

# DISEASES OF PINEAPPLE (*Ananas comosus*)

## Pathogen, symptoms, infection, spread & management

Joy P. P. & Sindhu G., Pineapple Research Station (Kerala Agricultural University), Vazhakulam-686 670, Muvattupuzha, Ernakulam, Kerala, India, Tel. & Fax: +914852260832, Email: prsvkm@gmail.com

Pineapple is one of the most important fruit crops of Kerala. The pineapple originated in South America, where native people selected a seedless mutation from a wild species. It belongs to the family Bromeliaceae, many members of which are epiphytes living on trees and rocks. Pineapples grow in the soil and resemble epiphytes in that their roots are intolerant of poor soil aeration. 'Kew' of the smooth-leaf 'Smooth Cayenne' group and 'Mauritius' of the rough leaf 'Queen' group are the two varieties of pineapple grown in India. Diseases of pineapple are associated with fungi, bacteria, nematodes and viruses. Pineapple roots are adventitious and will not regenerate if damaged. Mealy bug wilt also affects the root system. Base rot and water blister are economically significant. Diseases such as *Phytophthora* fruit rot, pink disease, yeasty rot and marbling at times become significant warranting control measures though they occur infrequently and have only a minor effect on yield or fruit quality in general.

### ■ FUNGI ASSOCIATED DISEASES

#### ■ PHYTOPHTHORA HEART (TOP) ROT

##### Pathogen

The oomycetes *Phytophthora cinnamomi* and *Phytophthora nicotianae*

##### Symptoms

- Plants of all ages are attacked, but three to four month old crown plantings are most susceptible.
- Fruiting plants or suckers on ratoon plants may be affected.
- The colour of the heart leaves changes to yellow or light coppery brown. Later, the heart leaves wilt (causing the leaf edges to roll under), turn brown and eventually die.
- Once symptoms become visible, young leaves are easily pulled from the plant, and the basal white leaf tissue at the base of the leaves becomes water-soaked and rotten with a foul smell due to the invasion of secondary organisms. The growing point of the stem becomes yellowish-brown with a dark line between healthy and diseased areas.



Plant collapse caused by *Phytophthora* heart rot

##### Infection and spread

Chlamydospores of the two species are the primary inoculum and they can survive in the soil or in infected plant debris for several years. They germinate directly to produce hyphae that are able to infect roots and young leaf and stem tissue, or indirectly to produce sporangia.

Phytophthora pathogens are soil inhabitants and require water for spore production and infection. As free water is required for producing sporangia and releasing motile zoospores, infection and disease development is exacerbated in soils with restricted drainage.



Rotten pineapple heart, leaves and fruit caused by *Phytophthora heart rot*

## Management

Use systemic fungicides to reduce heart rot. This program should start with the treatment of planting material before planting. After planting, drenching or spraying with registered fungicides at recommended rates and intervals is necessary to ensure against losses. Infected plants can be saved only if treated soon after symptoms appear.

Avoid excessively deep planting and prevent soil entering the hearts during planting. Well-drained soils are essential for minimizing the risk of *Phytophthora* infection. This can be achieved through careful field selection, planting on raised beds at least 20 cm high, constructing drains to intercept run-off before it reaches the plantation, constructing drains within the field so that water is removed rapidly without causing erosion and installing underground drains.

*Phytophthora cinnamomi* becomes more active as soil pH levels increase above 4.0. Liming materials, which raise pH, should be used cautiously. *Phytophthora nicotianae* tends to be more active in soils with higher nutrient status. Sulfur may be used to reduce pH in soils with a pH above 5.5, but this is not a replacement for other management practices.

## ■ PHYTOPHTHORA ROOT ROT

### Pathogen

The oomycete of *Phytophthora cinnamomi*

### Symptoms

- The symptoms above ground are similar to those caused by nematodes, mealy bug wilt and low levels of soil oxygen and are not diagnostic. Leaves change in colour from a healthy green through various shades of red and yellow.
- Leaf tips and margins eventually become necrotic, the root system is dead and plants can easily be pulled from the ground.



Roots destroyed by *Phytophthora cinnamomi* (right) compared with a healthy root system (left)



- Fruits from infected plants colour prematurely become small and unmarketable. If symptoms are recognized early and control measures are taken plants can recover. If roots are killed right back to the stem, they often fail to regenerate.

### **Infection and spread**

Losses can be severe in poorly drained fields. Plants on even relatively well-drained soils can be affected during prolonged wet weather. Losses from root rot can be serious in high rainfall areas where prolonged rains extend into the winter months. The disease can eliminate the ratoon crop. Rough leaf varieties and some low acid hybrids are more susceptible than Smooth Cayenne.

### **Management**

Use systemic fungicides to reduce heart rot. This program should start with the treatment of planting material before planting. After planting, drenching or spraying with registered fungicides at recommended rates and intervals is necessary to ensure against losses. Infected plants can be saved only if treated soon after symptoms appear.

Avoid excessively deep planting and prevent soil entering the hearts during planting. Well-drained soils are essential for minimizing the risk of Phytophthora infection. This can be achieved through careful field selection, planting on raised beds at least 20 cm high, constructing drains to intercept run-off before it reaches the plantation, constructing drains within the field so that water is removed rapidly without causing erosion and installing underground drains.

## **■ BASE (BUTT) ROT**

### **Pathogen**

The fungus *Chalara paradoxa*

### **Symptoms**

- Symptoms are seen only on crowns, slips and suckers before or immediately after planting. A grey to black rot of the soft butt tissue develops, leaving stringy fibers and a cavity at the base of the stem. If affected material is planted, partial decay of the butt severely reduces plant growth
- When butt decay is severe, plants fail to establish, wilt rapidly and leaf tissue dies. Unlike Phytophthora heart rot, the young leaves remain firmly attached to the top of the stem. Infected plants can easily be broken off at ground level.

### **Infection and spread**

The fungus is important in the breakdown of pineapple residues after cropping and survives as chlamydospores in soil and decaying pineapple residues. The fungus commonly infects plants through fresh wounds occurring where the planting material has been detached from the parent plant and destroys the soft tissue at the base of the stem. Material removed during showery weather and stored in heaps is particularly prone to infection. Tops (crowns) used for planting are particularly susceptible. Conidia are produced under conditions of high humidity and can be dispersed by wind. Losses of planting material and plantings from diseased material can be severe at times.





Base (butt) rot disease destroys the soft tissue at the base of the pineapple stem

## Management

Do not leave a portion of fruit attached to the crown when picking. Treat material to be planted with a recommended fungicide immediately after removal (without drying). Store planting material on top of plant rows in a single layer with the butts exposed to the sun, or laid them on the ground in a similar manner. Losses are reduced greatly by curing the planting material base. If prolonged wet weather occurs, spray upturned butts or dip with a recommended fungicide within five hours of harvesting. Improve soil drainage and avoid planting during wet weather.

## ■ FRUITLET CORE ROT (GREEN EYE)

### Pathogen

The fungi *Fusarium guttiforme* and *Penicillium funiculosum*

### Symptoms

- This is an internal fruit disease. Smooth Cayenne fruits do not usually show any external symptoms. However, fruit of the rough-leaf (Mauritius) may produce fruitlets that fail to colour – a condition often referred to as ‘green eye’.
- Severely affected fruitlets may become brown and sunken as the fruit ripens. Internal symptoms consist of a browning of the centre of the fruitlets starting below the floral cavity and sometimes extending to the core. The browning, which remains quite firm, varies in size from a speck to complete discolouration of one or more fruitlets.

### Infection and spread

*Penicillium funiculosum* infects the developing fruit at some stage between initiation and open flower. Infection is favoured by cool temperatures (16–20°C) during the five weeks after flower initiation, during which time the fungus builds up in leaf hairs damaged by mites. Similar cool temperatures are required for infection from about 10–15 weeks after flower induction. Symptoms of fruit let core rot on a fruit cylinder in damaged leaf hairs. *Fusarium guttiforme* enters the fruit through open flowers or injury sites. The risk of disease caused by this fungus is higher when flowers are initiated and fruit mature under warm conditions.





Pineapple fruitlet core rot (green eye) disease symptoms externally and internally

## Management

Fungicides have not been effective except when applied directly into the opening of the terminal leaves that is created by the emerging inflorescence.

## ■ FUSARIOSIS

### Pathogen

The fungus *Fusarium guttiforme*

### Symptoms

- It is sporadic and affects all parts of the pineapple plant but is most conspicuous and damaging on fruit.
- Fruits exhibit stem rosetting and curvature of the plant because portions of the stem are girdled or killed.
- Rough leaf pineapple cultivars are more susceptible than smooth-leaf varieties.

### Infection and spread

Infections of the inflorescence and fruit occur primarily via injuries caused by insects, particularly the pineapple fruit caterpillar (*Thecla basilides*) and by infected planting materials.

### Management

The sporadic nature of the disease makes chemical control impractical and uneconomic. Fungicide and insecticide applications at flower induction and three weeks after forcing can reduce disease.



Fusariosis showing brown discoloration and gum exudates. Inset: symptoms in cut fruit, close-up of gum exudate at the base of the fruit



## ■ GREEN FRUIT ROT

### Pathogen

The oomycete of *Phytophthora cinnamomi*

### Symptoms

- Green fruit in contact with the soil are liable to be infected.
- A water-soaked rot develops internally behind affected fruit lets with no external symptoms, As the disease progresses, a general, water-soaked rot of green fruit with a distinct brown margin develops in green fruit.

### Infection and spread

The pathogen lives in the soil and requires free water for spore production and fruit infection. Ratoon crop fruit lying close to or touching soil are most affected. Spores may be splashed by rain on to fruit near the ground.

### Management

Apply systemic fungicides that are used to control root and heart rot, protecting the inflorescence and young fruit with fungicides. Although most strains of *F. guttiforme* cause fruitlet core rot, some strains cause fusariosis. Besides symptom development, there is no test available to distinguish the strains, so identification requires pathogenicity testing.



Green fruit rot

## ■ INTERFRUITLET CORKING

### Pathogen

The fungus *Penicillium funiculosum*

### Symptoms

- Fruits affected by inter fruitlet corking often show shiny patches on the shell early in their development, where the trichomes (hairs) have been removed by mite feeding.
- Externally, corky tissue develops on the skin between the fruitlets, but usually only 'patches' of eyes are affected.
- Fine, transverse cracks may also develop on the sepals and bracts.
- In moderate to severe cases, corkiness surrounding fruitlets prevents their development and one side of the fruit will be malformed.

### Management

Inter fruit let corking is limited almost exclusively to fruit initiated in early autumn. It is sporadic and often confused with boron deficiency. Fungicides have not been effective except when applied directly into the opening of the terminal leaves that is created by the emerging inflorescence.



## ■ LEATHERY POCKET

### Pathogen

The fungus *Penicillium funiculosum*

### Symptoms

- Fruits do not usually show any external symptoms. Internally, the formation of corky tissue on the walls of the fruitlets makes them leathery and brown.

### Infection and spread

See fruitlet core rot. Leathery pocket occurs sporadically. *Penicillium funiculosum* infects the developing fruit at some stage between initiation and open flower. Infection is favoured by cool temperatures (16–20°C) during the five weeks after flower initiation, during which time the fungus builds up in leaf hairs damaged by mites. Similar cool temperatures are required for infection from about 10–15 weeks after flower induction.

### Management

The sporadic nature of the disease makes chemical control impractical and uneconomic. Miticide applications at flower induction and three weeks after forcing can reduce disease.

## ■ WATER BLISTER

### Pathogen

The fungus *Chalara paradoxa*, which also causes butt (base) rot and white leaf spot.

### Symptoms

- Symptoms include water blister, which is also referred to as black rot or soft rot. This causes a soft, watery rot of the fruit flesh and makes the overlying skin glassy, water-soaked and brittle.
- The skin, flesh and core disintegrate and the fruit leaks through the shell. In advanced cases, this leaves a fruit shell containing only a few black fibres. This shell collapses under the slightest pressure.



Internal symptoms of water blister

### Infection and spread

Infection occurs through shell bruises and growth cracks but mainly through the broken fruit stalks. The disease is most active in warm, wet weather and is most severe from January to April, when the summer crop is harvested. (The correlation between rainfall before harvest and disease after harvest has resulted in the name 'water blister'). When fresh fruits are marketed with the crowns left on, this eliminates a major point of entry for the fungus.



This is the major postharvest disease of fruit for the fresh fruit market. The disease takes three to four days to develop after harvest and is therefore not a common problem in fruit used for canning. Water blister can be severe in fresh fruit consigned to distant markets when refrigeration is not available. The disease does not occur in the field unless fruits are over-ripe or injured.

### Management

Handle fruit carefully to avoid bruising and scuffing. Rapid fungal invasion occurs through even minute, weeping fractures. Reject sun burnt and damaged fruit, because these often have minor skin cracks that are readily infected. Dip the base of the fruit in a recommended fungicide within five hours of harvesting and store fruit at 9°C. This is most important for fruit harvested during warm, wet weather. Remove pineapple refuse and rejected fruit from in and around the packing shed. Treat the shed with the recommended disinfectant once a week.

### ■ WHITE LEAF SPOT

#### Pathogen

The fungus *Chalara paradoxa*, which also causes water blister and butt (base) rot.

#### Symptoms

- The first symptom is a small, brown spot on the leaf, usually where the leaf margin has been rubbed by another leaf during strong winds.
- These spots lengthen rapidly during wet weather. During prolonged wet periods, spots may reach more than 20 cm in length and spread to the leaf tip. Fine weather rapidly dries the affected area leaving cream coloured or almost white, papery spots; hence the name 'white leaf spot'. The margins of the spot often remain brown.



White leaf spot symptoms appearing on a pineapple crop and a diseased leaf

#### Infection and spread

*Chalara paradoxa* is common in pineapple plantations. The fungus will only invade wounds and is most active in warm, wet weather.





## Management

White leaf spot occurs commonly between March and May. The disease is of no economic significance. Management measures are rarely warranted.

## ■ FRUIT ROT BY YEAST AND CANDIDA SPECIES

### Pathogen

The Yeast *Saccharomyces* spp. and *Candida* spp.

### Symptoms

- Yeasts ferment sugar solution, producing alcohol and releasing carbon dioxide. The first symptom is a bubbling exudation of gas and juice through the crack or injury where infection occurred.
- The shell then turns brown and leathery and, as the juice escapes, the fruit becomes spongy.
- Internally, the decaying flesh turns bright yellow and develops large gas cavities. Finally, all that remains of the fruit is the shell and spongy tissue.



Yeasty rot externally shows gas bubbles and juice exuding through the skin and internally fermenting

### Infection and spread

In spring, rapid changes in fruit growth, resulting from the shift from cold and dry to warm and wet weather, can result in the pineapple skin cracking between fruit lets. Fruit affected by even



minor frost damage are prone to cracking as they ripen in spring. Yeasts immediately invade the juice weeping from those wounds, and these fruits are severely damaged or destroyed as they ripen. The disease may occur before or after harvest.

## Management

Yeasts are among the most common organisms found in nature. Yeasty rot is widespread but occurs mainly during spring in overripe or damaged fruit. Protect fruit that will ripen in spring in frost-prone areas by covering young developing fruit with paper bags. Fruit showing even minor interfruitlet cracking should not be consigned to the fresh-fruit market. Any fruit showing fractures between fruitlets should be picked at the earliest stages of fruit maturity to minimize losses.

## ■ NEMATODES ASSOCIATED DISEASES

### Pathogen

Root-knot nematode (*Meloidogyne javanica*), the root lesion nematode (*Pratylenchus brachyurus*) and the reniform nematode (*Rotylenchulus reniformis*)

### Symptoms

- Root-knot nematodes produce distinct terminal swellings on the roots, stopping further root development. The root lesion nematode invades the outer root tissues, causing black areas (lesions) of dead or injured plant cells on the root surface.
- These lesions can completely encircle the root. Reniform nematodes reduce the number of lateral and fine feeder roots; the remainder elongate normally so that plants retain good soil anchorage. Root-knot nematodes cause stunting, yellowing and dieback of plants.

### Life cycle

Juvenile root-knot nematodes invade roots near the tips. As these mature into females, the cells enlarge and develop into galls. When each female matures, it will lay some 2000 eggs in a small mass on the root surface. Between 25 and 30 days after the initial egg laying, juveniles invade the root. Root-knot nematodes produce many generations each year and soil populations can increase rapidly in optimal growing conditions. Root-lesion nematodes primarily live in the plant roots. They only enter the soil when migrating from one plant to the other. They move through the root cells, feeding on the cells and generally disrupting the physiological processes of the root. This nematode first moults inside the egg then passes through three juvenile stages before reaching adulthood. Both juvenile and adult nematodes can penetrate roots, so that infested roots contain all development stages: eggs, juveniles and adults. Reproduction occurs quickly in summer and each generation is completed in 29 to 45 days. Reniform nematodes are well adapted to warm dry conditions, and very high populations can develop very quickly. They have a wide host range, including cow peas and watermelons, which may be grown in rotation with pineapple. Unlike root-knot nematode, the reniform nematode does not have to feed when it hatches and can survive in fallow soil for long periods.



## Management

Root-knot nematodes are the most damaging of all nematodes in field. Fruit yields can be markedly reduced, particularly in ratoon crops. Root lesion is common in all pineapple-growing districts and high populations can reduce ratoon crop yields, but effects are often masked by symptoms caused by root-knot nematodes.

Most nematode populations, except reniform nematodes, decline rapidly in a weed-free or host-free fallow period. However, more than six months' fallow is needed for good results. For short fallows, keep the fields free from weeds. For longer fallows, plant inter-fallow crops that are not hosts for nematodes. Thorough land preparation will directly reduce nematode numbers; it will allow the soil to dry out and accelerate the breakdown of plant material that harbours nematodes. Use preplant soil sampling to assess the level of nematodes. If significant numbers are found, apply a registered nematicide before planting. In the plant crop, use nematode testing to determine nematode levels at six to eight months, and at 12 months, after planting. If significant numbers are found, apply a registered nematicide. Use nematode testing to assess the incidence of nematodes immediately after plant crop harvest and apply a registered nematicide if testing indicates the need for.

## ■ BACTERIA AND PHYTOPLASMAS ASSOCIATED DISEASES

### ■ MARBLING

#### Pathogen

The bacteria *Pantoea ananatis* and *Acetobacter* spp.

#### Symptoms

- Infected fruits do not show any external symptoms. Internally, the flesh is red-brown and granular and has a woody consistency.



Pineapple marbling disease showing red-brown granular flesh with woody consistency

#### Infection and spread

The disease occurs when flowers are initiated and when fruit mature under warm, wet conditions. The bacteria enter through the open flower and natural growth cracks on the fruit surface. Infected fruit are usually low in both acid and sugars.



Marbling is a minor problem that occurs sporadically. The disease is serious only in countries where pineapple fruit mature under lowland, tropical conditions.

### Management

A practical way of managing marbling is not known. Internal symptoms are clearly visible in infected fruit, and fruit can be rejected easily during processing. Smooth Cayenne is moderately resistant.

## ■ PINK DISEASE

### Pathogens

Bacteria *Pantoea citrea* , *Gluconobacter oxydans* or *Acetobacter aceti*

### Symptoms

- Infected fruits do not show any external symptoms, even when fully ripe. Internally, the flesh may be water-soaked or light pink and have an aromatic odour, although these symptoms may not be obvious immediately. When sterilized by heat during canning, infected tissue darkens to colours ranging from pink to dark brown.
- In some fruits, only one or a few fruitlets may be infected. In highly translucent, low-brix fruit, the entire cylinder can be invaded.

### Infection and spread

The bacteria infect through the open flower during cool weather. Disease incidence increases in dry conditions before flowering, followed by rainfall during flowering. The bacteria are thought to be carried by nectar feeding insects and mites to open flowers from infected, decaying fruit near flowering fields.



Pineapple fruit core affected by pink disease (left) compared with one not affected by the disease (right)

### Management

This disease occurs only sporadically when fruits develop under cool, wet conditions. Since the bacteria are killed by high temperatures, pink disease occurs mainly in spring (September–October). The incidence of infected fruit is very low. Management is not usually warranted. Smooth Cayenne is relatively resistant.

## ■ VIRUS ASSOCIATED DISEASES

### ■ MEALYBUG WILT DISEASE

### Pathogen

Mealy bug wilt disease is caused by ampelovirus transmitted by mealy bugs.

### Symptoms

- The early symptoms are a slight reddening of leaves about halfway up the plant. The leaf colour then changes from red to pink and leaves lose rigidity, roll downwards at the margin and the tip of the leaf dies.



- The root tissue also collapses and the plant appears wilted. Plants can recover to produce symptomless leaves and fruit that are markedly smaller than fruit from healthy plants.
- Symptoms are most obvious in winter when plant growth and vigour are reduced.
- Disease development and incidence is affected by plant age at the onset of mealy bug infestation, with younger plants displaying symptoms two to three months following feeding, while older plants may take up to 12 months to develop symptoms.



**Mealy bug wilt disease causes reddening and yellowing in leaves and dieback in the leaf tips**

### Infection and spread

The disease is thought to be caused by viruses transmitted by mealy bugs with the pink mealy bug (*Dysmicoccus brevipes*) being the main vector. The disease is probably introduced in planting material that may not show obvious disease symptoms. Once established, the viruses are transmitted when the mealy bugs feed on young leaves. Mealy bugs are sedentary insects that are moved from plant to plant by attendant ants or by wind. Ants actively tend mealy bugs. The coastal brown ant (*Pheidole megacephala*) is common and active in pineapple plantations, but many other species can be involved in raising mealy bugs. Mealy bugs produce honeydew, which is harvested by ants for food. Ants also protect mealy bugs from predators and move them around and between plants. The removal of spiders from fields by ants often allows large populations of mealy bugs to develop, increasing the risk of severe mealy bug wilt outbreaks. The incidence is variable and sometimes high. The amount of wilt in a field is related to the number of mealy bugs present, the length of time they feed and the activity of ants.

### Management

Use planting material from wilt-free areas or from fields with a low level of wilt disease. If less than 3% of plants show wilt symptoms, remove infected plants by hand and destroy them. Use recommended insecticides for mealy bug and ant control where more than 3% of plants show wilt symptoms. If more than 10% of plants show wilt symptoms, do not use the field as a source of planting material. Eradicate badly affected areas immediately after harvest. Keep headlands and field boundaries free from weeds and rubbish as these may act as reservoirs for ants and mealy bugs.

## ■ YELLOW SPOT

### Pathogen

Tomato spotted wilt virus, Capsicum chlorosis virus (Tospoviruses)

### Symptoms

- Infection occurs on young crowns when they are still on the fruit or during the first few months after planting. Small (2–5 mm), round, yellow spots appear on the upper surface



of the leaves of young plants. These spots fuse and form yellow streaks in the leaf tissue, which soon become brown and die.

- The virus spreads to the leaves in the plant heart, causing the plant to bend sideways. Infection eventually kills the plant so that the virus is not transmitted to subsequent plantings. If the crown is infected while still on the fruit, the fruit dies from the top downwards. Infections can occur through open blossoms causing the development of large, blackened cavities in the side of the fruit.

### Infection and spread

The viruses are transmitted to pineapple plants by small flying insects (thrips). Infection occurs mostly on plants during early growth, and crowns on developing fruit are occasionally infected. As infection is always fatal, vegetative propagation does not spread the virus to subsequent plantings. Tospoviruses have a wide range of hosts among weed and crop plants. The disease is rarely seen.



Yellow spot symptoms on pineapple

### Management

Keep the plantation free from weeds. Avoid destroying old weedy patches near young crown plantings or fields with developing fruit. If this is impossible, it may be necessary to first spray the old infected field to control thrips.

### Registered/Suitable pesticides

- Fungicides:** Mancozeb (Indofil M-45 75WP, 3 g/l)  
 Carbendazim (Bavistin 50WP, 1 g/l)  
 Carbendazim 12WP+ Mancozeb 63WP (Saaf, 2 g/l)  
 Hexaconazole (Contaf 5SC, 2 ml/l; Samarth 2SC, 4 ml/l)
- Nematicide:** Carbosulfan 6G, 17 kg/ha, soil application
- Insecticides:** Chlorpyrifos (Hilban 20EC, 2.5 ml/l)  
 Imidacloprid (Tatamida 200SL, 0.3 ml/l)  
 Quinalphos (Ekalux 25EC, 2 ml/l)
- Miticide:** Dicofol 4 ml/l

Note: Use 500 l/ha for foliar spray and 1 l/m<sup>2</sup> for soil drenching

