantation within one season and makes the soil unfit for planting. The disease usually appears during rainy season and the severity depends upon the intensity of rainfall coupled with temperature. The one week old plants are more susceptible than one year old. The seedlings raised in the infested soil carry the disease to the field. Such seedlings later develop stem rot under favourable condition.

**Management:** Seed dressing with Captaf (Captan) or Chlorothalonil (Kavach) should be done before sowing the seeds. Soil at the orchard should be well drained. Before planting, application of Neem cake + *Trichoderma harzianum* should be provided. Healthy

nursery or healthy plants should be planted and crop rotation with non host crop should be followed.

Soil drenching with Tridemorph (Calixin 0.1%) or Metalaxyl + Mancozeb (Ridomil MZ 0.2%) or Chlorothalonil (Kavach 0.2%) at bimonthly interval provide effective control of the standing crop.

### 2.0 DAMPING OFF (*Pythium*, *Phytophthora*, *Rhizoctonia* and *Fusarium* spp.)

**Symptoms: Pre emergence damping off:** Characterized as toppling of the growing tip before it comes out of the soil.

**Post emergence damping off:** Seedlings show pale withering and bending symptoms near the ground level with the severe girdling of the stem tissue. In case of *Phytophthora* and *Fusarium*, root rot is also observed. Such effected seedlings suddenly topple down (Fig. 45).



Fig. 45. Papaya: damping off of seedlings

**Epidemiology:** Seeds extracted from diseased fruits carry the primary inoculum. Soils having diseased debris are also a source of disease. Excessive moisture/water stagnation predisposes seedlings to infection. Heavy rains during nursery stage causes heavy mortality.

**Management:** Seeds for raising nursery should be obtained from healthy fruits. Water stagnation and low lying areas should be avoided for nursery. Seeds should be treated with Oxycarboxin, Carbendazim SD, Captaf, Thiram @ 2 g/Kg seeds.

Soil amendments with solarization, application of neem cake + *Trichoderma harzianum*, Dazomet, Formaldehyde should be practised. Drenching of Nursery with Chlorothalonil (Kavach 0.2%) or Oxycarboxin (Vitavax 0.1%) or Carbendazim (Bavistin 0.1%) should be done.

### 3.0 ANTHRACNOSE (*Colletotrichum gloeosporioides* (Penz.) Penz. & Sacc.)

**Symptoms:** Disease can attack fruits petioles, leaves, floral parts, etc. Water soaked spots first appear as brown superficial discoloration of the skin and then develop into circular, slightly sunken areas 1-3 cm diameter. Gradually the lesions coalesce and sparse mycelial growth often appears on the margins. Under humid conditions, encrustations of salmon pink spores often arranged in a concentric pattern develop on the surface of older spots. Fruits later turn dirty brown and rot. Infection at early stages results in mummification and deformation of fruits whereas at mature stage soft rot develops. Sometimes Chocolate sunken brown lesions appear on the ripening fruits. The petioles of the lower leaves dry and are shed (Fig. 46).



Fig. 46. Papaya: Anthracnose

**Epidemiology:** Rotting of papaya fruit is favored by 25-30 °C with high humidity and availability of free surface water.

**Management:** Infected leaves should be removed and destroyed. Spraying of Mancozeb (Dithane M 45 0.2%) or Chlorothalonil (Kavach 0.2%) or Carbendazim (Bavistin 0.1%) at 15 days interval provides effective control. Dipping fruits in water at 46 to 49°C for 20 minutes shortly after harvest provides control of disease under storage.

### 4.0 POWDERY MILDEW (*Oidium caricae* (Noack.)

**Symptoms:** Small circular powdery patches develop on both the sides of leaves and on stem of young seedlings. These patches gradually extend, coalesce and cover the entire leaf surface. Badly infected leaves curl, dry, hang down and ultimately fall off. Young seedlings may die under severe disease attack. Sometimes in severe cases the pathogen attack fruits also (Fig. 47).



Fig. 47. Papaya: Powdery mildew

**Epidemiology:** The disease is observed between June to February months with peaks during September to November. Atmospheric temperature in the range of 16 – 23 °C and relative humidity above 65 % are favorable for the disease development.

**Management:** The disease is effectively controlled through the spraying of wettable sulphur (Sulfex 0.3%) when atmospheric temperature is below 30°C. Application of systemic fungicides namely Tridemifon (Bayleton 0.1%) or Carbendazim (Bavistin 0.1%) or Thiophanate methyl (Topsin M or Roko 0.1%) at monthly interval is much more effective.

## 5.0 PHYTOPHTHORA BLIGHT (*P. nicotianae* var. *parasitica* Dastur)

**Symptoms:** Though the main symptoms are noticed on the fruits yet stem and leaf scars are also get infected with dull colour patchy growth. These infected areas enlarged and often completely girdle the stem of young trees resulting in the wilting of the top of the plant that eventually dies. At times, particularly in the older trees the stem is not completely girdled but plants become so weak that they may be broken off with the wind. Fruits at any stage of development may become infected and hang on the tree. As the disease progresses, the fruits shrivel, turn dark brown and fall on to the ground. Such mummified fruits ultimately become brownish black, light in weight and stone like in texture (Fig. 48).



Fig. 48. Papaya: *Phytophthora* blight

**Epidemiology:** Disease is favored by continuous rain fall and high humidity, secondary spread through raise splash and wind. Temperature 15-35 °C is favorable for infection.

**Management:** Avoid planting in low lying fields and heavy soils and facilitate good drainage during rainy season to avoid water logging. Apply neem cake + *Trichoderma harzianum* before planting. Complete removal and destructions of infected plants and fruits from the orchard at the earliest is very important.

Spraying and soil drenching with protectant fungicides namely Mancozeb (Indofil Dithane M 45 0.2%) or

Chlorothalonil (Kavach 0.2%) at fortnightly intervals or systemic fungicides like Melalaxyl + mancozeb (Ridomil MZ 0.2%) or Fosetyl Al (Alliette 0.2%) impart effective disease control.

## 6.0 ALTERNARIA LEAF BLIGHT & FRUIT SPOT (*Alternaria alternata* (Fr.) Keissl.)

**Symptoms:** Disease infect both leaves and fruit. On leaves, light brown to dark brown prominent zonate spots are produced whereas on fruits depressed, circular to oval lesions are seen. As fungus sporulates, spots turn black. Lesions remain restricted to the surface of the fruit and rotting of the flesh is not observed. Lesions may coalesce and can cover entire fruit surface. Sometimes young growing crown gets infected and the plant dies (Fig. 49).



Fig. 49. Papaya: *Alternaria* leaf blight & fruit spot

**Epidemiology:** Disease restricted to dry environments. High disease incidence (>80%) is noticed when fruits kept in cold storage (10 °C for 14 days)

**Management:** Bi weekly application of Zineb (Indofil Dithane Z 78 0.2%) or Propineb (Antracol 0.2%) or Chlorothalonil (Kavach 0.2%) followed by Post harvest hot water dip (48 °C for 20 min).

## 7.0 BLACK SPOT (*Asperisporium caricae* (Speg.) Maubl.)

**Symptoms:** Distinct dark black spots appear on leaves which become dull and droop. Infected leaves shrivel and dry off. On fruits, black raised pustules scattered all over the fruit are produced that remained confined to



the rind. The infection renders the fruit unmarketable (Fig. 50).



Fig. 50. Papaya Black spot

**Epidemiology:** High humidity and temperature between 15 to 25 °C are the most favourable factors for the disease.

**Management:** Application of Zineb (Indofil Dithane Z 78 0.2%) or Propineb (Antracol 0.2%) or Chlorothalonil (Kavach 0.2%) provides effective control.

### 8.0 DRY ROT (*Phoma caricae papayae* (Tarr) Punith.)

**Symptoms:** Spotting of leaves, flowers and young fruits is noticed. Numerous small spots that remain slightly sunken, circular and black in colour with light brown translucent margin appear on the host surface. Infected tissues become dry and hard; at times causes stem end rot. On flowers and young fruits initially brown spots are produced which later becomes dark and sunken. In wet weather, light colored spores ooze out from pycnidia (Fig. 51).

**Epidemiology:** Disease is severe during rains and high humidity periods. Chilling injury and low temperature (7°C) are suitable for disease.

**Management:** Destroy the infected fallen leaves and fruits. Pre harvest field application of Thiophanate methyl (Topsin M or Roko 0.1%), Bitertanol (Baycor

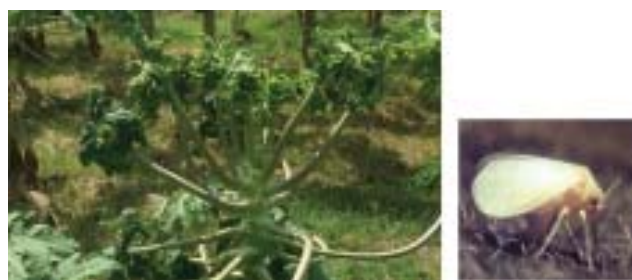


Fig 51. Papaya Dry rot

0.1%) or Propineb (Antracol 0.2%) or Chlorothalonil (Kavach 0.2%) gives good control whereas Post harvest hot water treatment at 48°C for 20 min is recommended.

### 9.0 PAPAYA LEAF CURL DISEASE (*Papaya leaf curl virus*):

**Symptoms:** Leaf curl of papaya is characterized by severe curling, crinkling and distortion of the leaves accompanied by vein clearing and reduction in the leaf size. Leaf margins get curled downwards and inwards with dark greenish, thick veins (Fig. 52). The leaves also become leathery and brittle and the interveinal areas get raised leading to rugosity of the leaves. In some cases enations are produced on the lower surfaces of the leaves. The petioles get twisted in a zigzag manner and cluster around the main trunk. The growth of the plant is drastically reduced. Affected plants fail to flower and in case of occasional flowering the fruit set would be rare.



a. Papaya leaf curl symptom

b. Papaya leaf curl Vector -Whitefly

Fig. 52. Papaya leaf curl disease

**Cause and Spread:** The virus belongs to the begomovirus genus of Geminiviridae. It is a single stranded DNA virus. It is transmitted in nature by the whitefly (*Bemisia tabaci* (Gennadius)). This virus is not transmitted through seed and mechanically. This disease increases with a rise in temperature coupled with relative humidity. The virus mainly perpetuates on weed hosts. Warm and dry weather favors disease spread. In southern India the disease epidemics would be more during March to June where as in Northern Indian conditions epidemics would occur from June to October.

**Management practices: A. Cultural:**

1. Growing of nursery under Nylon net cover (60-80) mesh.
2. Eradication of early-infected plants and weed hosts from the field.
2. Growing two rows of border cropping with Maize, Jowar, or Bajra gives a reduction in the disease spread.

**B. Chemical:** 1. Soil Application of Furadon @ 1.5 Kg ai / ha at the time of sowing.

2. Prior to transplantation the seedlings should be sprayed with Acephate 1.5 g/L or Monocrotophos @ 1.5ml per liter or Dimethoate @ 2.0 ml/L.
3. Foliar Spray of Acephate @ 1.5g per liter followed by Spraying of Imadacloprid @ 0.3 ml/L are effective.
4. Chemical spray followed by neem seed kernel extract @ 2% is also effective in rotation with insecticides.

**10.0 PAPAYA RING SPOT DISEASE (*Papaya ring spot virus*)**

Papaya ring spot disease is also known as papaya mosaic, papaya distortion mosaic, mild mosaic, papaya ring spot, papaya leaf reduction, thin leaf and distortion as all the above symptoms are caused due to Papaya ring spot virus. The typical mosaic caused by potexvirus so far not found in India.

**Symptoms:** PRSV-P strain naturally infects papaya and cucurbits. Plants of all ages are susceptible and symptoms are generally more severe during cooler weather. The disease derives its name from the characteristic dark green sunken rings that develop on fruit of affected plants. These rings often persist as dark orange to brown markings as the fruit matures. Dark green, water-soaked streaks develop on petioles and stems. Mottle and mosaic patterns of varying severity develop on leaves that often have a ruffled appearance (Fig. 53). One or more leaf lobes may become stunted and fruit set is markedly reduced or absent. Fruit from affected plants have poor flavor, a leathery appearance and are predisposed to fungal fruit rots.

**Cause and Spread:** The virus is flexuous particle of 680-760 X12nm and virus particles consists of positive

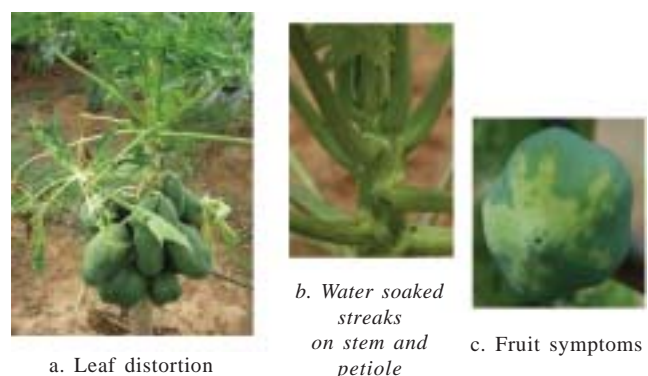


Fig. 53. Papaya ring spot virus symptoms



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sense monopartite ssRNA. PRSV is a *potyvirus* belonging to *Potyviridae*. PRSV is transmitted by several aphid species of which the following are important *Aphis gossypii* Glover, *A. craccivora* Koch, *Rhopalosiphum maidis* (Fitch) and *Myzus persicae* (Sulzer) all of which transmit the virus in a non-persistent manner. Papaya and Pumpkin are the major primary and secondary source of inoculums while rapid secondary spread can occur very fast leading to whole plantations getting totally infected. This would happen in plantations where young plants are in the vicinity of infected plants where populations of winged aphids are high. Transmission of PRSV-P is almost entirely due to transitory aphid populations, as papaya is not a preferred host for aphids and so colonies are very rarely found on plants.

**Management practices:** Growing of boarder crops two rows of *Sesbania* or castor 15 days before planting of papaya. Rouging and removal of early infected plants as when noticed. Several cultural practices have proven useful in slowing epidemics and reducing crop damage. Establishing plantations with seedling plants free of PRSV-P is essential, and new planting should be situated as far as possible from affected plantations. Plantations can be surrounded by non host crops or interplanted with other tree crops. Growing tolerant or resistant varieties is the best option. Genetically engineered resistance against PRSV has been achieved in Hawaii using Kapoho, Sunup and Rainbow cultivars. However, in India so far PRSV resistant cultivar is not available at present.

## 6.0 GUAVA

### 1.0 ANTHRACNOSE (*Colletotrichum gloeosporioides* (Penz.) Penz. & Sacc)

**Symptoms:** Anthracnose is manifested in symptoms as die-back, twig blight, wither tip and fruit spot. On the unripe fruits small, dark brown, sunken and small spots of pin head size are observed. These spots gradually enlarge to 5 – 6 mm in diameter; coalesce to form a corky hard lesion having cracks. The ripe fruits become soft and at times drop off. Unopened buds and flowers are also shed. Foliage develops necrotic gray lesion at tips and margins. Tender branches dry from tip downward exhibiting 'die back'. The growing tips of the branches die and necrotic and dead areas spread downwards. The leaves, flowers and fruits are shed and unripe fruits remained mummified. Fruits carry the incipient infection from the field that manifests itself in storage causing rotting of fruits (Fig. 54).

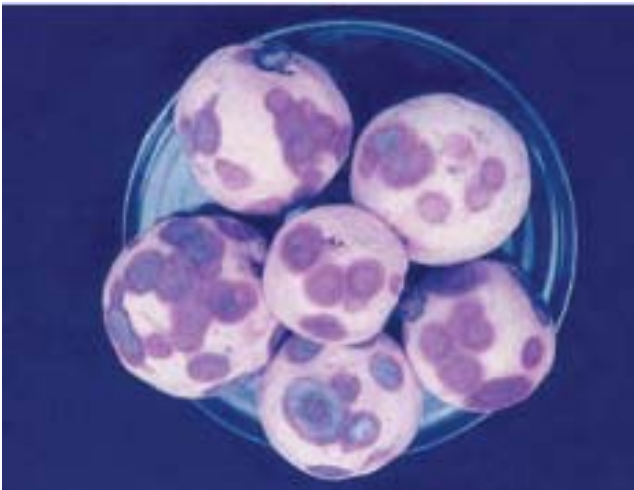


Fig. 54. Guava: Anthracnose

**Epidemiology:** The disease is mostly favored by high humidity. During moist weather profuse production of acervuli is noticed on dead parts of twigs and the spores come out as a pinkish mass. These are further disseminated by rain or wind and cause fresh infection.

The disease develops more rapidly on the ripe fruits and maximum spreads takes place at 30 °C and relative humidity of 96%.

**Management:** Sprayings of Bordeaux mixture (3:3:50) or Copper oxychloride (Blitox 0.2%) at weekly intervals starting from the month of July manage the disease. Among systemic fungicides Carbendazim (Bavistin 0.1%) or Thiophanate methyl (Topsin M or Roko 0.1%) provide effective disease control.

### 2.0 FRUIT ROT (*Phytophthora nicotianae* var *parasitica* Dastur)

**Symptoms:** The infection starts as circular brownish spots at styler end as well as on the fruits. Whitish cottony growth develops very fast as the fruits ripens and cover almost the entire surface with in a period of about 3-4 days during humid weather. Peduncle and fruits become soft and the colour of the fruit changes from light brown to dark brown, emitting a characteristic unpleasant odour. Incipient infection on fruits leads to rotting during storage (Fig. 55).



Fig. 55. Guava: fruit rot

**Epidemiology:** High relative humidity > 70% and temperature in the range of 20-27.5 °C are very



conducive for the disease. The rain fall spread over a period is more congenial than the total amount of rains for the disease progression.

**Management:** The disease can be effectively controlled through the sprays of Al phosphonate (Aliette 0.2%) + Indofil Dithane M-45 (0.2%) or Phosphonic acid (Phytoalexin (0.3%) or Akomin (0.3%) when sprayed at fortnightly intervals. The removal and destruction of diseased fruit is the foremost important.

### 3.0 STYLER END ROT (*Phomopsis psidii* de Camera):

**Symptoms:** Circular to irregular discolouration of fruits starts from the styler end side. The affected area turns reddish brown surrounded by light yellow region, becomes soft, the fruits start rotting which progresses further towards stem end side thereby covering the entire fruit. At times latent infection leads to the rotting of the mature fruits during storage which in turn spread infection to the other healthy fruits. Young growing leaves and shoots are also get infected by the pathogen (Fig. 56).

**Epidemiology:** The disease is more serious during rainy season. It appears in the month of December and rapidly

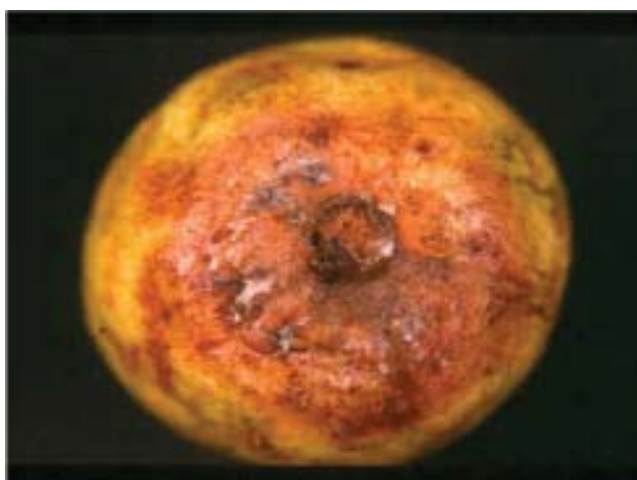


Fig. 56. Guava: Styler end rot

spreads during February and March.

**Management:** The disease can be effectively controlled through the sprays of Carbendazim (Bavistin 0.1%) or Thiophanate methyl (Topsin M or Roko 0.1%) or Chlorothalonil (Kavach 0.2%) at 20 days intervals.

### 4.0 FRUIT CANKER OR GREY BLIGHT (*Pestalotia psidii* & *C. gloeosporioides* (Penz)

**Symptoms:** Dark brown corky lesion or cankerous spots with raised margins and depressed center are produced on the immature fruits. Small dot like specks 0.4 -2.5 mm in size are commonly observed. On foliage reddish brown angular to irregular spots are produced. Leaves give burning appearance when severely affected (Fig. 57).



Fig. 57. Guava canker

**Epidemiology:** Disease is favored by the temperature range of 26-30 °C and relative humidity of 96-98%.

**Management:** Application of Ziride (CumanL 0.4%) or Zineb (Indofil Dithane Z 78 0.3%) followed by Mancozeb (Indofil Dithane M45 0.2%) or Carbendazim (bavistin 0.1%) provides good control of the disease.

## 5.0 SEEDLING BLIGHT (*Rhizoctinia solani* Khun):

**Symptoms:** Damping off of guava seedlings results in enormous losses in the nurseries. The pathogen mainly infects the seedling up to 4 month of age. On the leaves small, circular to irregular, brownish spots develop which spread very rapidly under humid conditions on lamina and petiole. The upper leaves are first to show the symptoms and disease progresses from tip downwards. The disease advances and finally the whole plants collapse and die. Elongated brown lesions are produced on petiole and stem.

**Epidemiology:** The disease is rarely observed in dry weather and even if it appears its spread is very slow. It is most severe during the month of July to August when seedlings have luxurious leafy growth and weather is humid.

**Management:** Drenching and spraying with Captaf (Captan 0.2%) or Chlorothalonil (Kavach 0.2%) effectively control the disease.

## 6.0 LEAF SPOT (*Cercospora psidii* Swada):

**Symptoms:** The affected leaves show scattered yellowish spots measuring up to 1.0 mm in diameter on



Fig. 58. Guava leaf spot

the upper surface of leaf. On the lower surface irregular water soaked brownish spots are seen. Leaves are curled and subsequently dropoff. Generally the older leaves get severe infection (Fig. 58).

**Epidemiology:** Disease is severe during December to February months when weather is relatively dry.

**Management:** The disease is effectively controlled through the sprays of Carbendazim (Bavistin 0.1%) or Thiophanate methyl (Topsin M or Roko 0.1%).

## 7. POMEGRANATE

### 1.0 LEAF AND FRUIT SPOT (*Pseudocercospora puniceae* (Henn.) Deighton)

**Symptoms:** This is a very serious disease of pomegranate plants affecting leaf and fruits. Pathogen causes irregular, scattered, yellowish spots on leaves having a halo around at the early stage, subsequently the spots increase in size and form bigger patches and become blackish. The lesions are covered with dull white crust of fungal growth. Severe infection of the disease leads to defoliation and hampers plant growth. On flower buds brownish black irregular small spots appear which grow in size along with the fruit. Spots become deeper and more prominent. At greenish stage of fruit, reddish irregular dots/spots develop on the fruits. The spots get covered with deposit of ash colored spores under favorable humid conditions. Mature fruits show numerous black, irregular, slightly corky patches of the infected hard necrotic tissue. Severely infected fruits show cracking at times. Disease is severe in high humidity areas and during rainy season (Fig. 59).



Fig. 59. Pomegranate: Leaf & fruit spot

**Management:** Hexaconazole (Contaf 0.1%) or Carbendazim (Bavistin 0.1%) or Thiophanate methyl (Topsin M or Roko 0.1%) sprayings control the disease. First spray at flower bud stage and subsequently 8-9 sprays at 7-10 days interval depending upon the weather conditions. Among non-systemic fungicide

Chlorothalonil (Kavach 0.2%) or Mancozeb (Indofil Dithane M 45 0.2%) also check the disease.

### 2.0 ANTHRACNOSE (*Colletotrichum gloeosporioides* (Penz.) Penz. & Sacc)

**Symptoms:** The disease manifest in various form of symptoms causing leaf blight, fruit spot, wither tip, die back and fruit rotting as described below:

**(i) Leaf blight:** The disease starts as minute, dull violet black or black spots surrounded by yellow necrotic areas. The spots enlarge; coalesce to form depressed large spots of aniline black in color. Severely infected leaves show necrotic areas extending from leaf margins to cover whole leaf blade. Leaves show curling at some points and severely infected leaves, become dry and fall off. Sometimes shot hole stage is also observed.

**(ii) Fruit spots:** The pomegranate fruits are highly susceptible to attack by this pathogen from early stages of development (flower bud stage - (Reddish) and fruit enlargement stage before attaining greenish color and subsequently at color breaking stage. Smaller brownish spots, which become depressed subsequently, increase in size to form the large spots. During greenish stage of fruit development infection remains quiescent and exhibit symptoms at color breaking stage. Mature fruits show numerous brownish black depressed spots, which coalesced to form bigger patch. The entire infected portion changes color to yellowish brown and fruits start rotting which becomes serious during storage. Severe infection of fruits results in flower bud and fruit drop and in mummified fruit and at times cause rupture of the fruit exocarp also (Fig. 60).

**(iii) Wither tip and die back:** Younger, developing



Fig. 60. Pomegranate: Anthracnose

shoot tips are killed due to attack of pathogen and some developing branches show drying from the tips backward with necrotic areas extending downwards, such branches become dry and devoid of foliage subsequently and give die back appearance. These symptoms are more pronounced in older trees and neglected orchards.

**Management:** Prune the dried twigs and branches and burn them. After pruning a general spray of copper oxychloride (Blitox 0.3%) and pasting of cut ends with copper fungicide should be practiced. Subsequently spraying with Hexaconazole (Contaf 0.1%) or Carbendazim (Bavistin 0.1%), Thiophanate methyl (Thiophanate methyl or Roko 0.1%) should be given. First spray at flower bud stage and subsequently 5 – 6 sprays at the interval of 7-10 days interval has to be provided. Chlorothalonil (Kavach 0.2%) or Mancozeb (Indofil Dithane M 0.2%) in non-systemic category also control the disease.

### 3.0 ALTERNARIA LEAF SPOT AND FRUIT ROT (*Alternaria alternata* (Fr.) Keissl.)

**Symptoms:** Minute pale brown to reddish brown circular to irregular spots develop on the ventral surface of the leaves. The spots, enlarge coalesce to form bigger spots, dark brown in colour having concentric rings. Within a few days of infection by pathogen, leaf brightening become more prominent and such affected pale yellow leaves dry and fall down. On fruits, the pathogen cause external as well as internal rotting. Initially minute brown coloured spots circular to irregular

in outline confined to rind appear on the fruits. As the disease advances the spots turn reddish brown and later on dark brown to black in colour. Fruits lose their natural luster and severe infection of the pathogen leads to internal rotting of fruits discolouration of central core and the seeds (Fig. 61).



Fig. 61. Pomegranate: Alternaria fruit rot

**Management:** Spraying with protectant fungicides namely Mancozeb (Dithane M45 0.2%) or Zineb (Dithane Z78 0.2%) or Chlorothalonil (Kavach 0.2%) or Ziride (Cuman L 0.4%) or with systemic fungicide - Iprodione (Rovral 0.2%) should be taken up as the symptoms appear.

### 4.0 LEAF, FLOWER AND FRUIT SPOTS (*Phytophthora nicotianae* var. *nicotianae*)

**Symptoms:** Brownish lesions develop on the leaf surface which extends in area causing blighting of leaves. Severely infected leaves fall off. Brownish black lesions develop on the flowers and fruits. The affected flowers shed off prematurely. In fruits brownish to black rotten areas extend from calyx end to the periphery. The fruits remain on the plants but become useless as infections spread inwards from the rind causing rotting. Disease is serious during high rainfall period (Fig. 62).





Fig. 62. Pomegranate: *Phytophthora* fruit spot

**Management:** Spraying with Metaxyl + Mancozeb (Ridomil MZ 0.2%) or Al Phosphonate (Alliette 0.2%) controls the disease.

### 5.0 LEAF BLOTCH AND FRUIT SPOT (*Pestalotiopsis versicolor* (Speg.) Steyaert)

**Symptoms:** At the onset of disease, sparse leaf lesions on tender leaves are produced. Mature leaves first show necrotic, angular lesions which spread from the leaf tip regions towards the proximal end, associated with desiccation and shedding. On the fruits, minute brown to rust coloured spots develop in the beginning. The spots coalesced with advancement of the disease and cause necrotic patches. The central portion of the lesions become depressed inside with raised margins and at advance stages of infection tear open the rind. In severe cases infection penetrates deep into the fruits and cause the discoloration of seeds.

**Management:** Spraying Ziride (Cuman L 0.4%) or Zineb (Dithane Z78 0.2%) or Chlorothalonil (Kavach 0.2%) or Bittertanol (Baycor 0.2%) at the onset of the disease provides good control.

### 6.0 DRECHSLERA FRUIT ROT (*Cochilobolus spicifer* Nelson)

**Symptoms:** Water soaked areas appear on the fruit surface in early stages which turn pale brown and then

to dark brown and cover the entire surface. Later on internal rotting takes place. The rind, arils and peel turn brown in colour. Affected young and mature fruits drop severely.

**Management:** Spraying of Mancozeb (Indofil Dithane M 45 0.2%) or Chlorothalonil (Kavach 0.2%) control the disease.

### 7.0 FUSARIUM LEAF SPOT (*Fusarium fusarioides* (Gonz. Frag. & Cif.) C. Booth)

**Symptoms:** The disease is characterized by appearance of minute specks, pale brown in colour, circular to irregular in outline towards the margin of leaves. At advanced stage of infection big dark brown necrotic blotch develops on the surface of leaves which fall off subsequently.

### 8.0 WILT (*Ceratocystis fimbriata* Ellis & Halts / *Fusarium oxysporum*)

**Symptoms:** In some pomegranate orchards, the few branches start dying back, the foliage turn sickly, dropping down turn yellow and shed off. After some time, the affected branches become dry and dead. In severe form the whole mature tree dies all of a sudden even when bearing fruits (Fig. 63).



Fig. 63. Pomegranate: wilt

**Management:** Orchards should be kept clean and managed scientifically with proper plant care approach. Branches showing die back symptoms and dried ones should be pruned and destroyed. Soil drenching with Benomyl (Benlate 0.1%) or Carbendazim

(Carbendazim 0.1%) or Propiconazole (Tilt 0.1%) should be practiced in plants showing symptoms and near by apparently healthy plants also.

## 9.0 BACTERIAL BLIGHT OR NODAL BLIGHT (*Xanthomonas axonopodis* pv. *Punicae*)

**Symptom:** The symptoms of the disease are noticed on fruits, leaves, branches and stems. On fruits circular brown to black lesions develop with L or Y or star shaped crack. In advanced stage entire fruit was covered by the lesions, which lead to cracking of the fruits (Fig. 64). On leaves water soaked pin head size lesions with yellow halo appear. In advanced stage, the spot enlarge covering entire lamina. Defoliation of infected leaves are noticed in severely affected orchards. On the node brown to black water soaked elliptical lesions near the auxiliary bud covering entire node is seen resulting into nodal blight. In the advanced stage of nodal infection, affected areas become flattened and depressed with raised edges. Cracking of nodes will lead to death of branches from the infected portion.



A. Leaf Symptoms



B. Nodal blight



C. Oily spots on fruit



D. Fruit Cracking

Fig. 64. Pomegranate: Bacterial blight

**Management:** Clean cultivation and orchard sanitation:

1. Raise pomegranate orchards with disease free planting material.
2. Maintain proper row to row and plant to plant spacing.
3. Remove and burn all affected plant parts.
4. Drench the soil under plant canopy with bleaching powder 150g/5-7lit water at the time of bahar treatment.
5. Apply Bordo paste (10-%) to pruned surface.
6. Sterilize secateurs during pruning with Sodium hypochlorite (1%) or Dettol (disinfecting secateurs can be used).
7. Avoid people handling diseased plants entering the healthy orchards with out proper precaution.

**Spraying of bactericides and chemicals:**

1. First spray: Bordeaux mixture (1%) immediately after pruning.
2. Second spray: Streptocycline 250 ppm + COC 0.3% during foliage initiation.
3. Third spray: Fifteen days interval with Bordeaux mixture (0.5%).
4. Fourth spray: Streptocycline (250 ppm) + Carbendazim (0.1) (Under cloudy and rainy season Streptocycline dosage can be increased to 500 ppm at 8-10 days interval).
5. During rest period spray Bordeaux mixture (1%) at monthly interval and one spray of Streptocycline(250 ppm) to be given.

## 8. SAPOTA

### 1.0 LEAF SPOT (*Phaeophleospora indica* (Chinn.)

**Symptoms:** Numerous, small, circular pinkish to reddish brown, conspicuous spots with whitish centre are produced on the mature leaves, which shed later there by giving a barren look to the branches. The young emerging leaves do not get the infection (Fig. 65).

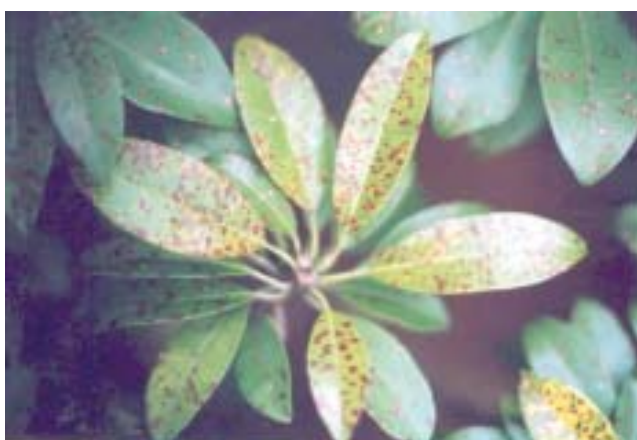


Fig. 65. Sapota: Leaf spot (*Phaeophleospora indica*)

**Epidemiology:** Temperature in the range of 10 and 35°C optimum being 25°C coupled with high humidity is most congenial for infection and disease development.

**Management:** For the control of the disease spraying with Zineb (Indofil Dithane Z78 0.2%) or Chlorothalonil (Kavach 0.2%) or Thiophantae methyl (Topsin M or Roko 0.1%) or Carbendazim (Bavistin 0.1%) is most effective.

### 2.0 LEAF SPOT (*Glomerella cingulata* (Stonem) Spauld and Schrenk)

**Symptoms:** Light, small irregular spots appear on both surfaces of leaves. The centre of the spot turns grayish white to dark olive with numerous acervuli of the fungus. The leaves turn yellow and defoliate when

infection is severe.

**Management:** Disease can be easily controlled by spraying Carbendazim (Bavistin 0.1%) or Thiophanate methyl (Topsin-M or Roko-0.1% or Mancozeb (Indofil Dithane M 45 0.2%) during August to November months.

### 3.0 LEAF SPOT (*Pestalotiopsis versicolor* (Speg.) Steyeart)

**Symptoms:** It is quite serious in the nursery as well as on the grown up orchards. Numerous, small, reddish-brown spots are produced on the leaf lamina which later turn olive-green. Black dots representing fruiting bodies develop within the affected area. The infected tissue of the leaf finally falls off and when severely infected the leaves get defoliated.

**Management:** Spraying of Zineb (Indofil Dithane Z78 0.2%) or Chlorothalonil (Kavach 0.2%) are effective against the disease.

### 4.0 SOOTY MOULD (*Capnodium* sp.)

**Symptoms:** The black sooty growth covers the surface of foliage, branches and even the fruits. The fungus grows on the honey-dew secreted by scales and or mealy bugs etc., and produces mass of black spores which stick on to the host surface. Although no direct damage is caused by the fungus, the photosynthetic activity of the leaf is adversely affected because of the black covering of spore masses over the leaves.

**5.0 Management:** Insecticidal spray is of foremost importance to control the insect. The sooty mould can be removed by spraying 2.0% soluble starch solution on to the plants. Spraying of Copper oxychloride (Blitox 0.3%) is also useful in killing the spores of the pathogen.

## 9. BER

### 1.0 POWDERY MILDEW (*Oidium erysiphoides* f. *zizyphi* Fr.)

**Symptoms:** The disease first appears on fruits as grayish white submerged growth sometime covering the whole fruits. The affected fruits later show brownish rusty patches with wrinkle on the skin. The fruits when attacked early, fail to develop, turn black and mummified. Flowers, if attacked, shed immediately. Later on the disease appears on young growing leaves which become chlorotic, curled and misshapen. White powdery growth is observed though on both the leaf surfaces but is more prominent on the upper surface. The young growing shoots, if attacked, fail to grow further (Fig. 66).

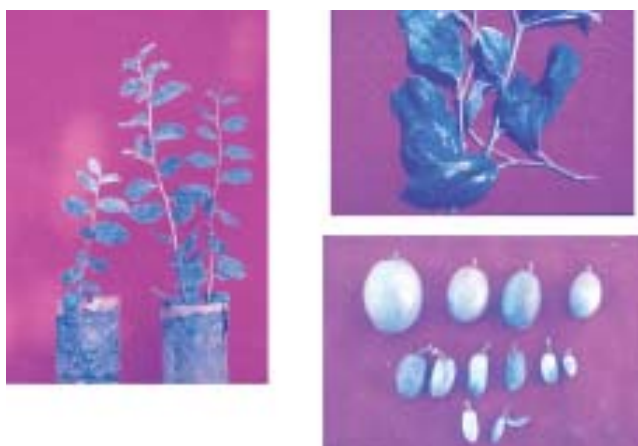


Fig. 66. Ber: Powdery mildew

**Epidemiology:** Temperature range of 21 - 28 °C and R.H. between 62 - 82% with diffuse sun light are favourable for the disease development.

**Management:** Prune off the preceding growth's twigs. Spraying of wettable sulphur (Sulfex 0.2%) or Dinocap (Karathane 0.1%) or Tridimefon (Bayleton 0.1%) or Myclobutanil (Systhane 0.1%) at fortnightly intervals during fruiting periods impart effective control.

### 2.0 BLACK SPOT (*Isariopsis indica* var. *zizyphi* P.C. Gupta & Maddan)

Black pustular growth develops on the lower surface of the leaves. Spots increase in number and size and cover the entire leaf. Such leaves turn yellow and get defoliated giving a barren look to the trees (Fig. 67).



Fig. 67. Ber: Black spot

**Epidemiology:** Disease is favoured by high humidity and temperature between 19-27 °C. The rains help in the initiation of the disease.

**Management:** The disease is effectively controlled by the sprays of Thiophanate methyl (TopsinM or Roko 0.1%) or Carbendazim (Bavistin 0.1%) or Chlorothalonil (Kavach 0.2%) when sprayed at fortnightly intervals during August and September months.

### 3.0 RUST (*Phakopsora zizyphi-vulgaris* Diet.)

**Symptoms:** Small, irregular dark brown pustules develop on the under surface of the leaf. The corresponding tissue on the surface leaf remains green giving a green island's appearance. The affected leaves turn yellow and get defoliated giving a barren look to the trees (Fig. 68).

**Management:** The disease can be effectively controlled through the sprays of Mancozeb indofil (Dithane M 45 0.2%) or Chlorothalonil (Kavach 0.2%)





Fig. 68. Ber: Rust

when sprayed at fortnightly intervals.

#### 4.0 LEAF BLIGHT (*Alternaria alternata* (Fr) Keissl)

**Symptoms:** The infected leaves show small, irregular dark brown spots on the upper surface with a dark brown to black tissue corresponding the lower side. Subsequently the spots coalesce to form a big blotch that lead to the blighting of leaves which are shed. On fruits dark brown blotches develop from the styler end side. If small younger fruits are attacked, they remain immature and insipient. The disease is more serious during November to January months.

**Management:** The disease can be checked through the sprays of Zineb (Dithane Z78 0.2%) or Chlorothalonil (Kavach 0.2%) when given at fortnightly intervals.

#### 5.0 FRUIT ROT (*Phytophthora nicotianae* var *parasitica*)

**Symptoms:** Dark brown, water soaked circular spots appear on the surface of the fruits, from the blossom end side. The affected fruits turn yellow giving the impression of ripening. Such fruits when stored lead to the production of profuse smoky white fluffy mycelial growth full of sporangia.

Incipiently infected fruits when mixed with the harvesting lot lead to the infection of healthy fruits. In severe cases infection on the leaves and young shoot is also observed. Such leaves give water soaked appearance, loss of turgidity and finally get dried and die. Typical die-back like symptoms is observed at times on the branches which are near to or touching the ground during rainy season (Fig. 69).



Fig. 69. Ber: Fruit rot

**Management:** Mancozeb (Dithane M 45 0.2%) or Chlorothalonil (Kavach 0.2%) at fortnightly intervals or systemic fungicides like Melalaxyl + mancozeb (Ridomil MZ 0.2%) or Fosetyl Al (Alliette 0.2%) provide effective disease control.

#### 6.0 ANTHRACNOSE (*Colletotrichum gloeosporioides* (Penz.) Penz. & Sacc.)

**Symptoms:** The initial symptoms appear as small water soaked sunken areas which enlarge as the fruit ripens. These lesions later turn brown or black. On infected tissue the fungus produces pink spore masses which sometimes appear in concentric rings. The infected fruit become darker and such affected fruits impart

unpleasant flavour. On leaves the infection is characterised by the small water soaked spots which later turn brown with darker borders and lead to the defoliation of the trees (Fig. 70).

**Management:** Disease is effectively controlled through the sprays of Carbendazim (Bavistin 0.1%) or Thiophanate methyl (Topsin M or Roko 0.1%) or Chlorothalonil (Kavach 0.2%) at fortnightly intervals.



*Fig. 70. Ber: Anthracnose*

## 10. CUSTARD APPLE

### 1.0 LEAF BLIGHT (*Alternaria sp.*)

**Symptoms:** Affected leaves show light brown spots which later develop into large blotches. These infections have a irregular outlines and sometimes involve a major portion of leaf lamina. Greenish black fruiting bodies are observed on the surface of the affected parts. Such leaves later get completely dried and ultimately fall off.

**Management:** The disease can be prevented and further controlled by spraying the plants with Zineb indofil (Dithane Z78 0.2%) or Copper oxychloride (Blitox 0.3%) when repeated at fortnightly intervals.

### 2.0 DRY ROT (*Colletotrichum gloeosporioides* (Penz.) Penz. & Sacc.)

**Symptoms:** The disease is characterized as blackening of the fruits starting from the stem attachment and spreads towards the periphery. The black spots with grayish centers are also observed on the individual compartments. The affected fruits become hard and mummified. If disease attacks during the early stages

of growth the entire fruit turn black, remains hard and attached to the twigs. The infection appears to be carried from the twigs having the previous season's



Fig. 71. Custard apple: Dry rot

infections. Small circular spots to regular spots with brick red margins are observed on the leaves (Fig. 71).

**Management:** The disease can be effectively controlled by removing affected fruits followed by spraying of Carbendazim (Bavistin 0.1%) or Thiophanate methyl (Topsin M or Roko 0.1%) or Mancozeb indofil (Indofil Dithane M 45 0.2%) at biweekly intervals.

## 11. FIG

### 1.0 RUST (*Cerotelium fici* (Butl.) Arth.)

**Symptoms:** Small round brownish to black eruptive lesions on the lower surface of the leaf are produced. The affected leaves turn yellow, curled and fall off prematurely causing severe reduction in the yield. The disease is most serious in the presence of water (Fig. 72).



Fig. 72. Fig: Rust

**Management:** Spraying of Mancozeb (Indofil Dithane M45 0.2%) or Chlorothalonil (Kavach 0.2%) or Tridimorph (Calixin 0.1%) provide effective control when sprayed at fortnightly intervals.

### 2.0 LEAF SPOT (*Cylindrocladium scoparium* Morgan)

**Symptoms:** The affected leaves show minute, brown spots, which enlarge into uniform or zonate brown spots with dark margins. The spots sometimes coalesce to form regular patches. The centre of such lesions usually drops off. A cob web like mycelial growth is observed on the lower surface of the leaf those shed.

**Management:** Spraying of Mancozeb indofil (Indofil Dithane M 45 0.2%) or Chlorothalonil (Kavach 0.2%) are recommended for the control.





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## 12. JACK FRUIT

### 1.0 LEAF SPOT (*Colletotrichum gloeosporioides* (Penz.) Penz. & Sacc.)

**Symptoms:** The disease is characterised as dark brown to brick red spot on both the leaf surfaces. These spots later turn into grayish white centres with dark brown boundaries. Eruptive dark coloured acervuli of the fungus are observed on grayish region, on tearing ooze out profused spore masses.

**Management:** The disease is effectively checked through the sprays of Carbendazim (Bavistin 0.1%) or Thiophanate methyl (Topsin M or Roko 0.1%) or Chlorothalonil (Kavach 0.2%).

### 2.0 DIE-BACK (*Botryodiplodia theobromae* Pat.):

**Symptoms:** The onset of die-back becomes evident by discolouration and darkening of the bark some distance from the tip. The dark area advances and young green twigs start withering first at the base and then extending outwards along the veins of leaf edges. The affected leaves turn brown and their margins roll upwards; the twig or branch dies, shrivels and falls.

There may be an exudation of gum from affected branches. The infected twigs show internal discolouration when split opened.

**Management:** Pruning of infected twigs followed by spraying of Carbendazim (Bavistin 0.1%) or Thiophanate methyl (Topsin M or Roko 0.1%) or Chlorothalonil (Kavach 0.2%) provide good control. The control of shoot borers and shot hole borers by spraying suitable insecticides is also recommended.

### 3.0 PINK DISEASE (*Botryobasidium salmonicolor* (Berk. & Broome) Venkatar)

**Symptoms:** The disease appears as a pinkish powdery coating on the stem. Pink colour represents profused conidial production of fungus. Young woody branches of the affected trees lose their leaves and show die-back.

**Management:** The affected branches should be pruned and the cut end should be pasted with Bordeaux paste or copper oxychloride. Spraying of Copper oxychloride (Blitox 0.2%) is also useful.

## 13. PASSION FRUIT

### 1.0 COLLAR ROT (*Haematonectria haematococca* (Berkeley & Broome) Samuels & Nirenberg (anamorph: *Fusarium solani* (Mart.) Sacc.))

**Symptoms:** The first aboveground symptom is mild dieback followed by changing of leaf color to pale green, leaf wilt, defoliation and finally plant death, resulting from the complete necrotic girdling of the plant collar. Necrosis generally reaches 2 to 10 cm above ground and may migrate to roots. Tumescence and fissures in the affected collar bark show purple lesion borders, where reddish structures slightly bigger than sand grains, which correspond to the pathogen perithecia, may appear under high relative humidity (Fig. 73).



Fig. 73. Passion fruit: collar rot & wilting

**Epidemiology:** The fungus survives for years as chlamydospores in the soil and may be spread by any practice resulting in movement of infested soil. Infected seedlings are also responsible for spreading the pathogen. The disease is favored by high temperatures and relative humidity.

**Management:** Areas previously presenting the disease should be avoided for new plantings and nurseries. Badly-drained soils have to be avoided and careful irrigation has to be conducted in order to avoid

the excess of water, water stress as well as injuries to plant collar and roots. Biweekly drenches of Copper oxychloride (Blotox 0.2%) reduce the number of plants developing collar rot. The use of a resistant rootstock is the best way to deal with the problem in contaminated areas.

### 2.0 FUSARIUM WILT (*Fusarium oxysporum* f. sp. *Passiflorae* Nelson)

**Symptoms:** When affected by the disease, the glossy green leaves of young passion fruit plants show a pale green color and mild dieback can be observed. Then, drop of lower leaves, general plant wilt and sudden death take place. In adult plants, the disease causes the yellowing of young leaves, followed by plant wilt and death. Symptom development may be unilateral or encompass the entire plant. The vascular system becomes darkened at the root, collar, stem and twig are as, condition that may reach an extent of 2 m above the soil line. The disease typically affects the xylem vascular system, leading to the impermeability of vascular walls and preventing the translocation of water to other plant parts. Under high relative humidity conditions, lesions and fissures can be found in the plant collar and stems, which may be confused with rot collar symptoms (Fig. 73).

**Epidemiology:** The pathogen presents resistance spores, known as chlamydospores, which are important long term survival propagules in the soil. Inside an orchard, the fungus is spread by soil movements (machines, implements, shoes, etc.) and by runoff or irrigation water. The disease intensity is greater in sandy soils and is favored by high

temperatures and relative humidity.

**Management:** Plantings areas previously affected by the disease should be avoided. It is recommended the use of healthy seedlings and a careful mechanical or chemical control of weeds in order not to injure roots. The disease can be controlled by using resistant rootstocks, such as *P. edulis* f. *flavicarpa*, *P. alata*, *P. quadrangularis* and *P. macrocarpa* or by using resistant hybrids from crosses between purple and yellow passion flowers.

### 3.0 PHYTOPHTHORA ROOT AND CROWN ROT (*Phytophthora cinnamomi* Simmonds, *P. nicotianae* Breda de Haan)

**Symptoms:** The disease affects adult plants and nursery plants. The symptoms observed are mild chlorosis followed by plant wilt, defoliation and death. The symptoms are the result of root and collar rot, which expose the plant cortical tissue. Plant intumescence and bark fissures can also be found in the collar. The occurrence of foliar blight and drop of flowers and fruits has also been reported. Injured leaves show a “burned” appearance. There is a change in leaf color from colorless to pale green, with leaves reaching a light copper color. The affected plant shows burned-like black twig tips and flowers which eventually die. Large grayish-green aqueous spots can be observed in fruits, which easily fall down (Fig. 74).



Fig. 74. Passion fruit: *Phytophthora* leaf Blight & fruit rot

**Epidemiology:** The disease appears in specific spots and spreads from one plant to another. High disease incidence is observed in clay and acid soils during rain periods and when temperatures vary between 26 and 30 °C.

**Management:** Besides the prophylactic measures already adopted to control crown rot, the elimination of diseased tissues during the initial stages of the disease and the use of Bordeaux mixture are recommended. Applications of fungicides effective against oomycetous organisms directly applied on the plant collar soon after the beginning of the rain season may control the disease. Pulverizations with copper oxychloride every seven to ten days to control foliar blight. *Passiflora caerulea* is more resistant to *P. nicotianaethan* *P. edulis* and *P. edulis* f. *flavicarpa* *P. caerulea* was widely used as rootstock for *P. edulis* in an attempt to control the disease.

### 4.0 ANTHRACNOSE (*C. gloeosporioides* syn. *Glomerella cingulata* (Stoneman) Spauld. & H. Schrenk)

**Symptoms:** All aerial organs of the plant are attacked. Small round light spots that later turn into brown spots, reaching over 1 cm in diameter can be observed on leaves. The centers of the spots become brittle and may break apart. As foliar lesions coalesce, large areas of the leaf die, resulting, eventually, in abscission. Elongate dark brown spots, up to 4-6 mm in diameter, appear on the twigs and later turn into cankers, exposing the wood. In some cases, lesions can completely surround the twig, making the twig extreme to wilt and die. Affected flowers abort and immature fruit abscise. Young fruit show oily spots that later become brownish in color. A corklike layer appears on the surface of the spot, which shows a



sunken appearance. As fruits mature, round dark spots up to 1 cm in diameter can be observed. These spots later turn into soft and sunken rot areas. Lesion may reach large extents on fruits, affecting the pulp and causing the early fruit drop. Lesions on leaves, fruits and twigs often show small black spots called acervuli, which under high relative humidity conditions and average temperatures between 26 and 28°C are covered with an orange mass formed by conidia soaked in a mucilaginous matrix.

**Epidemiology:** The fungus survives and sporulates in infected tissues and crop residues of passion flower and is most observed in the second planting year. Fungal dissemination in the field is carried out by raindrops, while long-distance dissemination relies on infected seeds, seedlings and cuttings. Long raining periods and average temperatures of 27 °C are the ideal conditions for the occurrence of epidemics.

**Management:** Use of pathogen-free seedlings, pruning to eliminate affected areas and improve ventilation and light conditions helps control the disease. Fruit should not be harvest during wet conditions, unduly exposed to the sun, or kept for long in the absence of refrigeration. Pruning should be done when plants are dry, and should be followed with applications of a fungicide. Applications of mixed formulations of protective and curative fungicides are necessary during favorable conditions. Under intense rain periods, fungicides have to be used weekly, while during scattered rain seasons, fungicides have to be used at fifteen-day intervals. Applications can be suspended in dry seasons with no occurrence of dew.

Fungicides quoted as efficient against anthracnose are Benzimidazole (Bavistin, Topsin M or Roko or Benomyl), Dithiocarbamate (Indofil M45, Antracol), Chlorothalonil (Kavach) and Tebuconazole (Folicur). The fungicides Prochloraz and Imazalil show the best results for the control of postharvest rots. The thermal treatment of *P. edulis* f. *flavicarpa* fruits at 42.5 and 45 °C for eight minutes significantly reduces the disease incidence in fruits.

### **5.0 SEPTORIA BLOTCH (SPOT) (*Septoria passiflorae* Syd., *Septoria fructigena* Berk. & M.A. Curt.)**

**Symptoms:** Leaves are the most affected organs, showing light brown slightly round necrotic spots of around 4 to 10 mm in diameter normally encircled by a chlorotic halo. A single lesion per leaf is sufficient to cause abscission, and even leaves without visible symptoms may fall prematurely. When the disease reaches 15 to 20% of leaves in the same plant, partial or even complete leaf abscission is observed. In young twigs, lesions may promote girdling; leading to wilt and twig tips death. Lesions on flowers are similar to those on leaves. The primary infection in the calyx may reach the stalk, causing the early drop of flowers. The infection may occur at any stage of development in fruits which show circular lesions presenting well-defined borders that may reach great extents on fruits, affecting maturation or development. However, damages are only concerned with fruit skin. Black punctuations in the center of lesions were also observed and correspond to the pathogen pycnidia. Leaf and fruit abscission, twig wilt and plant death may occur





Fig. 75. Passion fruit: *Septoria* leaf & fruit spot

under disease favoring conditions (Fig. 75).

**Epidemiology:** Conidia contained in cirri are spread by water, dew and insects. The fungus survives in infected tissues, and mucilage in the cirrus is thought to aid survival. Prolonged rains and mild temperatures favour disease development.

**Management:** Controlling measures used for other aboveground diseases, such as the use of carbamate and benzimidazole fungicides, are generally enough to avoid damages caused by septoriosi in nurseries and field plants. Thiabendazole or Thiophanate methyl (Topsin M or Roako 0.1%) + Chlorothalonil (Kavach 0.2%) applied at 15-day intervals showed to be efficient at controlling the disease. It is recommended to use Benomyl in a mixture or alternated with fungicides of different modes of action.

### **6.0 SCAB (*Cladosporium oxysporum* Berk. & M.A. Curtis., *C. herbarum* (Pers), *Cladosporium spp.*)**

**Symptoms:** The disease mainly affects young tissues of leaves, branches, tendrils, flower buds and fruits. Symptoms on leaves are small round spots, 3-6 mm in diameter. Spots are initially translucent but later become necrotic, showing greenish-grey centers, which correspond to fungal fructification. Lesions can perforate leaves or, when they occur on veins, cause

them to be deformed; they often cause abscission. Similar spots may appear on bud sepals or open flowers. High numbers of lesions on flower buds or on peduncles can greatly reduce the number of flower buds. Twigs and twig tips initially show lesions similar to the ones on leaves, which later turn into cankers of elongated and sunken aspect that become greenish-grey, where the pathogen fructification takes place. As scar tissue forms, branches become weak and break in the wind. On small fruits, symptoms are slightly sunken and dark small circular spots, 5 mm in diameter. On bigger fruits, lesions on fruit skin grow and become corklike, prominent and brownish but do not reach the inner fruit and, consequently, do not affect juice quality. Several lesions may form on the same fruit, causing it to be deformed and stunted.

**Epidemiology:** Dissemination occurs through infected seedlings, and by wind and sprinkler water. Although conidia are found frequently on seeds, there is no evidence for seed dissemination. High relative humidity is needed to promote the infection. Young tissues are more susceptible to the disease than adult tissues.

**Management:** High densities of seedlings have to be avoided in plant nurseries, as well as excessive irrigation. The management of adult plants should favor adequate ventilation of plants. Pruning and cleaning of plants have also to be conducted and infected tissues have to be burned, avoiding the transport of infected material. Fungicide applications have to be carried out especially during periods of intense growth and flowering. Fungicides quoted as efficient against the disease are Tebuconazole (Folicur 0.1%), Strobilurin (Amistar 0.1%), Copper oxychloride (Blitox or Fytolon 0.2%), Mancozeb (Indofil Dithane M45), Captan



(Captaf 0.2%) and Chlorothalonil (Kavach 0.2%) + copper oxychloride (Blitox or Fytolon 0.2%).

## 7.0 PASSION FRUIT MOSAIC DISEASE (*Cucumber mosaic virus*)

**Symptoms:** Leaf mosaic, mottle and ring spot symptoms are often associated with this disease. Mosaic symptoms appear as dark green, raised blisters on a yellow brown background. The fruit pericarp is malformed, thickened and hardened with a much reduced pulp cavity and fewer seeds. Growth is slowed, internodes shortened and the terminals have a bunch appearance.

**Cause and spread:** This disease is caused by cucumber mosaic virus belongs to genus cucumovirus. It has a single stranded, positive sense RNA genome consisting of three RNA, RNA2 and RNA3. The virus particles are 30 nm in diameter and typical of isometric shape. In nature, it is spread through different aphid species predominantly *Aphis gossypii* and *Myzus persicae* in a non persistent. Also spread through vegetative propagation. Temperature influences the development of fruit and leaf symptoms where as in summer symptom expression is less pronounced.

### Management practices:

1. Elimination of early infected plants.
2. Pruning of affected branches.
3. Spraying of systemic insecticides such as Acephate

at 1.5 g / L (or) Metasytox @ 1.5 ml/L.

## 8.0 PASSION FRUIT DISTORTION AND WOODINESS (*Passion fruit woodiness virus*)

**Symptoms:** Mottle, mosaic appears as numerous, small, yellow spots or flecks on young, mature leaves. Some time leaves may distort with severe mosaic symptoms on fruit, distortion hardening and thickening of the fruit pericarp. Plants also show stunted growths, shortened inter nodes and reduced leaf size.

**Cause and spread:** This disease is caused by passion fruit woodiness virus (PWV) belonging to the genus potyvirus. This virus is transmitted by different aphid species such as *Aphis gossypii* and *Myzus persicae* in a non-persistent manner. This virus also transmitted mechanically and by grafting but not through seed.

**Management practices:** 1. Roguing of early infected plants.

2. Elimination of weeds in and around the plantation.
3. Pruning operations can spread virus therefore sterilization of implements is required.
4. Pruning of infected branches below the symptomatic portion of the vine.
5. Selection of health planting material from disease free plants.
6. Spraying of systemic insecticides such as Acephate at 1.5 g / L (or) Metasytox at 1.5 ml / L especially during new flush stage is essential.



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## 14. AONLA

### 1.0 RUST (*Ravenalia emblica* Syd.)

**Symptoms:** Conspicuous rust pustules are observed on leaves and tender shoots as brown fosi initially followed by necrotic region. This is followed by dark black coloured lesions on fruits. On fruits black spots appear which sometimes cover the entire fruits. Such fruits

fail to develop further, become insipient in taste and drop off prematurely.

**Management:** Wetttable sulphurs (Sulfex 0.2%) sprays or Chlorothalonil (Kavach 0.2%) or Tridemorph (Calixin 0.1%) control the disease.

## 15. PHALSA

### 1.0 RUST (*Dasturella grewiae*)

**Symptoms:** Small dark necrotic spots develop on the upper surface of the leaf. On the underneath of such spots dark brown mass of uredospores of rust become clearly visible. Such spots are surrounded by yellow halo. As the number of spots increase the leaves turn chlorotic and get defoliated.

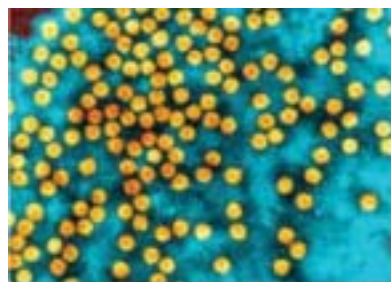
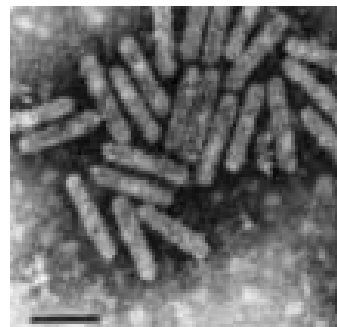
**Management:** Disease can be effectively controlled by spraying of Chlorothalonil (Kavach 0.2%) or Mancozeb (Indofil Dithane M 45 0.2%).

### 2.0 LEAF SPOT (*Cercospora grewiae* Srivastava & Mehta)

**Symptoms:** Small lesions which turn dull later develop on both the surfaces of the leaves. In due course of time such patches become blackish in the centre and gradually the black growth becomes cushion like.

**Management:** The disease can be controlled by spraying Carbendazim (Bavistin 0.1%) or Thiophanate methyl (Topsin M or Roko 0.1%) or Chlorothalonil (Kavach 0.2%) at biweekly intervals.

# Fruit Crop Diseases and Their Management



**DIVISION OF PLANT PATHOLOGY**  
**INDIAN INSTITUTE OF HORTICULTURAL RESEARCH**  
Hessaraghatta Lake Post, Bangalore-560089, India



## **Indian Institute of Horticultural Research**

Hessaraghatta Lake Post,

Bangalore – 560089, Karnataka, India

Tel. : +91-80-28466420-423;

Fax : +91-80-28466291

E-mail : [director@ihr.ernet.in](mailto:director@ihr.ernet.in)

Website : [www.ihr.ernet.in](http://www.ihr.ernet.in)

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Director

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### **Contributing Authors**

**A.K. Saxena**

**C. Gopalakrishnan**

**D.K. Samuel**

**N. Ramachandran**

**M. Krishna Reddy**

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## PREFACE



The importance of horticulture in contributing agricultural growth and overall economy has been revised. In the recent past, fruit production in India has touched 50 million tons, improving the much wanted nutritional security in addition to food security.

Under intensive and extensive crop cultivation and change in the climate situation, the disease problems assumed greater importance, as the farmers tend to use more and higher dose of pesticides which in turn leads to problem of pathogen resistance and residues leading to health hazards. This calls for an integrated management of diseases with the objective of achieving food and environmental safety.

This technical bulletin is a small attempt in addressing the problems for judicious management of diseases in horticultural crops. The information presented in this bulletin is based on the research conducted and validated over several years at the Indian Institute of Horticultural Research. This technical bulletin illustrates important diseases, their symptoms and management through an integrated approach.

I wish to acknowledge the efforts made by contributing scientists of the institute and publication committee chairman and members in bringing out this technical bulletin.



**Dr. Amrik Singh Sidhu**  
**Director**

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**For Further Details Contact:**

**Director**

**INDIAN INSTITUTE OF HORTICULTURAL RESEARCH**

**Hessaraghatta Lake Post,  
Bangalore - 560089, Karnataka, India**

**Tel.: 91-80-28466420 - 423**

**Fax: 91-80-28466291**

**E-mail: [root@iihr.ernet.in](mailto:root@iihr.ernet.in)**

**Website: [www.iihr.ernet.in](http://www.iihr.ernet.in)**



