

DISEASES OF TREE SPICES

R. Suseela Bhai

Clove (*Syzygium aromaticum* (L), Nutmeg (*Myristica fragrans*) and cinnamon (*Cinnamomum zeylanicum*) are the three spices of importance to India. Kerala has the largest area under cultivation of these spices. Crop loss due to severe diseases and pest incidence has been major constraints in these crop production. Many of these diseases are caused by fungi which are mostly soil borne in nature. This is further complicated by the involvement of more than one organism in different cropping systems rendering the disease management more complex. The present status of disease problems and its management strategies are outlined here.

CLOVE (*Syzygium aromaticum* (L) Merr and Perry.

Clove of commerce is the unopened flower buds of *Syzygium aromaticum*, the clove tree belonging to the family Myrtaceae. Zanzibar, Tanzania and Indonesia are the major producers of clove. In India clove is grown mainly on the eastern slopes of Western Ghats. It grows well in rich loamy soils of the humid tropics and can be successfully grown in the red soils of the midlands of Kerala and hilly terrain of Western Ghats in Tamil Nadu and Karnataka. The crop cannot survive under waterlogged conditions. Though it is a healthy perennial, it is susceptible to a number of fungal diseases both in the nursery and in the grown up plants.

Nursery diseases

Seedling wilt

Seedling wilt is a commonly occurring disease in the nurseries.

Symptoms:

The leaves lose their natural luster, droop off ultimately die. The root system and collar region of the seedlings show varying degrees of discoloration and decay.

Causal organism:

Cylindrocladium sp, *Fusarium sp*, *Rhizoctonia bataticola* and *Phytophthora* species were found to be associated with the disease.

Disease management: As the infected plants serve as the source of inoculum for further spread of the disease, it is advisable to remove the infected plant parts as and when noticed. Spraying and drenching of carbendazim 0.1% can reduce the spread of infection (Joshi and Rant 1995). Foliar spray with 1% Bordeaux mixture and soil drenching with 0.2% COC is also found effective in reducing the disease.

Leaf rot

The disease occurs both in the nurseries and in plantations. In nurseries severe infection leads to defoliation and death of seedlings (Wilson et al., 1979).

Symptoms:

The infection starts as water soaked lesions from the margin or tip of the leaves, which coalesce to form chocolate brown coloured areas resulting in leaf rot (Plate 1, page 421).

Causal Organism:

Cylindrocladium quinquesepatum (Fig. 1)

Disease management:

Spraying 1% Bordeaux mixture in the nursery during the onset of monsoon rains can check the incidence and spread of the disease.

Diseases in the plantation

Twig blight:

The disease is found to occur throughout the year but severe during the monsoon season leading to heavy crop losses. The disease is prevalent in the nursery as well as in grown up plants.

Symptoms:

The disease is seen in the form of leaf spots, twig blight and flower shedding. Leaf spot initiates as brown pinhead like dots scattered all over the lamina. Leaves of all stages are equally vulnerable to infection. Necrotic spots vary in size and shape. The spots gradually enlarge and form circular to irregular spots with ashy-

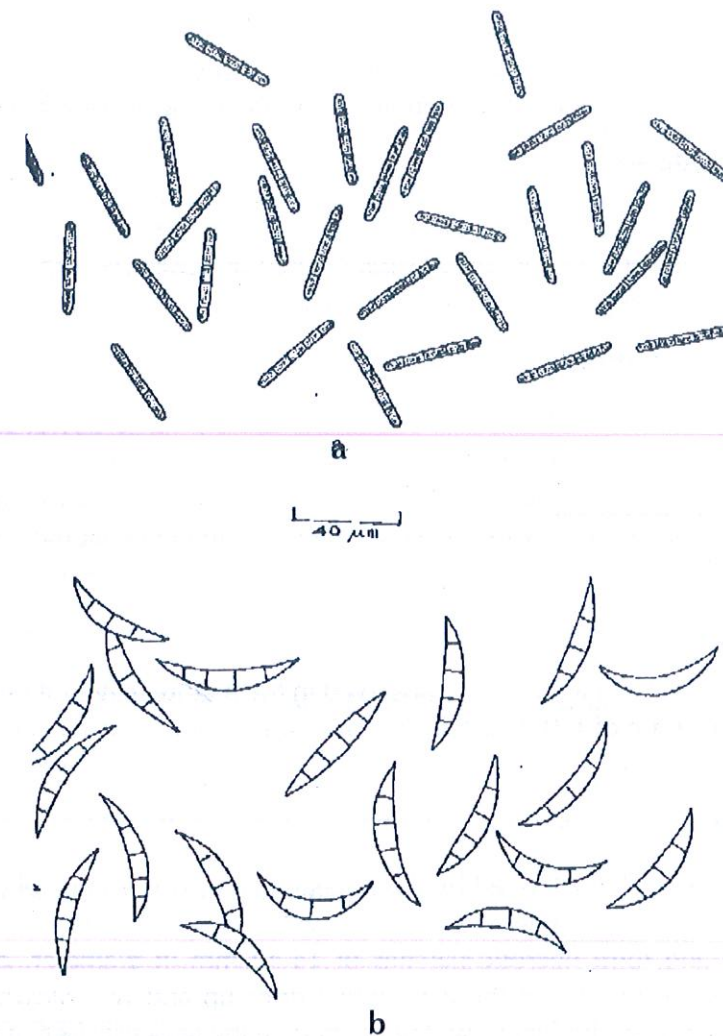


Fig 1. a. Conidia. b. Ascospores of *C. quinque septatum*

grey centre and darker margins. The size of the lesions varies from 0.5 to 13 mm in diameter. The adjacent spots coalesce to form irregular necrotic patches with numerous acervuli. In severe cases the leaves withered and drop off. Young leaves show crinkling and twisting .

From leaf, infection spreads to petiole resulting in twig blight which appears in the form of light brown elongated spots or streaks of variable size, with plenty of acervuli. In advanced stages of infection, branches defoliate leaving behind the skeleton of dead twigs. Finally flower buds are affected. The symptoms on flower

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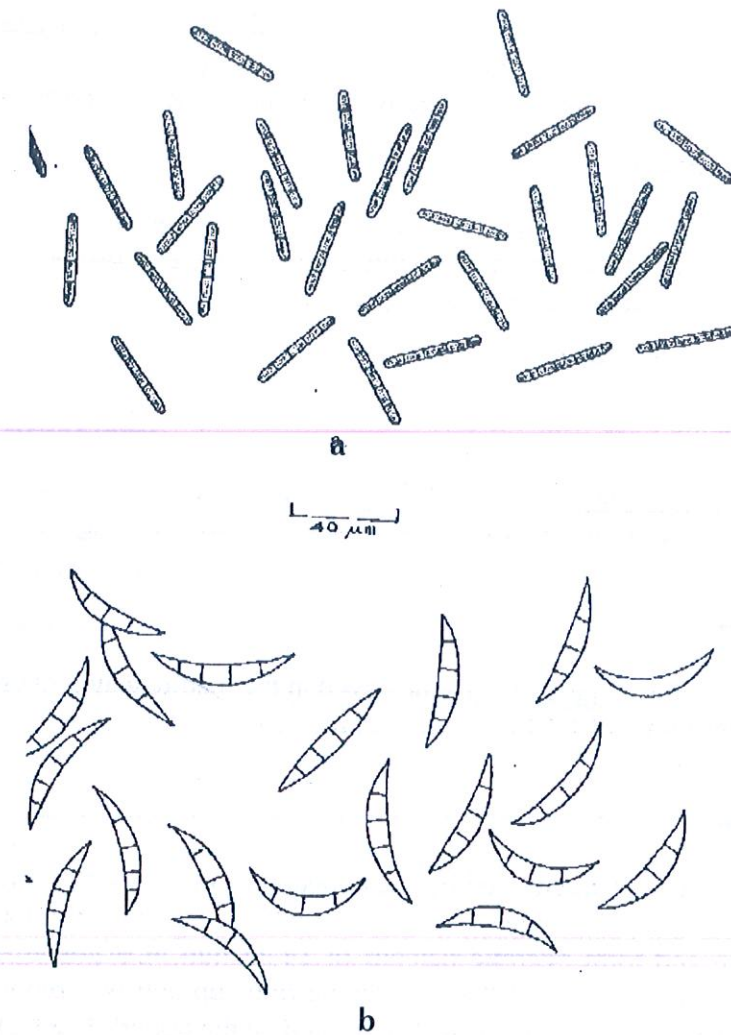


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bud appears as blackening of the flower buds and shriveling and drying of the pedicel resulting in dropping of the flower buds. Mostly immature buds are often affected by this disease. (Nair and Menon, 1983) (Plate 2 & 3, page 421).

Causal organisms:

The disease is caused by *Colletotrichum gloeosporioides* Penz. Conidia are cylindrical, hyaline and are formed on simple conidiophores. The conidia measures 12.58µm-17-90µm long and 3.58-4.47µm broad.

Disease management:

Spraying the trees with 1% BM or Dithane- Z 78 prior to flower setting and repeat the spraying at an interval of 45 days until harvest is found highly effective in reducing the disease (Karunakaran 1981). As Clerodendron act as an alternative host to the pathogen, destroying the weed also help in checking the disease to a great extent.

Grey blight

It is a common disease of clove observed in the mature leaves of young clove trees in the age group of 1-10 years during June-July months in many parts of Kerala (Joshi and Raut 1991).

Symptoms:

The disease is characterized by the appearance of very small yellow brown oval spots which later become whitish to grey with a dark brown border. The spots soon enlarge and form necrotic patches of 14-42 mm in diameter. As disease advances, a major portion of the leaf lamina dries up and was blown away by wind. Dark acervuli of the fungus will be formed on the upper surface of the center of necrotic patches (Karunakaran et al., 1993). In the nursery stage, the spots were more circular and whitish grey in colour. Shade and overcrowding favours the proliferation of the pathogen which usually spread by dispersal of spores.

Causal organism:

Pestalotiopsis palmarum (Cooke)/ *Pestalotia versicolor*

Disease management:

Carbendazim 0.3%, Bordeaux mixture 1% or Difolatan 0.3% were found very effective in controlling the disease.

Foliar diseases (Joshi and Raut 1995)

Symptoms:

Young leaves are prone to infection resulting in shedding. The infection of the young shoot takes place through the petiole resulting in die back. The infection proceeds downwards and infects the entire shoot till it touches the older tissues of stem. Clove being a slow grower, when comes in the grip of die back, loses complete vitality. Such seedlings remain as such for months together without forming any side shoots. The infected seedlings in due course of time loose older leaves leaving barren stem which later on dries.

Causal organism:

Colletotrichum gloeosporioides Penz. Other foliar pathogens associated with clove are *Pestalotia versicolor*, *Ozonimum texanum* Nil. *Alternaria alternata* and *Gloeosporium* sp. etc.

Leaf blotch

Leaf blotch disease occurs during the monsoon season.

Symptoms :

The symptoms are visible as minute spots surrounded by a chlorotic halo on the leaf lamina. These spots later enlarge and form irregular necrotic patches, the centre of which become dirty brown in colour. In the nursery, the affected seedlings show downward curling of the leaves and in mature plants the leaves become crinkled and show distorted in appearance . In both the cases defoliation occurs.

Causal organism :

The disease is caused by *Cylindrocladium quinquesseptatum* Boelialin and Reitsma.

Leaf spot:

The disease has been reported as early as in 1937 (Hein and Bouiquet 1937).

Symptoms:

The disease appears as minute spots on leaves. The spots are almost circular and enlarged to about 0.5-1mm in diameter with a greyish center and brown or purplish margin. The disease is of fast spreading (Plate 4, page 421)

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Causal Organism:

The causal organism was identified as *Colletotrichum gloeosporioides* (Penz.) Penz and Sacc. Mycelium is septate and branched, conidiophores are short and arranged compactly. Conidia formed singly on simple conidiophores. They are ovoid to subovoid or cylindrical rods with round ends. Conidia measure 13.60-22.19 x 3.52-2.2µm with an average of 18.87x 5.60µm. (Fig 2 A & B).

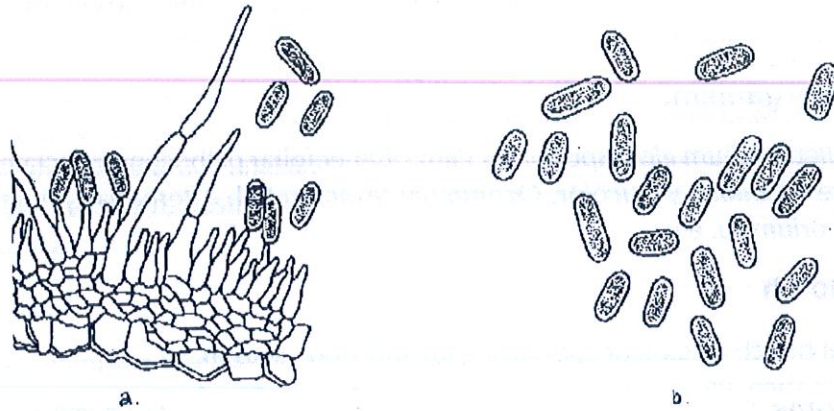


Fig. 2 A. a. Acervulus of *C. gloeosporioides* b. Conidia of *C. gloeosporioides*

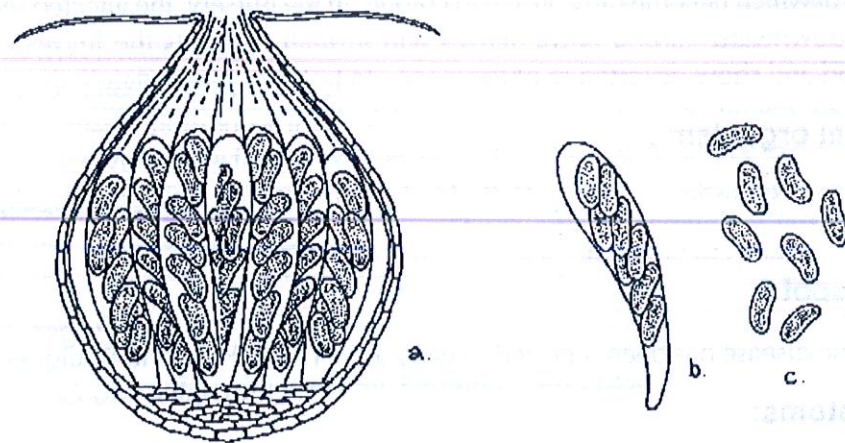


Fig. 2. B. a. Perithecia of *Glomerella cingulata* b. Ascus c. young ascospores.

Another type of leaf spot caused by *Alternaria citri* Ellis and Pierce was also observed. It has been reported as early as 1937 (Hein and Bouiquet). It appears as small light brown specks in any part of leaf lamina. The spots are more or less circular which enlarged slowly and got zonated. Infected mature leaves are found early detachable.

Disease management:

The disease can be effectively controlled by spraying Difolatan 0.3% or Dithane M45 0.3% twice at fortnightly intervals (Suharban et al., 1990)

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Initial symptoms appeared on the leaves as brown spots, which later turns dark brown in colour. Small spots coalesce and cover the entire leaf let. Advanced stages of infection results in defoliation. Pycnidia of the fungus can be seen on infected leaves.

Causal organism:

Botryodiplodia theobromae Pal.

Little leaf of clove

Symptoms:

The symptoms of the disease appears as shortening of internodes. Leaves become reduced in size and fresh leaves fail to emerge. In certain cases the leaves were found twisted or crinkled and finally the affected seedlings collapse.

Causal organisms:

The disease is suspected to be due to MLO.

Disease management:

Tetracycline spray at fortnightly intervals for 5 times is effective in reducing the disease infection (Karunakaran and Nair 1980).

Sudden death:

This is the most important disease of clove tree in Zanzibar and Pemba. The periodical incidence of this disease has resulted in losses, which have accounted

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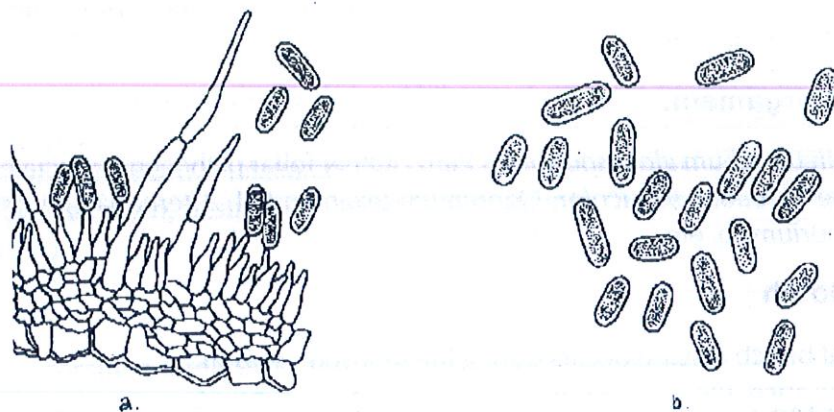


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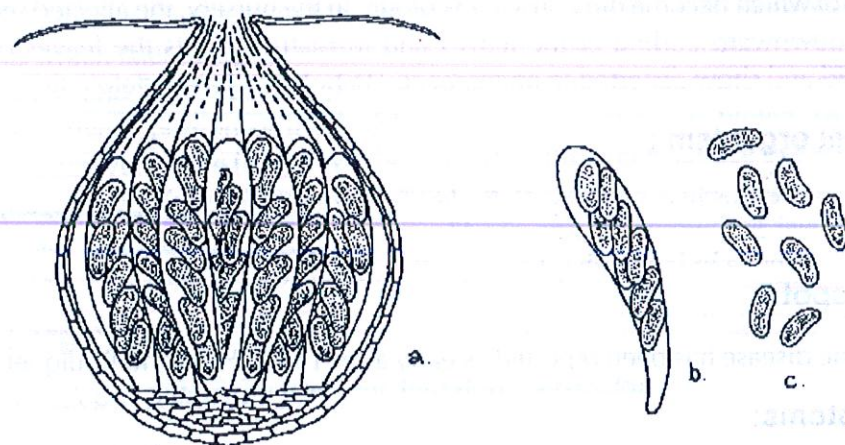


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for the destruction of about half the mature trees of Zanzibar islands. Recently the disease has been observed in Thiruvanthapuram district also (The Saga of Spices Research)

Symptoms:

The first visible symptom is slight chlorosis followed by a very rapid leaf fall and wilt. Considerable portions of the leaves dry up on the tree without abscessing and become a bright russet-red within a few days. The fine ramification of the root system has completely disappeared and the plant dies as a result of water stress. The cambial areas of the collars of the trees are stained bright yellow which spreads up the trunk, and after some months, the yellow stain becomes widespread throughout the year (Purseglove 1984) .

Causal Organism:

The causal organism was identified as *Valsa eugineae*. *Pseudomonas psidi* was also reported from Indonesia as the causal organism. *Valsa eugineae* is a primary root parasite of older trees and a rather un aggressive wound parasite of the aerial branches. The signs of fungal infection could be observed 3-4 months after the death of the plant by the formation of perithecia . Ascospores are formed during the rainy period and washed down into the soil which again infects the root system.

Disease management :

Strategies have not been worked out so far.

Die-back:

Symptoms:

The disease is always associated with some form of injury to the tree, particularly when branches are broken during harvesting. The branch slowly dies back, the leaves turning brown, and the fungus proceeds downwards. When a fork is reached the unaffected branch above it dies suddenly, the infected tree may take a few to many years to die depending on the height of the original point of entry. If the affected branch is split open, a reddish brown discoloration occurs between the dead and living tissues and mycelium of the fungus is present in the stained stone. The pathogen progresses down the branch often girdling it and eventually reach the main trunk. Pycnidia and perithecia develop at or near the point of entry.

Causal organism :

The disease is reported to be caused by *Cryptosporella euginae*

Disease management: Control of the die back consists of cutting off the branch cleanly below the stained infected area and the painting the cut surface with a fungicide. Care should be taken to avoid breaking the branches at harvesting and those that are broken should be cut cleanly and treated with fungicidal paint.

Sumatra disease

The sumatra disease was first recognized from western Sumatra in 1961 and hence the name.

Symptoms:

Leaf fall and twig die back of the trees are the main symptoms. Usually trees of 6-18 months are prone to the disease. Initially die back occurs on a part of the crown, which extends down on one side of the tree and killing a vertical series of branches. Over the rest of the canopy the foliage usually shows signs of physiologic stress. General and intervenal chlorosis with marginal scorches and subsequent leaf shedding progresses rapidly and tree dies usually within a year of the appearance of the first symptoms (Waller & Sitepu 1975)

Causal Organism:

The disease is found to be of unknown etiology. Nutritional disorder is considered to be a possible cause. Affected leaves had high manganese and aluminum and low levels of phosphorus and potassium. *Endothia* sp., *Phymatotrichum* sp. and *Phytophthora* sp. are reported to be associated with the disease (Nair and Menon, 1983). But the etiology is not yet proved correctly.

Disease management:

As the etiology of the disease is of controversy, no proper control measures were worked out for the disease. Stride *et al.* (1991) evaluated insecticides against *Hendola fulva*, a vector of Sumatra disease of cloves in Indonesia.

Juvenile Decline:

The disease is also called immature die back and slow decline. The disease is characterized by gradual reduction of a young trees canopy from the base upwards, resulting in the death of twigs and branches from bottom upwards. Dead twig and

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Causal organism:

Valse eugenia

Mutibudjanj:

The disease has been noticed in many parts of Indonesia.

Symptoms:

The disease begins with a general decay of the fine feeder roots, which soon produces secondary leaf shedding and die back. Initially at the top of the crown and subsequently extending through the whole canopy. It produces a slow decline of the tree leading to complete death in two or three years from the onset of the symptoms. Hadwidjaja (1956) attributed the disease to unfavourable soil conditions, as the disease is more prevalent in areas of poor physical soil (Purseglove 1984).

Sooty mold :

Symptoms :

Sooty growth of the fungus can be seen on the entire leaf surface and also on the stem. The growth is superficial and can be removed by gentle scraping. Severe infection reduces the photosynthetic ability of the plant (Plate 5, page 421).

Causal organism

***Phragmocapnias betle*
Thesis and Syd.**

The perithecia are scattered and aggregated in groups and roughly spherical (Fig. 3). They measured 143.20 to 161.10 μm in dia. (AV. 150.36 μm). Perithecia where

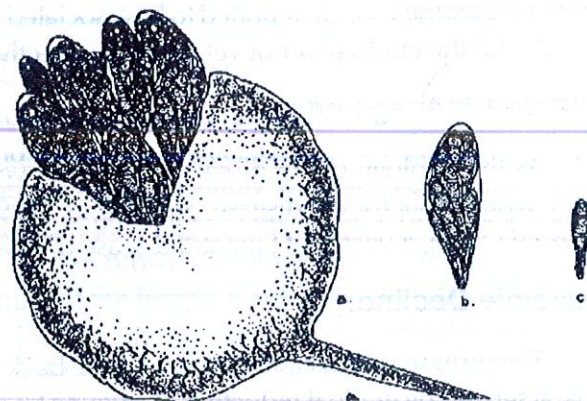


Fig. 3. a Perithecium b. Asci c. Ascospore

provided with setae varying from 1 to 4, which were dark coloured. The setae measured 60.86 to 68.02. x 6.44 to 7.16 μm (AV. 64.44 x 6.80 μm). Setae were wider at the base and tapering gradually towards the apex.

Asci were bitunicate , each ascus had 8 ascospores. Several asci usually 8 to 16 were found in each perithecium, formed a loose basal group within the perithecium. Asci measured 35.80 to 46.89 x 11.81 to 15.39 μm . (AV. 38.66 x 13.60 μm)

Eight ascospores were observed in each ascus. Ascospores were narrowly clavate, 4 septate, hyaline, measured 17.54 to 22.55 x 3.93 x 5.01 μm . (AV.18.25 to 4.68 μm). They were constructed at the region of the septa. The distal end of the spores were wider than the lower end. (Fig. 3).

Red rust (Algal Leaf spot)

Symptoms :

Orange to rust or reddish coloured velutinous patches of growth of the alga can be seen on the leaves. The growth patches vary from 5 to 8 mm in dia. The patches may coalesce together forming irregular areas and assumes dull grey patches (Plate 6, page 422). The growth of the alga reduces the photosynthetic area.

Causal organism

The pathogen is a parasitic green alga *Cephaleuros virescens* Kunze. (Syn. *C.parasitica* Karst. *C. mycoides* karst.)

The orange tufts represent the thallus of the algae. The orange colouration is due to the abundance of discoid shaped chloroplasts in the algal cells which contain b – carotene. The thallus produces erect stalks which enlarge to vesicles. On these vesicles stalked terminal or avoid sporangia 30 x 24 μm are produced. Sporangia produced biflagellate zoospores which are dispersed by rains splash and wind and are the primary infection propagules.

Diseases of Cinnamon

Cinnamomum verum of family *Lauraceae* is cultivated for its dried inner bark, which is used as spice. The plant is susceptible to more than 30 diseases, of which the infection of the bark causes maximum economic loss. Among the diseases Stripe canker, Pink disease and Twig blight are most serious

branches break off so that the lower part of the stem becomes devoid of branches. In the initial stages affected trees are left with a small canopy restricted to the top of the trees. The leaves become smaller and chlorotic. Root rot is also noticed in some cases.

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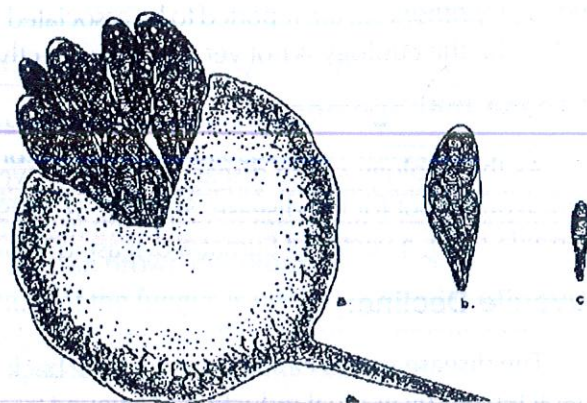


Fig. 3. a Perithecium b. Asci c. Ascospore

provided with setae varying from 1 to 4, which were dark coloured. The setae measured 60.86 to 68.02. x 6.44 to 7.16 μm (AV. 64.44 x 6.80 μm). Setae were wider at the base and tapering gradually towards the apex.

Asci were bitunicate , each ascus had 8 ascospores. Several asci usually 8 to 16 were found in each perithecium, formed a loose basal group within the perithecium. Asci measured 35.80 to 46.89 x 11.81 to 15.39 μm . (AV. 38.66 x 13.60 μm)

Eight ascospores were observed in each ascus. Ascospores were narrowly clavate, 4 septate, hyaline, measured 17.54 to 22.55 x 3.93 x 5.01 μm . (AV.18.25 to 4.68 μm). They were constructed at the region of the septa. The distal end of the spores were wider than the lower end. (Fig. 3).

Red rust (Algal Leaf spot)

Symptoms :

Orange to rust or reddish coloured velutinous patches of growth of the alga can be seen on the leaves. The growth patches vary from 5 to 8 mm in dia. The patches may coalesce together forming irregular areas and assumes dull grey patches (Plate 6, page 422). The growth of the alga reduces the photosynthetic area.

Causal organism

The pathogen is a parasitic green alga *Cephaleuros virescens* Kunze. (Syn. *C.parasitica* Karst. *C. mycoides* karst.)

The orange tufts represent the thallus of the algae. The orange colouration is due to the abundance of discoid shaped chloroplasts in the algal cells which contain b – carotene. The thallus produces erect stalks which enlarge to vesicles. On these vesicles stalked terminal or avoid sporangia 30 x 24 μm are produced. Sporangia produced biflagellate zoospores which are dispersed by rains splash and wind and are the primary infection propagules.

Diseases of Cinnamon

Cinnamomum verum of family *Lauraceae* is cultivated for its dried inner bark, which is used as spice. The plant is susceptible to more than 30 diseases, of which the infection of the bark causes maximum economic loss. Among the diseases Stripe canker, Pink disease and Twig blight are most serious

Stripe canker (Bark canker)

The disease is found on the trunk and branches of young trees of *Cinnamom verum* or on *C. burmanni* in Indonesia. The disease is more prevalent under conditions of poor drainage.

Symptoms:

Vertical stripes or dead bark occur particularly near the ground level. The first visible symptom of the disease is the formation of sunken necrotic zones on the bark up to 5cm wide along the main trunk. These zones are parallel, narrow and exceeds 10mm in length. The interior discolouration is characteristically brown and gummy, sometimes reddish and exudes an amber coloured liquid.

Causal organism:

The disease is caused by *Phytophthora cinnamomi* Rands. (George F Weber 1973)

Sooty mould:

Symptoms:

The disease is characterized by a black superficial growth of the fungus on the upper surface of the leaf lamina. There are two types of symptoms. One type was characterized by the superficial growth of the fungus as black encrustations on the upper surface of the leaf lamina. The other type symptom is characterized by the formation of black coating or crust of the fungus on the under surface of the leaf. In both the cases the growth of the fungus was found associated with scale insect infestation especially scale insects. (Plate 7, page 422)

Though the fungal growth was superficial, the vigour of the plants reduced and growth retardation results due to infection.

Causal organism:

Phragmocapnia beetle Thesis and Syed. A hyperparasite viz. *Spiropes bolladynno* was also identified on the sooty mould. (Plate 9, page 422).

Root rot

Symptoms:

The occurrence of this disease was observed under conditions of excessive

moisture and poor drainage. The growth of the infected trees are very slow and leads to slow decline. On freshly infected root surfaces snow white and compact mycelial growth of the fungus, which turns reddish brown on ageing.

Causal Organism:

The disease is caused by *Ganoderma pseudoferream* Wakef. Spores can be seen on the older dead parts in the base of the trunk. They are reddish brown above and grayish white below shelving or sessile and some times zonate. The arthrospores are brown ovoid 1 celled and 68 x 4-5m.

Root rots caused by *Rosellina* spp. were also reported. (Purseglove *et al.*, 1981). A brown rot by *Phellinus lamaensis* (Murr.) Heim and a white rot by *Leptoporus lignosus* (Klot.) Heim.

Red leaf spot

This disease was observed in lower Pulney hills of Tamil Nadu. (Prakasam 1992)

Symptoms:

The infection appears as small red circular spots near the margin of the leaves, which later extends and cause reddish elongated spots with dark red margins. In severe cases, the symptoms can be seen on the entire leaf lamina, leading to drying and defoliation. Shot hole symptoms were also observed. In the center portion of the spots, several black dots representing the fructification of the fungus was observed.

Causal organism: The disease is caused by *Colletotrichum capsici*. The conidia are falcate fusiform with acute tips and narrow truncated base. They are single celled, hyaline and measure 15-30 (18- 25) x 2.3- 4.1(3.2-4.2) μ m in size. The acervuli formed on the leaves are round in shape and are sub- epidermal (Prakasam 1992).

Leaf spots and die back

Symptoms:

The disease is found in the nursery seedlings as well as in mature plants.

On seedlings small dark brown specks develop as the leaf lamina, which enlarge and coalesce results in drying of the leaf. The size of the specks extend up to 15mm in die. The infection spreads to the stem leading to necrosis from the apex downwards.(Plates 8,9 &10, page 422)

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enlarge forming necrotic splotches. These later become papery white with red brown margins. Under changing wet and dry conditions, concentric zonations develop on these spots characteristically. (Plate 10 & 11, page 422).

These zoned spots were limited from green healthy area by a well-defined dark brown band.

In some cases shedding of the papery which necrotic tissue leaving the red brown margin produced the shot hole which can be up to 8-12 mm in diameter. Acervuli of the fungus can also be noticed in the necrotic tissues.

The causal organism is *colletotrichum gloeosporioides* Penz.

Grey blight:

The disease could be observed on several parts of Kerala.

Symptom:

Small yellow brown spots which later on becoming whitish to grey with dark brown borders. The spots vary in shape from oval to irregular and sometimes small adjacent spots coalesce forming big necrotic patches. In advanced stages of infection a major portion of the affected lamina dries up and blown by wind. Dark acervuli could be noticed on the upper surface of the central necrotic patches (Karunakaran 1993) (Plate 11&12, page 422)

The disease is caused by *Pestalotiopsis palmarum* (Cooks) Stoyaert based on morphological characters. (Fig. 4)

Disease management:

Spraying 1% Bordeaux mixture can control the disease.

Algal leaf spot

Symptom:

Characterized by the appearance of circular patches of varying size on the abaxial side of the leaves.

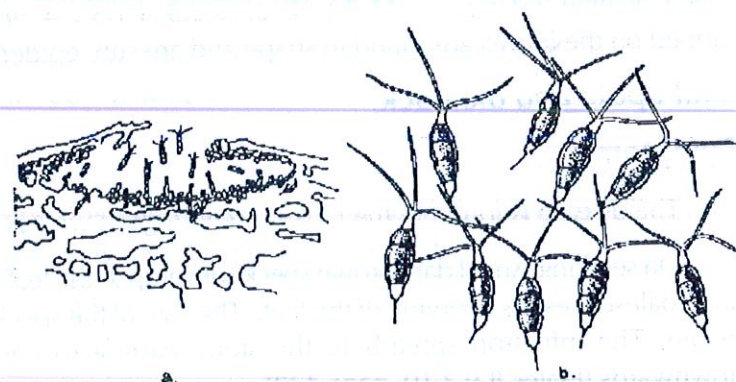


Fig 4. a. Acervulus of *P. palmarum* b. Conidia

Seedling blight:

Symptoms:

Light brown patches girdle the stem resulting in the death of the plant.

Causal Organism:

Diplodia sp. is found associated

Disease management:

Spraying with Bordeaux mixture 1% can control the disease.

Pink Disease

The disease is caused by *Corticium salmonicolor* B. & Br. has been found on cinnamon. It causes pink encrusted areas on the stem with death of the smaller shoots (Purseglove 1984)

Maistre (1964) recorded a rust *Aecidium cinnamomi* Rac. and leaf diseases caused by *Leptosphaeria* spp. and *Exobasidium* spp.

Diseases of Nutmeg

Nutmeg (*Myristica fragrans* Houtt) is one of the major spice crop in India. It is cultivated as an intercrop in coconut and arecanut gardens. It produces two separate spices, namely nutmeg (the dried kernel of the seed) and mace (the dried aril surrounding the seed) which are of great commercial value. The plant is susceptible to a number of diseases of which fruit drop is serious malady causing heavy crop loss.

Fruit Drop:

The disease makes its appearance during the monsoon season when there is heavy and continuous rainfall.

Symptoms:

Symptoms are expressed only on half matured or unripe fruits. The disease appears as water-soaked lesions at the base or any part of the fruit, which later turn brown in color followed by premature splitting of the pericarp and rotting of the mace and seed (Plate 13, page 423). As the disease progresses the internal tissues were completely rotten. The infection of the pathogen on the fruit stalks result in dropping off of the fruit (Karunakaran et al., 1992).

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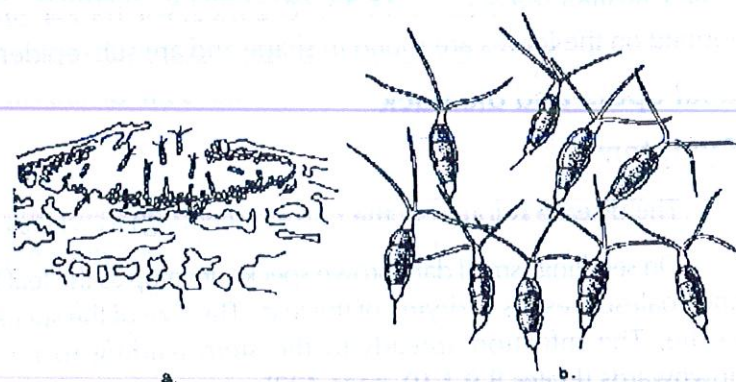


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Causal Organism:

A number of organisms are found associated with the disease. *Diplodia natalensis* Evans, *Thielaviopsis paradoxa*, *Colletotrichum gloeosporioides* and *Botryodiplodia theobromae*.

A premature fruit fall is found in Indonesia and a possible related disorder has been reported from Malaysia. It is associated with the fungus *Coryneum myristicae* but it is not certain.

Bacterial wilt:

The disease is observed in plants of age between 10-15 years.

Symptoms:

The disease appears as water soaked glistening golden brownish patches on the leaves with irregular margin delimited by veins. Gradually the infected leaves dries up and remain attached to the plant without defoliation. Decaying and shredding of roots, girdling and peeling of the cortex tissue, brown vascular discoloration, characterize infection in the root system. The plants wilt with in 2-3 weeks after infection.

Causal organism :

Is pseudomonas solanacearum (Smith) Smith.

Leaf spot and shot hole disease:

The disease is prevalent in Kerala resulting in large-scale destruction of the crop. The disease was first reported from Meghalaya (Berkeley 1856). It was also observed in the Konkan region of Maharashtra (Lawafe 1996). The disease is restricted to the foliage and the pathogen infects at all stages of leaf growth. However young leaves are more prone to infection. (Plate 14, page 423).

Symptoms:

The initial symptoms appear as small necrotic spots of 2-3mm diameter on both sides of the leaf. They are surrounded by yellow chlorotic haloes. Several such spots coalesce together to form bright necrotic patches covering about 50% of the leaf area, reducing as much the photosynthetic area. In the final stage of the disease withering of affected leaf tissues imparting a shot hole effect is the most characteristic symptom of this disease. It is observed within 15-20 days after appearance of the visible initial spot. In spite of the heavy damage there is no defoliation (Sardesh Pande 2000)

Causal Organism:

Cladosporium oxysporum Berk and Curt was identified as the causal organism of the disease. The colonies on potato dextrose agar are circular, dark olive green and radiating towards the periphery with superficial growth. The hyphae are septate measuring $3.75\mu\text{m}$ in width. Conidiophores are short straight and light green with chains of conidia. Conidia are single celled, hyaline or pale oliveaceous brown. *Colletotrichum gloeosporioides* and *Alternaria* sp. were also found associated with leaf spot diseases of nutmeg.

Disease management:

The disease can be significantly controlled by spraying fungicides such as carbendazim (0.1%), borax (0.1%) or Bordeaux mixture 1%. First spray should be given in the month of October followed by one or two sprays at monthly intervals.

Root rot:

Symptoms:

The above ground parts of the plant laid to decline because of malfunctioning of the root system. Yellowing of the foliage leads to defoliation. The fruits become dry and shrivel resulting in die back. The fungus invades the root system forming a black layer over the root. It penetrates the wood and ultimately kills the plant.

Causal organism:

The disease is reported to be caused by *Rosellinia pepo* Pat. The fungus develop black shaft hair like structures which produces conidia that are hyaline perithecia are black, embedded, globose and contain ascospores that are brown, straight and pointed at each end. Root rot by *Fomes noxius* Corner and the brown root rot *F.camoensis* occur in Indonesia

Disease management:

Trench isolations of infected trees followed by cutting and burning in situ. Application of systemic fungicides Benlate was also found effective.

Thread blight:

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along the lower surface of twigs and branches. The thread grows rapidly and upon encountering a petiole, a portion extends up to the blade where the larger threads far out in a fine, light brown, silky net like covering of the lower surface. The parenchyma is invaded and the cells killed. The leaves die, the older ones wilt, and often remain hanging from the twigs by the thread of the fungus.

Causal organism

Ceratobasidium Steoen Six (Burt) Venkat. Thread blight caused by *Corticium stevensii* has been reported from Grenada and Trinidad.

Pink Disease:

The disease is fatal to foliage branches and fruit.

Symptoms:

Threads of fungus mycelium could observe on aerial parts of the plant. The strings or threads composed of fine parallel, mycelial filaments up to 3m in diameter and grow more or less superficially along the lower surface of branches and twigs. The infection advance up the petiole and fan out over the leaf blade, the blade is killed and becomes brown. The infection extends to the branches to the petiole and fruits. The diseased parts are shed and sporophores developed on the soil. The pileups is white circular disk shaped, convey up to 2.5 mm in diameter, with a small lamella. The basidia are white barrel shaped. The mycelium survives in the aerial parts of the host. The fruiting structure may be sessile, resupinate or have short stripes attached directly to the mycelium.

Causal organism:

Botryobasidium salmoricolor (Berk and Br.) Venue. External appearance is of a rosy pink, resupinate, relatively thin over growth that may extend many inches along the branch. The fungus is found invading the cambium and cortex.

Nut rot/ Fruit rot:

The disease is of common occurrence in many parts of Kerala during the monsoon period. The disease cause severe crop loss due to premature fruit fall.

Symptoms:

The fungus causes damage to the nuts when they break open after falling. Sometimes they become covered with greenish black spots up to 2 cm in diameter and the tissue on the lower side is brown. The infection initiates as water soaked,

dull green to dark brown lesions on the rind near the stalk portion. These discoloured areas later develop typical rotting and spread to the entire fruit resulting in fruit fall. Rotting extends to the mace also. Mycelial growth of the fungus formed on the rotten areas of the fallen fruits. Sometimes the damage is light, but the quality and yield is reduced.

Causal organism

The disease is caused by *Coryneum myristica* stein. The oblong conidia are pale olive, claviform to cylindrical, straight or slightly curved 4-8 celled without constriction and measures 30-80 x 3-5µm.

Sooty mold

The symptoms are same as in clove (Plate 15, page 423).

All the plates are contributed by P. Santha Kumari.

Conclusions

Climatic conditions play a major role in the occurrence and spread of many of these fungal diseases such as the rots, blights, spots etc., which account for the major crop losses. Plant sanitation and timely application of suitable fungicides are to be taken up at the outbreak of such diseases for checking their spread. For *Phytophthora* and other fungal pathogens prophylactic usage of Bordeaux mixture can save the crop.

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