

CHAPTER 7

DISEASES

Cashew is subject to the attack by a multitude of important pests and diseases, limiting the production considerably. However, compared to the number of pests attacking cashew and the intensity of damage they inflict on the crop, the magnitude of the disease problem is rather very low. Though more than four dozens of fungi have been reported from cashew (Appendix 7.1) those of economic importance are only a few. Because of this fact, the research thrust on diseases also is very meagre. Rao (1969), Nambiar (1978) and Agnoloni and Giuliani (1977) gave brief accounts of important diseases of cashew. The diseases of cashew and their control measures are described in this chapter.

Inflorescence blight

As the very name indicates, the malady is characterised by the drying of floral branches. Minute water-soaked lesions are discernible in the early stages on the main rachis and/or secondary rachis. Gummy exudations can be seen at the lesion site. The lesions turn pinkish brown in a day or so, enlarge in size and turn scabby within 2–3 days. The adjoining lesions coalesce to form bigger lesions. As a result of this, the affected inflorescences dry up and present a scorched appearance. The incidence of the disease becomes much aggravated when cloudy weather prevails. Studies carried out at Cashew Research Station, Ullal, India showed that this malady was caused by fungi like *Gloeosporium mangiferae* and *Phomopsis anacardii* in association with tea mosquito, *Helopeltis antonii* Sign. and hence a combination spray of a fungicide (Cuman 100g in 100 lit or Blitox 250g in 100 lit) and an insecticide (Dimecron 30 ml in 100 lit) was recommended earlier for the control of this blight (Anon, 1960 and Anon, 1965, 1966, and 1969). Damodaran and Nair (1969) reported the control of the disease with D D T 0.2% spray, but did not specify the exact role of the fungus and insect in the causation of the malady. However, recent investigations (Nambiar *et al.*, 1973) revealed that the disease was primarily caused by tea mosquito infestation and the fungi associated with it were only secondary saprophytic colonizers (Table 7.1). The fungi could be isolated only from old scabby lesions and not from small fresh lesions indicating the above fact. The finding is important in that the fungicide can now be eliminated from the spray schedule against this malady. (For details see chapter on pests).

A floral shoot die-back disease was reported from Nigeria by Olunloyo and Esuruoso (1975). The disease was caused by *Lasiodiplodia theobromae* (= *Botryodiplodia theobromae*). The fungus was isolated from cashew nuts in Tanzania also (Riley, 1960). Withering of petals and other floral parts followed by a progressive die-back of the rachis are the symptoms of this malady. It usually starts from the apex

TABLE 7.1. Incidence of inflorescence blight of cashew with tea mosquito and fungi*

<i>Treatment</i>	<i>Total no. of inflorescences treated</i>	<i>Total no. of inflorescences affected</i>
Caging the inflorescence with <i>H. antonii</i> alone	20	20
Caging the inflorescence with <i>H. antonii</i> after inoculating with fungus		
(i) <i>G. mangiferae</i>	20	20
(ii) a non-sporulating fungus	20	20
Inoculating with fungus alone		
(i) <i>G. mangiferae</i>	20	0
(ii) a non-sporulating fungus	20	0
Inoculation of injured inflorescences with fungus		
(i) <i>G. mangiferae</i>	20	0
(ii) a non-sporulating fungus	20	0
Caging fungicide-treated inflorescence with <i>H. antonii</i>	10	10
Caging insecticide-treated inflorescence with <i>H. antonii</i>	20	0
Control : (i) Inflorescence caged	20	0
(ii) Injured inflorescence caged	20	0
(iii) Inflorescence left open	20	18

* Source: Nambiar *et. al.*, 1973.

developing downwards to the main peduncle which loses its normal green colour. As a result of the die-back the flowers are lost and no fruit set takes place. The immature nuts and apples when attacked become black and remain attached to the moribund floral shoots. The discolouration of the pith is traceable from the peduncle to the twigs when cut longitudinally. Insect damage is supposed to predispose the peduncles to infection by the pathogen. This is supported by the frequent isolation of the fungus from the tissues of dead flowers. The fungus enters the host slowly from the apex of the peduncle to the pith and within six months produce die-back symptoms.

Die-back or pink disease

The disease caused by *Corticium salmonicolor* (= *Pellicularia salmonicolor*) is prevalent during the South West Monsoon period (Anon, 1960; Rao, 1969; Estibeiro, 1970). The affected branches show white or pinkish growth on the bark. The fungus penetrates into the deeper tissues and causes gradual death of the shoots from apex downwards and hence the name die-back. Towards the cessation of monsoon, a film of silky thread of the fungus is seen on the branches. The mycelium is silvery white in the beginning but changes to a general pink at later stages. The asexual spores are hyaline individually, but pink in mass, and readily germinate in water and form the infective propagules. In advanced stages the bark splits and peels off. In a tree either one branch or many branches will be affected. On the affected branches, the leaves turn yellow and fall off giving a barren appearance to a portion of the tree (Fig.7.1). Control measures include pruning the affected branches, well below the site of infection and destroying them, protecting the cut surface by application of Bordeaux paste and giving prophylactic sprays with Bordeaux mixture (1%) twice, one in May-June before the onset of South-West monsoon and the second in October. Phytosanitary measures are important lest the affected branches serve as a source of inoculum for further spread of the disease. If left unpruned, these branches will also be the site of infestation and multiplication of bark beetles., etc.

Damping-off of seedlings

The disease occurs in nurseries where drainage conditions are poor. Kumararaj and Bhide (1962) found that damping-off caused severe loss of nursery seedlings in Vengurla in Maharashtra. Different fungi have been reported from different parts of the country as causative agents of the disease. Thus *Fusarium* sp., *Pythium* sp., *Phytophthora palmivora* and *Cylindrocladium scoparium* have been reported as pathogens from Kerala, Karnataka, Tamil Nadu, Andhra Pradesh and Maharashtra (Anon, 1960; Kumararaj and Bhide, 1962; Susamma Philip, 1973). *Sclerotium rolfsii* also has been implicated with the disease (Agnoloni and Giuliani, 1977). The fungi attack either the root or collar region or both of tender seedlings. In the case of *P. palmivora*, the affected seedlings become pale, show water soaked girdles of darkened tissues around the stems and the seedlings later droop ultimately leading to their death. In severe cases, leaves also exhibit water soaked lesions. The lesions enlarge and coalesce involving some times the entire lamina.

Susamma Philip (1973) reported infection of four month-old seedlings by *Cylindrocladium scoparium* causing wilting and withering of seedlings and rotting of

underground parts. The disease incidence was severe during rainy season. The fungus on inoculation produced identical symptoms in 14–25 days. The conidiophores of the fungus are erect 400–500 μ long, 6–7 μ wide and dichotomously branched at the apex. Conidia are borne on phialides, cylindrical, uni-septate, 50–60 x 5 μ and show polar germination. Control measures suggested are provision of adequate drainage conditions in the nursery beds or bags and drenching the beds/bags with ceresan wet 0.1% or Bordeaux mixture 1%.

Olunloyo (1976) observed a severe root rot of seedlings raised in polythene bags, the pathogen associated being *Pythium ultimum* and other fungi. He recommended incorporation of dexton in the soil at the rate of 113.6 kg/ha for controlling the disease.

Anthracoise disease

The disease is called "soorai" in Tamil Nadu and has appeared on epidemic form in Trichy in 1965 (Singh *et al.*, 1967; Anon, 1967). In Brazil, anthracnose disease is known to cause severe economic loss to the crop (Agnoloni and Giuliani, 1977). It was found to affect tender leaves, twigs, inflorescences, nuts and apples. Reddish brown, shiny, water-soaked lesions followed by resin exudation on the affected parts are the earliest symptoms seen. The lesions soon enlarge in size, killing the affected shoots. Affected tender leaves become crinkled and nuts and apples shrivelled. The inflorescences turn black as a result of attack. Successive attacks of terminal shoots for a couple of years may result in eventual death of the affected plants. Singh *et al.*, (1967) reported that *Colletotrichum gloeosporioides* (= *Gloeosporium mangiferae*) was the causative fungus, and that the fungus perennated on the dead tissues. The fungus enters the fruit through the floral stigma in the very early stage itself. The attacked nuts exhibit small black spots and apples become mummified. Rainfall seems to aid in spreading the disease. The disease is severe when rainfall coincides with the flowering season. Removal of affected parts of the plant, spraying the plants with 3:3:50 Bordeaux mixture (as has been recommended for control of anthracnose of mango caused by *C. gloeosporioides*) and provision of wind breaks by growing tall trees like casuarina, eucalyptus etc. to arrest the spread of the disease through-wind-blown spores, have been suggested for controlling the disease (Singh *et al.*, 1967). In Brazil, control of anthracnose was obtained by spraying Dithane M-45, Orthodifolatan 4F, Cercobin etc. (Lima *et al.*, 1975, Menzes, Karam and Moura, 1975, and Menezes, Karam, Lima and Parente, 1975) Bastos and Figueiredo (1967) found that partially purified cultures of *Bacillus subtilis* inhibited the growth of *C. gloeosporioides* in culture.

In Cuddalore and Trichy areas of Tamil Nadu *Fusarium* sp. was isolated from dark brown shiny lesions (Anon., 1972). Perithecia of *Melanospora* sp. were found on affected parts when kept under moist conditions. However, the pathogenicity of the fungus has not been clearly established.

In addition to the above major diseases, the following diseases of less serious nature also were reported on cashew.

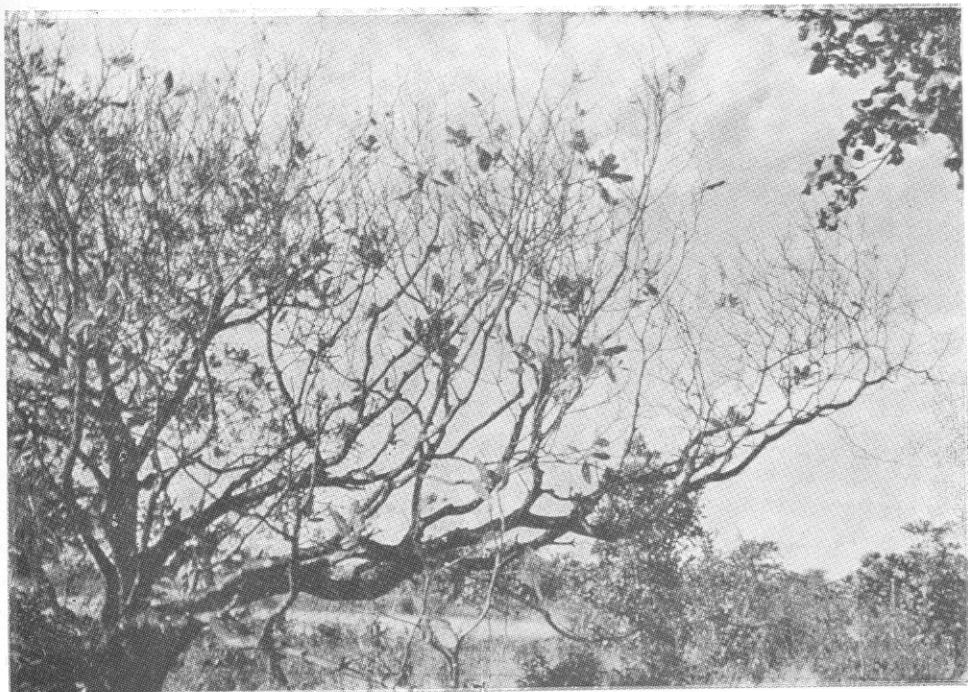


Fig. 7.1. Defoliation of a tree affected by 'die-back'

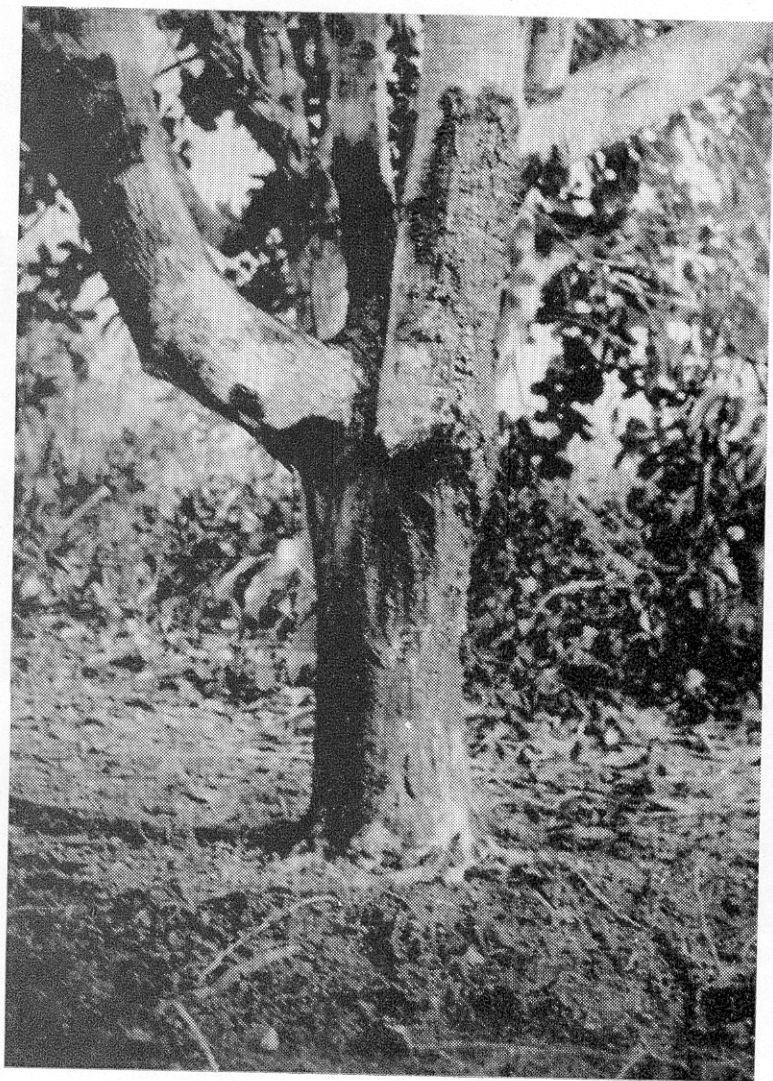


Fig. 7. 2. GUMMOSIS AFFECTED CASHEW TREE

Shoot-rot and leaf fall

Thankamma (1974) who reported the disease first in Kerala identified the causal organism as *Phytophthora nicotianae* var. *nicotianae*. The disease incidence was at its peak in July. During the South West monsoon period, black linear lesions develop on the stem along with gum exudations. The lesions enlarge in size resulting in collapse of the affected shoots and shrivelling of tender leaves. In the mature leaves the lesions are seen first on the midrib which later spread to the main lateral veins and leaf blade. Leaf and stem infection results in extensive defoliation. The fungus produces chlamydospores (35—37 μ) and sporangia (43.70—62.78 μ). Oospores were not observed in single culture, but formed when paired with *P. meadii*. The oospores measured 42 μ .

Decline in cashewnut

The disease was reported from Calicut (Ramakrishnan, 1955) causing defoliation and drying of twigs in the dry season. In 2—3 years the affected trees succumb to the disease. Fibrous roots of the affected trees were found to be infected by *Pythium spinosum*. Inoculation trials showed that the infection took place in rainy season and the symptoms appeared only later during the dry season. Application of cheshunt compound in the soil at the base was recommended to control the disease.

Leaf spots

Many types of leaf spots have been reported on cashew (Batista, 1957; Anon., 1960; Guba, 1961; Early and Punithalingam, 1972): grey blight (*Pestalotia microspora*, *P. dictyota*) red leaf spot (*Phyllosticta* sp.), brown leaf spot (*Colletotrichum gloeosporioides*) ferruginous spots (*Phomatospora anacardicola*) leaf spot caused by *Phomopsis anacardii*, and red rust caused by an alga *Cephaleuros mycoides*. Spraying of 1% Bordeaux mixture, copper oxide 0.3% or Benlate 0.3% was recommended to control these diseases (Anon., 1960, Matta and Lellis, 1973). Olunloyo (1975) reported a leaf blight caused by *Pestalotia paeoniae* in Nigeria, while Polanaco (1973) observed in Venezuela *C. gloeosporioides* (*Glomerella cingulata*) affecting young leaves and *P. conglomerata* affecting older leaves. Batista (1957) studying foliage lesions on cashew caused by *Phomatospora anacardicola* reported that the asci measured 35—50 $\mu \times 15$ —16 μ . A vein and leaf blight caused by *Colletotrichum* sp. was reported recently from Maharashtra (Anon., 1973). Aquino and Melo (1974) and Castro *et al.*, (1977) reported *Diplodinium anacardiacearum* from lower surface of cashew leaves causing small black disk shaped dots. *Phyllosticta anacardicola* and *Cercospora anacardii* were recorded from cashew leaves (Batista and Vital, 1952; Golato, 1970a). Against *Cercospora* leaf spot, Golato (1970b) recommended treatment with Zineb 0.2%. In some of the cashew growing areas, leaves of a few cashew trees show yellow spots. Sometimes the spots will be innumerable. The etiology of this disease is not exactly known.

Sooty mould

Leaves are often covered by dense sooty masses of the fungus, *Capnodium* sp. on both the surfaces, thus hindering the normal photosynthetic activity (Anon., 1960; Arailde and Mattos, 1971). This can be controlled by spraying fish oil rosin soap 1.5 kg.

in 100 lit water followed by 2% starch solution. The spray will control the associated insects and enable the sooty mould to fall off in flakes from the leaves when dried.

Powdery mildew

Phadnis and Elijah (1968) reported that cashew blossoms were affected by the fungus *Oidium* sp. in Maharashtra during cloudy days. Fruit set was found to be affected to a considerable extent. Powdery mildew was often found to occur along with anthracnose (Aquino and Camelo, 1971). Julio da Ponte (1971) described the fungus as *O. anacardii* Noach, and found that leaves, shoots and inflorescences were infected. In severely affected trees, the leaves become shrivelled and dry. Dusting of sulphur was recommended as a control measure. A hyperparasite *Cicinnobolus cesatii* was recorded from the lesions (Aquino and Camelo, 1971).

Leaf rot disease

This is a minor disease occurring in sporadic cases. The pathogen, *Cylindrocladium quinqueseptatum* causes leaf rot during the monsoon season resulting in defoliation.

Gummosis

The disease is characterised by exudation of a brownish liquid which later turns black in colour. Main stem and branches are affected and longitudinal cracks can be seen on the affected branches from which gum exudes (Fig. 7.2). This was observed in Kerala and Tamil Nadu. Different fungi have been implicated with the disease. Fungi like *Pellicularia salmonicolor*, *Diplodia natalensis* (Medeiros, 1951) and *Ceratocystis* sp. have been isolated from affected parts in different places.

Diseases of apples and nuts

Fungi like *G. mangiferae*, *Aspergillus niger*, and *Rhizopus* sp. have been found to affect the cashew apple resulting in their decay (Anon., 1960). While immature and mature nuts were infected by *Cladosporium* sp. (Rangaswami *et al.*, 1970) and *Nematospora coryli* Peg. and *N. gossypii* Ash and Nowell (Golato, 1970a), *Aspergillus niger*, *A. flavus*, *A. tamaris*, *Rhizopus nigricans*, *Fusarium* sp. and *Gliocladium* sp. infected kernels causing dry rot (Esurioso, 1974). Olunloyo (1978) reported a dry rot of immature cashewnuts in the plantations in Nigeria, resulting in reduced nut production per inflorescence. Fungi like *A. tamaris*, *Penicillium citrinum* and *L. theobromae* were found associated with the disease. Olunloyo (1978) found that the release of sugary exudation from immature nuts served as a predisposing factor to invasion by the above fungi. It was also observed that insect *Atopmyrmex* sp. which feed on the sugary exudate, help in disseminating the microorganisms. Infection of kernels by *A. niger* and *Rhizopus* sp. resulted in 8% damage (Anon., 1960). The fungi *Nematospora* sp. penetrate into the kernel and cause sunken dark spots which lower the market value of nuts (Agnoloni and Giuliani, 1977). Since injuries made by insects predispose the nuts to such infection, insecticide treatment as well as avoiding mechanical injuries while harvesting and drying were suggested by these authors to control the fungi.

Storage diseases may be due to imperfect drying or poor storage. Krishnaswamy *et al.*, (1973) reported contamination of cashew kernels with *Escherichia coli*, *Salmonella* sp. and *Clostridium* sp. in Kerala and Tamil Nadu. The extent and type of contamination depend on the level of sanitation in the processing units. Raw nuts were much more contaminated than the processed ones. Okwelogu and Mackay (1969) found that cashew-nuts are infected by *Aspergillus* sp., *Fusarium* sp., *Paecilomyces* sp., *Penicillium* sp. and *Rhizopus* sp. at 27°C when relative humidity is above 75%.

A "sudden death" disease was first recorded in Tanzania and is supposed to be caused by *Valsa eugeniae* Nutman and Roberts (Wallace and Wallace, 1955; Westergaard and Kayumbo, 1970). The other possible causative agents suggested are bacteria, virus, mineral deficiency, fungi like *Botryodiplodia theobromae* etc. The affected trees show foliar yellowing, defoliation and quick death. No definite control measures are known.

In Maharashtra, Sathe and Srinivasulu (1971) recorded *Diatrypella indica* from dried stems of cashew.

In addition to fungi, diseases due to bacteria and nutritional deficiencies are also known to affect cashew. In Brazil, Robbs (1954) recorded a bacterium, *Pseudomonas mangiferae* occurring in cashew. Lefebvre (1973) reported a little leaf disease in cashew characterised by small, narrow, rolled leathery leaves which in extreme cases become needle like. He attributed this to Zinc deficiency and found that application of Zn to the soil or by foliar spray alleviated the symptoms. Adams *et al.*, (1971) opined that leaf necrosis observed in the Kenya coast was probably due to iron deficiency as they found that in pot culture studies application of iron chelates eliminated the necrosis. Symptoms due to deficiencies of N, P, K, Ca, Mg and S in young cashew plants grown in nutrient solutions were described by Avilan and Brasil Sob (1976).

APPENDIX 7.1. Fungi, alga and bacteria recorded on cashew

Name of the fungi/alga/bacteria	Reference
FUNGI	
<i>Aspergillus flavus</i> LK. ex. Fr.	Esuruoso, 1974
<i>A. niger</i> van Tieghem	Esuruoso, 1974
<i>A. tamarii</i> Kita.	Esuruoso, 1974
	Olunloyo, 1978
<i>Asterina carbonacea</i> Cooke	Polanco, 1973
<i>Botryodiplodia theobromae</i> Pat.	Olunloyo, 1975
(<i>Lasiodiplodia</i>	Wallace and Wallace, 1955
<i>theobromae</i> (Pat.) Gr. & M.)	Olunloyo and Esuruoso 1955
<i>Capnodium</i> sp.	Anon., 1960
<i>Ceratocystis</i> sp.	Author's observation (Unpublished)
<i>Cercospora anacardii</i>	Golato, 1970

- Cicinnobolus cesatii* de Bary
Cladosporium sp.
Colletotrichum gloeosporioides Penzig.

Corticium salmonicolor B. & Br.
(*Pellicularia salmonicolor* (B. & Br.) Dastur)
Cylindrocladium quinqueseptatum
Boed. & Reit.
C. scoparium Morg.
Cytonema sp. (*Valsa eugeniae* Nut-
man and Roberts)
Dendrodochium paraense
Diatrypella indica Sath. & Srin.
Diplodia natalensis Evans.
Diplodium anacardiacearum Bat.
& Covalcante

Fusarium sp.
F. udum (Berk.) Woll.
(*Gibberella bacata*)
Ganoderma lucidum (Leys.) Karst
Gibberella bacata
(*Fusarium udum* (Berk.) Woll.)
Gliocladium sp.
Gloeosporium mangiferae P. Henn.
Glomerella cingulata (St.) Sp. & Schr.
Lasiodiplodia theobromae (Pat.) Gr. & M.

Melanospora sp.
Meliola anacardiacearum (St.) Hans.
Nematospora coryli Peg.
N. gossypii Ash & Now.
Oidium anacardii Noach

Oidium sp.
Paecilomyces sp.
Pellicularia salmonicolor (B. & Br.) Dastur

Aquino and Camelo, 1971
Rangswamy *et al.*, 1970
Singh *et al.*: 1967 Santos, 1968
Cordoba, 1967 Morton, 1961
Anon., 1960
Browne, 1968, Morton, 1961
Sarma *et al.*, (Personal
communication)
Susamma Philip, 1973
Wallace and Wallace, 1955
Westergaard and Kayumbo, 1970.
Ludowijk, 1927
Sathe & Srinivasulu, 1971
Medeiros, 1951
Aquino and Melo, 1974
Castro *et al.*, 1977; Anon., 1972
Ludowijk, 1927.
Anon., 1972
Browne, 1968
Okwelogu and Mackay, 1969
Bohlen, 1973
Browne, 1968
Okwelogu and Mackay, 1969
Esuruoso, 1974
Anon., 1960
Polanco, 1973
Olunloyo and Esuruoso, 1975
Olunloyo, 1978
Anon., 1972
Ohler, 1977
Golato, 1970
Golato, 1970
Aquino and Camelo, 1971
Julio da Ponte, 1971
Calzavara, 1970
Phadnis and Elijah, 1968
Okwelogu and Mackay, 1969
Anon., 1960, Browne, 1868,
Morton, 1964

- Penicillium* sp. Okwelogu and Mackay, 1969
P. citrinum Sopp. Olunloyo, 1978
Pestalotia conglomerata Polanco, 1973
P. dictaeta Speg. Anon., 1960
P. microspora Speg. Guba, 1961
P. paeoniae Olunloyo, 1975
Phomatospora anacardicola Bat. Batista, 1957
Phomopsis anacardii Earl. Anon., 1960 Early,
& Punith. and Punithalingam, 1962.
Phyllosticta anacardicola Batista and Vital, 1952
Phyllosticta sp. Anon, 1960
Phytophthora nicotianae var. Thankamma, 1974
nicotianae Van. Breda de Hann Kumararaj and Bhide, 1972
P. palmivora Butl., Ramakrishnan, 1955
Pythium spinosum Sawada Olunloyo, 1976
P. ultimum Trow. Esuruoso, 1974
Rhizopus nigricans Ehrenb. Anon., 1960
Rhizopus sp. Browne, 1968
Sclerotium rolfsii Sacc. Polanco, 1973

Valsa eugeniae Nutman and Roberts Wallace and Wallace, 1955
Westergaard and Kayumbo, 1970

ALGA

- Cephaleuros mycoides* Karst.
(= *C. virescens* Kze.) Anon, 1960; Golato, 1970
(= *C. parasiticus*) Ludowijk, 1927.

BACTERIA

- Clostridium* sp. Krishnaswamy *et. al.*, 1973
Escherichia coli (Migula) Cast. Krishnaswamy *et al.*, 1973
and Chalm. Robbs, 1954
Pseudomonas mangifera Krishnaswamy *et. al.*, 1973
Salmonella sp.