Diseases of Cultivated Crops in Pacific Island Countries

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South Pacific Commission
Noumea, New Caledonia
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Contents

This book is dedicated to the memory of Ivor Firman, former SPC Plant Protection Officer, who spent most of his working life in the Pacific. He is remembered not only for his contribution to our knowledge of plant diseases in the Pacific and their control, but also for the wit and good humour with which he carried out his work.

Foreword

In 1992, the Institut Français de Recherche Scientifique pour le Développement en Coopération (ORSTOM) published *Pathologie des végétaux cultivés*, a manual on plant diseases of New Caledonia, French Polynesia, and Wallis and Futuna. The authors, Franz Kohler and Frédéric Pellegrin, realising that many of the diseases in these three territories were common to other Pacific Island countries, proposed an English version. The South Pacific Commission welcomed this idea and sought financial support for the project from the Australian Centre for International Agricultural Research, Canberra. This was generously provided.

The purpose of the manual is to assist extension personnel and farmers in the identification of important plant diseases in their countries and to give them information on options for control. It is hoped, too, that the manual will have a place in schools. It could provide a useful reference for crop protection in the agriculture curriculum, assisting in disease recognition and control measures using both traditional and modern techniques.

It is realised that for many growers in Pacific Island countries, control options are limited. Pesticides are often difficult to obtain, are costly, and, in many small islands and atolls, environmental concerns may preclude their use. For these reasons the manual emphasises cultural controls and the use of plant varieties tolerant to disease.

In order for the English edition of the manual to be relevant to all the countries and territories of the region served by the South Pacific Commission, some 70 extra diseases, in addition to those of the French version, are described and illustrated and methods are prescribed for their control.

Many scientists, both those working in the region and those in countries outside, have contributed photographs from their personal collections, and are thanked for their generosity. These include John Bridge, International Institute for Parasitology; Richard Davis, Australian Quarantine Inspection Service, Mike Ivory, University of Oxford; Leon Mu, Service de l'économie rurale, Papeete; Mike Pearson, University of Auckland; Semisi Pone, South Pacific Commission; Chris Prior, International Institute of Biological Control; Brian Thistleton, South Pacific Commission; John Randles, University of Adelaide; John Thomas, Department of Primary Industries, Queensland; Fauoro Vilsoni, Koronivia Research Station; George Wall, University of Guam; and Bill Zettler, University of Florida. Photographs were also kindly provided by staff of the Bureau of Sugar Experiment Stations, Queensland.

Many of the photographs have appeared previously in three plant disease publications. On pages 9, 15, 17,19, 21, 25, 27, 31, 51, 53, 55, 63, 115 and 137 certain of the photographs are from *Plant diseases of Western Samoa* by Wolfgang Gerlach, published by Deutsche

Gesellschaft für Technische Zusammenarbeit (GTZ) GmbH. And some of those photographs on pages 7, 9, 15, 19, 21, 31, 37, 63, 65, 73, 85, 87, 89, 91, 93, 103, 109, 111, 113, 117, 119, 121, 127, 133 and 151 have been provided by the Department of Primary Industries (DPI), Queensland from their books, *Diseases of fruit crops* and *Diseases of vegetable crops* published by the DPI, Queensland. The authors of these texts and the publishers are thanked for their generosity in sharing the photographs for use in this manual. In addition, we are grateful to Denis Persley and Tony Cooke for arranging the duplication of plant disease photographs from the collection maintained by DPI, and to Robin Palmer for taking photographs of plant diseases in Fiji.

Much more needs to be done to make this manual a comprehensive well-illustrated collection of important plant diseases of Pacific Island countries. Readers may find some diseases of interest are not included, and, for some that are present, the photographs could be improved. This is acknowledged, and the challenge now is to get the illustrations required. It is, therefore, hoped that readers will assist the South Pacific Commission by contributing photographs for future supplements to the manual. These will be published in the same format as well as on CD-ROM, and incorporated into the Pacific Plant Protection Information System.

Dr Bob Dun
Director-General
South Pacific Commission
Noumea, New Caledonia

Symptoms *and* treatments

Key to the Symptoms

Site of infection

R	Root
C	Collar
S,T	Stem, Trunk
L	Leaf
Fl	Flower
Fr	Fruit

Importance of the disease

√	Minor
√√	Moderate
√√√	Severe

Control treatments : The number given for each disease coincides with control measures detailed on pages 153–177

ABELMOSCHUS ESCULENTUS

OKRA

MALVACEAE

Pseudocercospora abelmoschi

Leaf spot

Site of infection: L

Importance of the disease: √

Symptoms

Angular spots, mostly on mature leaves, at first yellowish on the upper leaf surface, later becoming brown. On the lower surface, the spots become covered with grey or brown fungal growth. Usually, the spread of the spots is restricted by the veins.
Bele, *A. manihot,* is also a host.

Treatment: **110**

ACACIA SPIRORBIS

WATTLE

MIMOSACEAE

Uromycladium tepperianum

Rust

Site of infection: L,Fr

Importance of the disease: √√

Symptoms

Large, hard, irregular knobs or galls, up to 150 mm across, formed within the 'leaves' (leaf-like petioles) and fruits. The galls are light brown when young and spore-producing, becoming dull brown with age. In severe attacks, the trees may be full of galls, and made weak by the reduced leaf canopy. Seed production may be affected.
Several *Acacia* spp. are hosts.
Another rust, *Uromyces phyllodiorum*, occurs on *Acacia* spp. The spore-producing pustules are light brown and occur in groups, deforming the pods and flowers.

Treatment: **144**

ACTINIDIA DELICIOSA

KIWI FRUIT

ACTINIDIACEAE

Glomerella cingulata
=Colletotrichum gloeosporioides

Anthracnose

Site of infection: L

Importance of the disease: √√

Symptoms

Light brown leaf spots, without clear margins, merging as they age and affecting a large part of the leaf blade, giving a scorched appearance. Leaf stalks are seldom attacked.
Kiwi fruit is a recent introduction into the Pacific Islands and, as yet, has not been planted widely. *Colletotrichum*, however, has the potential to cause a serious problem on this crop. Many other plants are hosts, including avocado, coffee, eggplant, mango, papaya, sweet pepper, tomato and yams.

Treatment: **62**

Photo: Eric McKenzie

Photo: Eric McKenzie

Pseudocercospora abelmoschi

Photo: Kohler Collection

Photo: Kohler Collection

Uromycladium tepperianum

Photo: Kohler Collection

Glomerella cingulata

AGATHIS SPP.

KAURI

ARAUCARIACEAE

Aecidium fragiforme

Rust

Site of infection: L

Importance of the disease: √

Symptoms

Raised galls, 5 mm high, on the upper leaf surface, up to 15 mm diam. The corresponding lower leaf surface is often depressed. White to yellow pustules are formed within the galls. The galls are more common on younger plants, sometimes causing defoliation.

Treatment: **2**

AGATHIS SPP.

KAURI

ARAUCARIACEAE

Glomerella cingulata
=Colletotrichum gloeosporioides

Anthracnose

Site of infection: L,S

Importance of the disease: √

Symptoms

The disease is mostly a problem on seedlings in the nursery, where it can cause substantial leaf fall, weakening and even killing the plants. Many other plants are hosts, including avocado, coffee, eggplant, mango, papaya, sweet pepper, tomato and yams.

Treatment: **62**

ALLIUM CEPA

ONION

ALLIACEAE

Colletotrichum circinans

Smudge

Site of infection: L

Importance of the disease: √

Symptoms

Small, round, dark blotches on the bulb and zonate patterns on the outer scale leaves, particularly on white-skinned varieties.

Treatment: **34**

Photo: Kohler Collection

Photo: Kohler Collection

Aecidium fragiforme

Photo: Kohler Collection

Glomerella cingulata

Photo: DPI Collection

Colletotrichum circinans

ALLIUM PORRUM

LEEK

ALLIACEAE

Alternaria porri

Purple blotch

Site of infection: L

Importance of the disease: √√

Symptoms

Small, white spots on the leaves, spreading under moist conditions into large oval purple lesions with yellowish borders, up to 150 mm long. Dark fungal growth containing spores of the fungus occurs at the centres of the lesions. Infection results in leaf-tip dieback, with the leaves drying out and collapsing after 3–4 weeks. A yellow to reddish watery rot may occur in the bulb.
Other *Allium* spp.—garlic, onion (lower photograph) and shallot—are hosts.

Treatment: **8**

ALLIUM SATIVUM

GARLIC

ALLIACEAE

Aspergillus niger

Mould

Site of infection: L

Importance of the disease: √

Symptoms

On garlic, a dry rot, associated with dark brown to black spore masses. On onion, (lower photograph), the fungus occurs on the outer scale leaves, especially along the veins, and may cause a neck rot.
Aspergillus niger is a common soil fungus. Spores are carried on the surface of the cloves, and cause rots if storage conditions are poor. Other plants are hosts, including coconut, maize and peanut.

Treatment: **10**

ALOCASIA MACRORRHIZOS

GIANT TARO

ARACEAE

Mycosphaerella alocasiae
=Cercospora colocasiae

Leaf spot

Site of infection: L

Importance of the disease:√

Symptoms

Small, round or irregular spots with grey centres and brown margins, often with yellow haloes, up to 8 mm diam., but smaller on heavily infected leaves. Fungal fruiting bodies are often visible on the upper leaf surface as small black dots. The spots are usually only present on the older leaves.

Treatment: **81**

Photo: Kohler Collection

Photo:Wolfgang Gerlach

Alternaria porri

Photo: Kohler Collection

Photo: DPI Collection

Aspergillus niger

Photo: Eric McKenzie

Mycosphaerella alocasiae

ANANAS COMOSUS

PINEAPPLE

BROMELIACEAE

Ceratocystis paradoxa
=Chalara paradoxa

Water blister and soft rot

Site of infection: Fr

Importance of the disease: √√

Symptoms

Soft, watery fruit rot at first, leaving the brittle outer shell intact. Later, the skin, flesh and core break down and the fruit leaks through the shell. The rots are often associated with wounds. On the leaves, long (up to 200 mm), cream to white papery spots form with brown margins. A soft, grey to black butt rot may also occur after planting, creating a cavity at the base of the stem and resulting in stunting or death.
Other species are also hosts: banana (crown rot of fruit bunches), coconut (stem bleeding), sugarcane cuttings (pineapple disease).

Treatment: **24**

ANNONA SQUAMOSA

SUGAR APPLE/SWEETSOP

ANNONACEAE

Glomerella cingulata
=Colletotrichum gloeosporioides

Anthracnose

Site of infection: L

Importance of the disease: √

Symptoms

Brown areas of rot, spreading along the veins and leading to total infection of the leaf. Occasionally, the fungus causes partial or severe defoliation.
Many other plants are hosts, including avocado, coffee, eggplant, mango, papaya, sweet pepper, tomato and yams.

Treatment: **62**

ANTHURIUM ANDREANUM

ANTHURIUM

ARACEAE

Glomerella cingulata
=Colletotrichum gloeosporioides

Anthracnose

Site of infection: L,S

Importance of the disease: √

Symptoms

Round black spots with yellow margins on the leaves, especially at the margins. The centres of the spots may fall out as they enlarge. The disease is important on plants grown under shade or in screenhouses, as it spoils the appearance of this ornamental plant.
Many other plants are hosts, including avocado, coffee, eggplant, mango, papaya, sweet pepper, tomato and yams.

Treatment: **62**

Photo: Kohler Collection

Ceratocystis paradoxa

Photo: Kohler Collection

Glomerella cingulata

Photo: Kohler Collection

Glomerella cingulata

ANTHURIUM ANDREANUM

ANTHURIUM

ARACEAE

Fusarium oxysporum

Root and collar rot

Site of infection: S,C,R

Importance of the disease: √√

Symptoms

Decay of the collar region and roots causes plants to wilt. In the screenhouse, the disease is rapidly spread in water used for irrigation.

Treatment: **55**

APIUM GRAVEOLENS

CELERY

APIACEAE

Glomerella cingulata
=Colletotrichum gloeosporioides

Anthracnose

Site of infection: L,S

Importance of the disease: √√

Symptoms

Dark brown areas of rot rapidly spreading through the leaf blades and stalks. The fungus is capable of destroying the entire base of the celery plant.
Many other plants are hosts, including avocado, coffee, eggplant, mango, papaya, sweet pepper, tomato and yams.

Treatment: **62**

APIUM GRAVEOLENS

CELERY

APIACEAE

Physiological disorder

Brown heart

Site of infection: L,S

Importance of the disease: √√

Symptoms

A black wet rot of the leaf base and apical bud associated with boron deficiency. The necrotic tissues are often invaded by opportunistic bacteria and fungi which cause further decay.

Treatment: **19**

Photo: Kohler Collection

Fusarium oxysporum

Photo: Kohler Collection

Glomerella cingulata

Photo: Kohler Collection

Physiological disorder (Brown heart)

ARACHIS HYPOGAEA

PEANUT

FABACEAE

Athelia rolfsii
=Sclerotium rolfsii

Basal rot

Site of infection: S,R

Importance of the disease: √√

Symptoms

Initially, a wilt of a single leaf or branch, rapidly followed by a wilt of the entire plant. The base of the stem becomes covered in white fungal growth in which small, 1–2 mm diam., sclerotia develop. These are at first white and later light brown as they mature. During warm wet weather the fungus spreads from plant to plant.
A wide range of cultivated plants and weeds are hosts, including beans, carrot, cucurbits, sweet pepper, sweet potato, taro and tomato.

Treatment: **11**

ARACHIS HYPOGAEA

PEANUT

FABACEAE

Mycosphaerella berkeleyi
=Cercosporidium personatum

Late leaf spot

Site of infection: L

Importance of the disease: √√

Symptoms

Light to dark brown spots, 1–10 mm diam., with or without a yellow halo. Spore masses of the fungus form on the lower leaf surface.
Early leaf spot, caused by *M. arachidis*, also commonly occurs. The yellow halo may be more noticeable, and spores develop on the upper leaf surface. The two may be present together on the same leaf. Because symptoms are similar, microscopic examination is required to separate the species.

Treatment: **82**

ARACHIS HYPOGAEA

PEANUT

FABACEAE

Puccinia arachidis

Rust

Site of infection: L

Importance of the disease: √√

Symptoms

Brown pustules on the under surface of the leaf, often with a yellow halo. The leaves turn yellow, dry out and fall.

Treatment: **117**

Photo: DPI Collection

Photo: Mike Pearson

Photo:Wolfgang Gerlach

Photo:Wolfgang Gerlach

Athelia rolfsii

Photo:Wolfgang Gerlach

Mycosphaerella berkeleyi

Photo: Eric McKenzie

Puccinia arachidis

ARANDA SP.

ARANDA ORCHID

ORCHIDACEAE

Glomerella cingulata
=Colletotrichum gloeosporioides

Anthracnose

Site of infection: L,S

Importance of the disease: √

Symptoms

Large, oval, rapidly expanding spots with broad water-soaked margins on the leaves. In severe attacks, plants may become defoliated and even killed. Fungal fruiting bodies develop in concentric rings, producing pink spore masses and sometimes small black structures containing the sexual stage of the fungus.
The same symptoms occur on species of *Cattleya*, and a severe disease also occurs on vanilla.
Many other plants are hosts, including avocado, coffee, eggplant, mango, papaya, sweet pepper, tomato and yams.

Treatment: **62**

ARTOCARPUS ALTILIS

BREADFRUIT

MORACEAE

Lasiodiplodia theobromae
=Botryodiplodia theobromae

Collar rot

Site of infection: T,C

Importance of the disease: √

Symptoms

Dry rot of the collar and trunk associated with external white strands of the fungus. Beneath the bark, the wood shows white patches with dark brown margins.
This disease has only been recorded on plants from Wallis and Futuna held in quarantine.
Many other plants are hosts, including banana (post-harvest crown and fingertip rot); passionfruit (associated with collar rot); cocoa (associatcd with *Phytophthora* pod rot); and papaya (fruit and stem rot).

Treatment: **71**

ARTOCARPUS ALTILIS

BREADFRUIT

MORACEAE

Phellinus noxius

Brown root and collar rot

Site of infection: T,C,R

Importance of the disease: √√

Symptoms

A brown crust, sometimes with a white margin, up to 1 m, on the base of the trunk. The wood beneath the crust turns brown. Roots are covered with the same crust; characteristically soil particles are attached, giving the root a rough appearance. As the crust develops on the outside of the tree, branches begin to die back, leaves and fruits fall, and eventually the entire tree dies.
Many other trees are hosts, including cocoa, coffee, *Leucaena,* mango, oil palm and forest trees (*Eucalyptus* spp.—lower photograph).

Treatment: **100**

Photo: Kohler Collection

Photo: Kohler Collection

Glomerella cingulata

Photo: Kohler Collection

Lasiodiplodia theobromae

Photo: Grahame Jackson

Photo: Wolfgang Gerlach

Phellinus noxius

ARTOCARPUS ALTILIS

BREADFRUIT

MORACEAE

Phytophthora palmivora

Fruit rot

Site of infection: Fr

Importance of the disease: √√

Symptoms

Spots at first brown, rapidly enlarging, up to 100 mm diam., round and covered with white fungal growth. There may be several spots on the same fruit. The lower fruit are often first to be infected. Infected fruit drop from the tree.
Many other species are hosts, including black pepper, cocoa, papaya and vanilla.

Treatment: **104**

BRASSICA CHINENSIS

CHINESE CABBAGE

BRASSICACEAE

Albugo candida

White blister rust

Site of infection: L

Importance of the disease: √√

Symptoms

Raised circular, sometimes concentric, yellow-green spots on the upper leaf surface; below, the spots rupture exposing white, powdery spore masses. The leaves may be deformed.
The fungus has little effect on yield, but the unsightly appearance of the leaves affects market value.
Other crucifers are hosts, including radish.

Treatment: **3**

BRASSICA OLERACEA VAR. *CAPITATA*

CABBAGE

BRASSICACEAE

Alternaria brassicicola

Leaf spot

Site of infection: L

Importance of the disease: √√

Symptoms

Brown or black leaf spots, circular or irregular, sometimes concentric, and mostly between the veins. Under favourable conditions, the spots merge, causing the leaf to dry out and appear scorched.
The fungus is common on leaves following attack by leaf scald, caused by the bacterium, *Xanthomonas campestris* pv. *campestris*.
Similar symptoms result from infection by *A. brassicae*, the cause of grey leaf spot, except that they are lighter in colour. They also occur on the fruits and stalks.

Treatment: **6**

Photo: Wolfgang Gerlach

Phytophthora palmivora

Photo: Kohler Collection

Photo: DPI Collection

Albugo candida

Photo: Wolfgang Gerlach

Photo: DPI Collection

Alternaria brassicicola

BRASSICA OLERACEA VAR. *CAPITATA*

CABBAGE

BRASSICACEAE

Peronospora parasitica

Downy mildew

Site of infection: L

Importance of the disease: √√√

Symptoms

On the upper leaf surface, yellow to pale brown spots which develop rapidly under favourable, wet conditions, into large irregular patches. These turn brown and papery in dry weather. White fungal growth is abundant on the under surface of the leaf. Older leaves may have a speckled appearance.
Other crucifers are hosts, including broccoli and cauliflower.

Treatment: **95**

BRASSICA OLERACEA VAR. *CAPITATA*

CABBAGE

BRASSICACEAE

Thanatephorus cucumeris
=Rhizoctonia solani

Damping-off, Leaf rot, Web blight

Site of infection: L,S,R

Importance of the disease: √√

Symptoms

A variety of symptoms, depending on time of infection. Seedlings are attacked at soil level, resulting in pre- and post-emergence damping-off. Older plants may show basal rots, and leaves may develop large white, grey or pale brown areas of decay. The fungus forms webs which are often visible in the early morning over the areas of rot, spreading over the healthy parts of the leaf, or between leaves, joining them together.
Many other plants are hosts, including other species of cabbage, lettuce, legumes, grasses, potato, tomato and yams.

Treatment: **135**

BRASSICA OLERACEA VAR. *CAPITATA*

CABBAGE

BRASSICACEAE

Erwinia spp.

Bacterial soft rots

Site of infection: L,C

Importance of the disease: √√

Symptoms

A watery soft rot at the base of the plant, followed by a wilt of the outer leaves. Rots are particularly serious after harvest, rapidly expanding, covered in bacterial slime and foul-smelling.
Many other plants are hosts: carrot, celery, Chinese cabbage (lower photograph), cucumber, lettuce, potato and sweet pepper.

Treatment: **53**

Photo: Kohler Collection

Photo: Eric McKenzie

Photo: DPI Collection

Photo: DPI Collection

Peronospora parasitica

Photo: Eric McKenzie

Thanatephorus cucumeris

Photo: Wolfgang Gerlach

Erwinia spp.

CANNA INDICA

CANNA

CANNACEAE

Puccinia thaliae
=Puccinia cannae

Rust

Site of infection: L

Importance of the disease: √√

Symptoms

Orange powdery pustules on the lower leaf surface surrounded by a yellow halo. In severe cases of attack, the leaves yellow and wither prematurely and plants lose their ornamental quality.
Another rust, *Uredo pseudocannae,* also infects this host. Pustules occur on the lower leaf surface, associated with diffuse brown blotches. Large areas of the leaf may be affected.

Treatment: **118**

CAPSICUM ANNUUM

SWEET PEPPER

SOLANACEAE

Cercospora capsici

Frog-eye leaf spot

Site of infection: L,Fr

Importance of the disease: √√

Symptoms

Concentric leaf spots, white in the centre with brown margins, up to 10 mm diam. Often the centre of the lesion falls out. Spores form on the under surface of the leaf. Infection results in premature leaf fall. The fungus also causes a stem-end rot of the fruit.
Chili is also a host.

Treatment: **25**

CAPSICUM ANNUUM

SWEET PEPPER

SOLANACEAE

Colletotrichum capsici

Anthracnose

Site of infection: L,S,Fr

Importance of the disease: √

Symptoms

Sunken, dirty grey to greenish-black spots, merging to cover large areas of the fruit. The centres of the rot may appear papery. Red spore masses are formed on the rot, especially during wet weather, oozing from fruiting bodies which often develop in concentric circles.
The disease usually occurs on the fruits when they begin to ripen. Leaves and shoots are also attacked.
Chili, eggplant and tomato are also hosts.

Treatment: **34**

Photo: Kohler Collection

Puccinia thaliae

Photo: Kohler Collection

Photo: Kohler Collection

Cercospora capsici

Photo: Kohler Collection

Photo: Kohler Collection

Colletotrichum capsici

CAPSICUM ANNUUM

SWEET PEPPER

SOLANACEAE

Fusarium oxysporum

Wilt

Site of infection: S,C,R

Importance of the disease: √

Symptoms

Plants wilt as the fungus invades the water-conducting tissues of the root and stem. Spore masses of the fungus sometimes occur on the decayed collar region at soil level.
Many other plants are host, including woody species, field crops, vegetables and ornamentals. More than one hundred specialised host-specific races exist.

Treatment: **55**

CAPSICUM ANNUUM

SWEET PEPPER

SOLANACEAE

Pseudomonas solanacearum

Bacterial wilt

Site of infection: S,R

Importance of the disease: √√

Symptoms

Leaves wilt, especially during the hottest part of the day, roots show decay and vascular tissues are brown. A cream-coloured bacterial slime oozes from the cut ends of the stems when these are placed in water. Plants may show a slow dieback rather than a sudden wilt of the foliage.
Many other plants are hosts, including eggplant, peanut, potato and tomato.

Treatment: **115**

CARICA PAPAYA

PAPAYA

CARICACEAE

Corynespora cassiicola

Leaf spot

Site of infection: L,Fr

Importance of the disease: √

Symptoms

Circular spots, up to 5 mm diam., light brown or grey, sometimes with yellow haloes. The spots appear first on the lower leaves and gradually spread upwards. As the spots age, the centres fall out, giving a characteristic shot-hole effect. On leaf stalks, the spots are more elliptical and are covered with dark spore masses. Infection may cause premature leaf fall. Spots occasionally occur on the fruit; they are small, dark and sunken. On some hermaphrodite trees, fruits appear healthy, but the seed cavity becomes totally colonised. The fungus can damp off seedlings.
The fungus is probably a secondary invader of rotting fruits of papaya and tomato.

Treatment: **42**

Photo: Kohler Collection

Photo: Kohler Collection

Fusarium oxysporum

Photo: Wolfgang Gerlach

Pseudomonas solanacearum

Photo: Eric McKenzie

Photo: George Wall

Corynespora cassiicola

CARICA PAPAYA

PAPAYA

CARICACEAE

Glomerella cingulata
=Colletotrichum gloeosporioides

Anthracnose

Site of infection: L,Fr

Importance of the disease: √√

Symptoms

Sunken brown spots developing into large lesions as fruits ripen. If the humidity is high, pink spore masses are produced on the corrugated surfaces of the lesions. Fruits drop prematurely, and leaves fall due to infections at the base of the petioles. On fruits, infections occur while the fruits are still green.
Many other plants are hosts, including avocado, coffee, eggplant, mango, sweet pepper, tomato and yams.

Treatment: **62**

CARICA PAPAYA

PAPAYA

CARICACEAE

Phytophthora nicotianae var. *parasitica*
=Phytophthora parasitica

Fruit rot

Site of infection: Fr,S,R

Importance of the disease: √

Symptoms

Water-soaked spots on mature fruits, spreading rapidly and developing a white fungal crust. Rots on the fruits may start from stem-end cankers while the fruit is still green. Infected fruits shrivel, blacken and fall. Lesions on the stems can girdle them, causing the leaves above to turn yellow and fall. Infection of the roots causes a general yellowing and collapse of the leaves. Similar symptoms occur from infection by *P. palmivora* (lower photograph).

Treatment: **105**

CARICA PAPAYA

PAPAYA

CARICACEAE

Sphaerotheca fuliginea
=Oidium sp.

Powdery mildew

Site of infection: L,T

Importance of the disease: √

Symptoms

Superficial white growth of the fungus on both surfaces of young leaves, causing light yellow to green patches. The growth is often dense on the leaf stalks, and is also present on the stems and flower buds. Leaves may die prematurely.
Only the *Oidium* or conidial form is known from the Pacific Islands.
Many species of cucurbit are hosts, as well as legumes and members of the Compositae.

Treatment: **130**

Photo: Kohler Collection

Glomerella cingulata

Photo: Kohler Collection

Photo: Wolfgang Gerlach

Phytophthora nicotianae var. *parasitica*

Photo: Kohler Collection

Sphaerotheca fuliginea

CARICA PAPAYA

PAPAYA

CARICACEAE

Papaya ringspot potyvirus

Mosaic

Site of infection: L,Fr

Importance of the disease: √√√

Symptoms

Symptoms vary depending on the stage of infection, plant vigour, temperature and strain of the virus. Seedlings show yellowing of the leaf veins, mottling and distortions; leaves of older plants are mottled and distorted; dark green streaks occur on the stems and leaf stalks; and ringspots develop on the fruits. Plants may be stunted, with fewer fruits than normal.
Cucurbits are hosts to some strains of the virus.

Treatment: **89**

CARICA PAPAYA

PAPAYA

CARICACEAE

Unknown

Dieback

Site of infection: L,S

Importance of the disease: √√√

Symptoms

Bunching of inner crown leaves, rapid yellowing of the larger leaves, bending of the growing point, and rapid death of the entire crown within 1–4 weeks. Any fruit which is present either falls off while still green or rots.

Treatment: **138**

CASUARINA EQUISETIFOLIA

SHE OAK, POLYNESIAN IRONWOOD

CASUARINACEAE

Ganoderma applanatum

Root and butt rot

Site of infection: T,C,R

Importance of the disease: √

Symptoms

The fungus spreads in the soil, causing a root and butt rot on susceptible species. Infected trees die back and are eventually killed. Spread to neighbouring trees is by root-to-root contact. Fructifications of the fungus occur on dead and living trunks and branches of standing and fallen trees.
The fungus occurs on a wide range of woody plants, causing a white heart rot.

Treatment: **60**

Photo: George Wall

Photo: Grahame Jackson

Papaya ringspot potyvirus

Photo: Kohler Collection

Unknown

Photo: Kohler Collection

Photo: Kohler Collection

Ganoderma applanatum

CHRYSANTHEMUM LEUCANTHEMUM

CHRYSANTHEMUM

ASTERACEAE

Uredo sp.

Rust

Site of infection: L

Importance of the disease: √

Symptoms

Spore-producing pustules on both sides of the leaves causing distortions. The leaves turn yellow and fall prematurely.
A disease of relatively recent occurrence in the region.

Treatment: **140**

CITRULLUS LANATUS

WATERMELON

CUCURBITACEAE

Colletotrichum orbiculare
=Colletotrichum lagenarium

Anthracnose

Site of infection: L,Fr

Importance of the disease: √√√

Symptoms

On the fruits, whitish-cream sunken spots with dark brown margins, mostly on the lower parts. The spots may merge and the centres split open. Pink to orange spore masses develop on the spots in wet weather. Secondary infections may develop, causing extensive decay. On the leaves, brown spots with yellow margins, later developing into large dark brown to black lesions which often merge.
An important fungus, more common in the wet season.

Treatment: **36**

CITRULLUS LANATUS

WATERMELON

CUCURBITACEAE

Didymella bryoniae
=Ascochyta cucumis

Gummy stem blight

Site of infection: L,Fr

Importance of the disease: √√√

Symptoms

On leaves, decay begins as a rot at the margins, with water-soaked lesions spreading rapidly throughout the leaf. Lesions develop on the stems, producing a characteristic gummy exudate, and may girdle them, causing premature death of the plant. Stem-end rots develop on fruits.
Other cucurbits are hosts, including melon (lower photograph).

Treatment: **47**

Photo: Kohler Collection

Uredo sp.

Photo: Kohler Collection

Photo: Kohler Collection

Colletotrichum orbiculare

Photo: Wolfgang Gerlach

Photo: DPI Collection

Didymella bryoniae

CITRULLUS LANATUS

WATERMELON

CUCURBITACEAE

Acidovorax avenae **subsp.** *citrulli*
=Pseudomonas pseudoalcaligenes

Watermelon fruit blotch

Site of infection: L,Fr

Importance of the disease: √√

Symptoms

Water-soaked spots on cotyledons, mature leaves and upper surface of the fruit. On the fruit, the oval to circular spots expand rapidly, covering most of the upper surface, but the infection remains superficial.

Treatment: **1**

CITRUS SPP.

CITRUS

RUTACEAE

Elsinoe fawcettii
=Sphaceloma fawcettii

Scab

Site of infection: L,S,Fr

Importance of the disease: √√

Symptoms

Small, corky, raised, grey to light brown scabs, up to 1 mm diam., on both leaf surfaces, especially along the veins. They also occur on the fruit and young stems. Leaves become puckered and stunted with torn margins and may fall prematurely. Small branches may be killed. Many species of citrus are hosts, including bush lemon, mandarin, sour orange and trifoliate orange.

Treatment: **50**

CITRUS SPP.

CITRUS

RUTACEAE

Glomerella cingulata
=Colletotrichum gloeosporioides

Anthracnose

Site of infection: S,C

Importance of the disease: √

Symptoms

A disease of seedlings or grafted plants in the nursery. Brown lesions girdle the young stems, rapidly killing the plants. Fruiting bodies occur on the lesions in large numbers.
Many other plants are hosts, including avocado, coffee, eggplant, mango, papaya, sweet pepper, tomato and yams.

Treatment: **62**

Photo: George Wall

Acidovorax avenae subsp. *citrulli*

Photo: Kohler Collection

Photo: Eric McKenzie

Elsinoe fawcettii

Photo: Kohler Collection

Glomerella cingulata

CITRUS SPP.

CITRUS

RUTACEAE

Capnodium citri

Sooty blotch

Site of infection: L,S

Importance of the disease: √

Symptoms

Leaves are covered by a black fungal crust which develops on exudates produced from scale insect infestations. The fungus does not penetrate the leaf surface, but it reduces photosynthesis and, because of this, the vigour of the trees may be reduced.

Treatment: **80**

CITRUS SPP.

CITRUS

RUTACEAE

Penicillium digitatum, P. italicum

Blue and green moulds

Site of infection: Fr

Importance of the disease: √

Symptoms

At first, small water-soaked areas on the fruits, enlarging rapidly to form rots several cm in diam. Spore masses develop, giving the moulds their characteristic colours—green (*P. digitatum*), and blue (*P. italicum*).
The diseases caused by these moulds mostly occur in storage.

Treatment: **92**

CITRUS SPP.

CITRUS

RUTACEAE

Phanerochaete salmonicolor
=Corticium salmonicolor

Pink disease

Site of infection: S,T

Importance of the disease: √

Symptoms

A stem pathogen causing dieback. A pink to salmon-coloured fungal crust forms on the bark, fading to light cream with age. As the branch is girdled, the foliage wilts and dies, cracks appear in the bark and these may exude gum.
Many other plants are hosts, including black pepper, cocoa, coffee, rubber, tea, and some forest trees.

Treatment: **98**

Photo: Kohler Collection

Capnodium citri

Photo: Kohler Collection

Photo: Kohler Collection

Penicillium digitatum, P. italicum

Photo: Kohler Collection

Phanerochaete salmonicolor

CITRUS SPP.

CITRUS

RUTACEAE

Phytophthora nicotianae* var. *parasitica
=Phytophthora parasitica

Root and collar rot

Site of infection: T,C,R

Importance of the disease: √√√

Symptoms

Dark water-soaked areas at the collar, often with gum seeping through cracks in the bark. Beneath the bark, light brown areas of rot are present, often with clear boundaries separating diseased and healthy tissues. Infection usually progresses from discoloured and decayed roots to the trunk, although infection can also occur through wounds. As root and collar rots progress, leaves yellow, wither and fall, and branches die back. Initially, the symptoms may be more obvious on one side of the tree, corresponding to the part of the root system with most damage; later, the entire tree may wither and die.

Treatment: **105**

CITRUS SPP.

CITRUS

RUTACEAE

Xanthomonas campestris* pv. *citri

Citrus canker

Site of infection: L,Fr

Importance of the disease: √√√

Symptoms

Raised corky-brown spots on the leaves, surrounded by bright yellow haloes. On the fruit, the spots often merge and develop deep cracks. Infected fruit and leaves may fall. The disease reduces the market value of the fruit. It is a disease of major quarantine importance.

Treatment: **151**

COCOS NUCIFERA

COCONUT

ARECACEAE

Aspergillus flavus

Copra mould

Site of infection: Fr

Importance of the disease: √

Symptoms

The fungus grows on stored copra that has not been dried properly, turning it to a yellowish green, the colour of the spores of the fungus. The mould produces a highly carcinogenic toxin known as aflatoxin and, because of this, affected copra cannot be used for industrial or human use.
Other plants are hosts, including onion, maize and peanut.

Treatment: **9**

Photo: DPI Collection

Photo: Kohler Collection

Phytophthora nicotianae var. *parasitica*

Photo: Fauoro Vilsoni

Photo: Eric McKenzie

Xanthomonas campestris pv. *citri*

Photo: Kohler Collection

Aspergillus flavus

COCOS NUCIFERA

COCONUT

ARECACEAE

Bipolaris incurvata
=Drechslera incurvata

Seedling blight

Site of infection: L

Importance of the disease: √√

Symptoms

Leaf spots at first small, oval, brown; later, enlarging to 15 mm, light brown in the middle with a broad dark margin. In severe attacks, the fronds dry out and die prematurely. Brown fungal spore masses occur on the under surfaces of the leaves. The disease can be extremely serious in coconut nurseries, but symptoms are rare on palms in the field.

Treatment: **15**

COCOS NUCIFERA

COCONUT

ARECACEAE

Corticium penicillatum

Thread blight

Site of infection: L

Importance of the disease: √

Symptoms

White fungal threads appear on the underside of the leaflets and midrib. The affected parts of the leaves become necrotic and dry. Occasionally, entire fronds are attacked, and these die and fall prematurely. The disease is more severe under shaded conditions.

Treatment: **41**

COCOS NUCIFERA

COCONUT

ARECACEAE

Marasmiellus albofuscus

Trunk rot

Site of infection: T

Importance of the disease: √

Symptoms

Associated with brown rots on the trunk of mature trees. Rots grow into the trunk from the base of old fronds. They are often extensive, with pockets of white fungal growth. Small white mushrooms grow from the decayed fronds and also on weeds and legume ground covers. The fungus has also been found on non-germinating seednuts.

Treatment: **76**

Photo: Kohler Collection

Photo: Kohler Collection

Photo: Grahame Jackson

Photo: Eric McKenzie

Bipolaris incurvata

Photo: Kohler Collection

Corticium penicillatum

Photo: Grahame Jackson

Marasmiellus albofuscus

COCOS NUCIFERA

COCONUT

ARECACEAE

Marasmiellus cocophilus

Basal rot

Site of infection: L,S

Importance of the disease: √√

Symptoms

On seedlings, outer leaves die prematurely, as brown rots, associated with thick fungal growth, attack the leaf bases. Younger leaves are successively colonised and plants may snap at the junction of the stem and nut. Roots decay as they penetrate the leaf bases. Rots extending into the bole develop a reddish-brown margin. Where root damage is extensive, seedlings develop a little-leaf symptom when field-planted, but recover and grow normally.
This disease has only been recorded from Solomon Islands. The fungus is also known from East Africa, where it has been associated with a lethal bole rot.
Many grasses are hosts, including *Cynodon dactylon*, *Echinochloa colona* and *Eleusine indica*.

Treatment: **77**

COCOS NUCIFERA

COCONUT

ARECACEAE

Marasmiellus inoderma

Embryo rot, Basal shoot rot

Site of infection: L,Fr,S

Importance of the disease: √√

Symptoms

The fungus colonises the shoot as seed-nuts germinate. Early infection destroys the embryo, leading to invasion of the nut cavity and the development of a pinkish-white fungal growth over the endosperm. Secondary rots which are soft and foul-smelling may develop. Where shoots survive early infection, brown rots may develop at the base of the leaves and stems, and these are often associated with large amounts of white fungal growth. Usually, seedlings outgrow this attack, but growth may be slow, or the plants may be killed if growing conditions are poor. Mushrooms form on the nuts and at the base of the seedlings.
Banana (stem rot), maize and rice (root rot and wilt) and taro (shallow corm rot) are also hosts.

Treatment: **78**

COCOS NUCIFERA

COCONUT

ARECACEAE

Pestalotiopsis palmarum

Grey leaf spot

Site of infection: L

Importance of the disease: √

Symptoms

Leaf spots oval, up to 15 mm long, grey with dark brown borders, and sometimes with yellow haloes. Spots may merge. Fungal fruiting structures occur as black dots within the spots, especially on the upper leaf surfaces.
Other palms are hosts, including betel nut and oil palm.

Treatment: **96**

Photo: Grahame Jackson

Photo: Eric McKenzie

Photo: Eric McKenzie

Photo: Grahame Jackson

Marasmiellus cocophilus

Photo: Kohler Collection

Marasmiellus inoderma

Photo: Kohler Collection

Pestalotiopsis palmarum

COCOS NUCIFERA

COCONUT

ARECACEAE

Phytophthora heveae

Bud and nut rot

Site of infection: L,Fr

Importance of the disease: √

Symptoms

A lethal wet bud rot of mature palms. Symptoms on mature palms are similar to those caused by *P. palmivora*. Nuts are also attacked; if infections occur at the point of attachment to the flower stalk it may lead to premature nutfall.

Treatment: **104**

COCOS NUCIFERA

COCONUT

ARECACEAE

Phytophthora palmivora

Bud rot

Site of infection: L

Importance of the disease: √√

Symptoms

Infections at the base of the youngest leaves, killing them and spreading outwards, causing older leaves to wilt. Seedlings commonly die from the attack, but some may recover, producing a little-leaf symptom. On mature palms, the disease often follows cyclone damage. Early symptoms are sometimes difficult to detect and only apparent when bud rot has caused almost complete destruction of the shoot. Many other species are hosts, including black pepper, breadfruit, cocoa, papaya and vanilla.

Treatment: **104**

COCOS NUCIFERA

COCONUT

ARECACEAE

Pseudoepicoccum cocos

Brown leaf spot

Site of infection: L

Importance of the disease: √

Symptoms

Oval spots, up to 10 mm long and 4 mm wide, usually smaller, sometimes with pale centres and darker margins on upper leaf surfaces. Black powdery spore masses develop on the spots on the lower leaf surface.
Betel nut and oil palm are also hosts.

Treatment: **113**

Photo: Kohler Collection

Photo: Kohler Collection

Photo: Eric McKenzie

Photo: Kohler Collection

Photo: Kohler Collection

Phytophthora heveae

Phytophthora palmivora

Pseudoepicoccum cocos

COCOS NUCIFERA

COCONUT

ARECACEAE

Coconut foliar decay nanavirus

Coconut foliar decay

Site of infection: L

Importance of the disease: √√√

Symptoms

At first, yellowing on several leaflets on fronds five to eleven from the crown, followed by more extensive yellowing and the appearance of areas of rot in the petiole. Fronds may break and hang down through the canopy. Other fronds die and break as they reach the same position in the crown. At this stage, young and older leaves remain green. Further development of symptoms depends on variety. In some cases, the symptoms disappear, whereas in susccptiblc palms the crown dies six months to two years after symptoms first appear.
The disease is known only from Vanuatu.

Treatment: **31**

COCOS NUCIFERA

COCONUT

ARECACEAE

Coconut tinangaja viroid

Tinangaja

Site of infection: L,Fl,Fr

Importance of the disease: √√√

Symptoms

Yellow spots on the leaves and the production of small, scarified, elongated nuts lacking kernels. Inflorescences become necrotic, nut production declines and then ceases, frond production slows, and a general yellowing appears, followed by death of the crown.
The viroid is related to cadang-cadang viroid, the cause of a lethal disease of coconuts in the Philippines. Coconut tinangaja viroid is known only from Guam.

Treatment: **32**

COFFEA ARABICA & C. CANEPHORA

COFFEE

RUBIACEAE

Cercospora coffeicola

Brown-eye leaf spot

Site of infection: L,Fr

Importance of the disease: √

Symptoms

Circular spots, up to 30 mm diam., but mostly 5–10 mm, like a bird's eye: bright grey centres, dark brown borders with yellow haloes. Spots are most obvious on the upper leaf surface. Dark spore masses occur on the grey centres. Severe attacks on seedlings cause leaf-fall and slow growth. It is less important on mature plants. On berries, spots are dark grey or brown, oval, sunken and usually less than 5 mm diam. Affected berries turn black, shrink and fall. Unshaded trees are more likely to be attacked, especially if nutrition is poor.

Treatment: **26**

Photo: Grahame Jackson

Photo: Grahame Jackson

Photo: Kohler Collection

Photo: John Randles

Coconut foliar decay nanavirus

Photo: Grahame Jackson

Coconut tinangaja viroid

Photo: Kohler Collection

Cercospora coffeicola

COFFEA ARABICA & C. CANEPHORA

COFFEE

RUBIACEAE

Fusarium oxysporum **f. sp.** *coffeae*

Wilt

Site of infection: T,C,R

Importance of the disease: √

Symptoms

A soil fungus causing a serious wilt of young plants. Brown rots occur at the collar, which sometimes becomes covered with fungal mycelium. The plants wilt, gradually dry out and die.

Treatment: **57**

COFFEA ARABICA & C. CANEPHORA

COFFEE

RUBIACEAE

Glomerella cingulata
=Colletotrichum gloeosporioides

Anthracnose

Site of infection: L,Fr

Importance of the disease: √

Symptoms

Anthracnose of the foliage and berries is more serious on Arabica varieties weakened by rust attack. The foliage blackens and dries, brown spots on the berries become darker and the berries become mummified and fall. In extreme cases, the trees are defoliated. On Robusta, damage from anthracnose sometimes occurs on coffee exposed to heavy rains.
Many other plants are hosts, including avocado, eggplant, mango, papaya, sweet pepper, tomato and yams.

Treatment: **62**

COFFEA ARABICA & C. CANEPHORA

COFFEE

RUBIACEAE

Hemileia vastatrix

Rust

Site of infection: L

Importance of the disease: √√√

Symptoms

Yellow-orange leaf spots, up to 15 mm diam., circular, forming powdery blotches on the underside of leaves and yellowing on upper surfaces. Later, the centres of the blotches die and turn brown, and on the upper surface brown spots develop with yellow halos. Blotches may merge and cover the entire leaf blade. In severely affected plants, leaves fall and branches die back. Plants weakened by rust are also more susceptible to attack by anthracnose, which is not normally the cause of serious disease.

Treatment: **68**

Photo: Kohler Collection

Fusarium oxysporum f. sp. *coffeae*

Photo: Kohler Collection

Photo: Kohler Collection

Glomerella cingulata

Photo: Kohler Collection

Photo: Kohler Collection

Hemileia vastatrix

COFFEA ARABICA & C. CANEPHORA

COFFEE

RUBIACEAE

Pellicularia koleroga
=Corticium koleroga

Thread blight

Site of infection: L

Importance of the disease: √

Symptoms

Mats and thread-like fungal growth on the branches, spreading over the under surfaces of leaves. At first, the foliage appears slightly grey and dry. Later, the leaves blacken and fall. In severe cases, the dead leaves become detached from the branches, but are held in place by threads of the fungus. Branches may die back. Other plants are hosts, including citrus, cocoa and woody plants.

Treatment: **91**

COFFEA ARABICA & C. CANEPHORA

COFFEE

RUBIACEAE

Phanerochaete salmonicolor
=Corticium salmonicolor

Pink disease

Site of infection: L,S,T

Importance of the disease: √√

Symptoms

A stem pathogen causing dieback. The fungus forms a pinkish-white crust on the surface of the bark. Later, this becomes light cream, the bark develops cracks, and the foliage dries out and dies. In some countries, the disease is more common on Robusta coffee.
Many other plants are hosts, including black pepper, citrus, cocoa, rubber, tea, and some forest trees.

Treatment: **98**

COFFEA ARABICA & C. CANEPHORA

COFFEE

RUBIACEAE

Phellinus lamaensis

Brown root and collar rot

Site of infection: L,T

Importance of the disease: √√

Symptoms

A sudden yellowing of all or part of the foliage, followed by withering of the leaves and defoliation. At the same time, a tough brown crust grows up the tree from the base of the trunk. Beneath the crust, the wood is discoloured, later becoming dry and honeycombed. Often, several adjacent trees are affected as the fungus spreads through the soil by root-to-root contact.
The spore-producing bracket or fruit body is not commonly found, as it does not develop until some years after the death of the tree.

Treatment: **99**

Photo: Eric McKenzie

Photo: Kohler Collection

Pellicularia koleroga

Photo: Kohler Collection

Phanerochaete salmonicolor

Photo: Kohler Collection

Photo: Kohler Collection

Phellinus lamaensis

COFFEA ARABICA & C. CANEPHORA

COFFEE

RUBIACEAE

Verticillium hemileiae

Rust hyperparasite

Site of infection: L

Importance of the disease: Nil

Symptoms

Pustules of the coffee rust pathogen become covered in a dense white growth of the fungus, which lives on the spores.

Treatment:

COLOCASIA ESCULENTA

TARO

ARACEAE

Cladosporium colocasiae

Ghost spot

Site of infection: L

Importance of the disease: √

Symptoms

Reddish brown, circular or irregular blotches often with a yellow halo, up to 15 mm diam., on older leaves. Spots are smaller when there are many on the same leaf. Usually, they are less evident on the opposite leaf surface. Spots at the border of the leaves may merge, causing the margins to turn brown and dry out.

Treatment: **29**

COLOCASIA ESCULENTA

TARO

ARACEAE

Marasmiellus stenophyllus

Corm and leaf rot

Site of infection: L,S,R

Importance of the disease: √

Symptoms

Leaves collapse due to the development of large brown rots at the base of the plant associated with thick white fungal growth. The leaves are often stuck together by the fungal threads. Mushrooms form in large numbers on the withered leaves at soil level. Shallow rots occur in the corms and the roots are decayed.

Treatment: **78**

Photo: Kohler Collection

Photo: Grahame Jackson

Photo: Kohler Collection

Photo: Kohler Collection

Verticillium hemileiae

Photo: Wolfgang Gerlach

Cladosporium colocasiae

Photo: Kohler Collection

Marasmiellus stenophyllus

COLOCASIA ESCULENTA

TARO

ARACEAE

Neojohnstonia colocasiae

Orange ghost spot

Site of infection: L

Importance of the disease: √

Symptoms

Yellow-brown, round or irregular spots, up to 15 mm diam., on both sides of the leaf, sometimes with a brown margin and yellow halo, becoming darker as the spore masses develop. The spots are smaller when large numbers develop on the same leaf.

Treatment: **86**

COLOCASIA ESCULENTA

TARO

ARACEAE

Phoma spp.

Leaf spot

Site of infection: L

Importance of the disease: √

Symptoms

Oval leaf spots, up to 30 mm long, brown with a yellow border, sometimes merging. The centre of the spots characteristically tears and may fall out to give a shot-hole effect.
The disease is widespread in the Pacific, where it has often been identified as a species of *Phyllosticta*. It has occasionally been confused with taro leaf blight caused by *Phytophthora colocasiae*.

Treatment: **101**

COLOCASIA ESCULENTA

TARO

ARACEAE

Phytophthora colocasiae

Leaf blight

Site of infection: L,S

Importance of the disease: √√√

Symptoms

At first, small circular spots, brown on the upper leaf surface, water-soaked below, rapidly enlarging, becoming irregular in shape, dark brown, zoned, with yellow margins and containing characteristic yellowish to red droplets drying as hard pellets. Spots often start on the older leaves, usually at the edges where water collects. White fungal spore-producing areas occur at the margins of the spots.
Typically, the leaves collapse in 10–20 days. Petiole infections are less common, but occur on susceptible varieties. The fungus is also responsible for a post-harvest corm rot.
Giant taro, *Alocasia macrorrhizos*, is also a host (lower photograph).

Treatment: **103**

Photo: Wolfgang Gerlach

Photo: Eric McKenzie

Neojohnstonia colocasiae

Photo: Grahame Jackson

Phoma spp.

Photo: Grahame Jackson

Photo: Grahame Jackson

Phytophthora colocasiae

COLOCASIA ESCULENTA

TARO

ARACEAE

Pseudocercospora colocasiae

Leaf blotch

Site of infection: L

Importance of the disease: √

Symptoms

Pale, indistinct yellow-red patches, up to 15 mm diam., on the upper leaf surface; light brown spots with black fungal growth on the lower surface.

Treatment: **111**

COLOCASIA ESCULENTA

TARO

ARACEAE

Pythium spp.

Corm rot

Site of infection: S,R

Importance of the disease: √√

Symptoms

Symptoms vary, depending on the age of the plants when attacked and the species of *Pythium* involved. Roots and basal parts of young plants may be attacked before they develop leaves, and they die or remain stunted. On mature plants, the first symptom is often a rapid collapse and withering of the outer leaves due to a loss of lateral and feeder roots. The colour of those remaining is an unhealthy greyish blue-green, often with pale yellow margins. Rots caused by *Pythium* fungi may occur in the corms. Later, corms may be invaded by *Erwinia* bacteria which produce a foul-smelling soft rot. *P. splendens* is the cause of a post-harvest corm rot.

Treatment: **120**

COLOCASIA ESCULENTA

TARO

ARACEAE

Hirschmanniella miticausa

Root and corm rot

Site of infection: S,R

Importance of the disease: √√

Symptoms

Internally, corms show brown areas of dry rot extending in narrow bands upwards from the base. At first, the rots are confined to the vascular tissues, but later they spread to adjacent areas. Healthy tissue alongside the rots are red and corms have the appearance of raw meat—hence the pidgin name of the disease in Solomon Islands of 'mitimiti'. The rots are often not apparent until the taro are harvested, although sometimes wetland taro wilt and the plants become stunted.

Treatment: **69**

Photo:Wolfgang Gerlach

Pseudocercospora colocasiae

Photo: Grahame Jackson

Photo: Kohler Collection

Pythium spp.

Photo: Grahame Jackson

Photo: Grahame Jackson

Hirschmanniella miticausa

COLOCASIA ESCULENTA

TARO

ARACEAE

***Colocasia* bobone disease (?) rhabdovirus =CBDV**

Bobone

Site of infection: L

Importance of the disease: √√

Symptoms

Leaves are puckered, distorted, brittle and thickened, but remain green. Symptoms appear after planting or at any other time during the growing cycle. After three or four affected leaves are produced, plants recover by producing apparently healthy leaves. Some plants develop symptoms twice during the same crop.

Treatment: **37**

COLOCASIA ESCULENTA

TARO

ARACEAE

***Colocasia* bobone disease (?) rhabdovirus and dasheen bacilliform (?) badnavirus**

Alomae

Site of infection: L

Importance of the disease: √√

Symptoms

Initially, symptoms are similar to plants with bobone. Leaves are short, thick, often with galls, but often remain green. The next leaves to be produced are yellow with prominent veins, and they remain rolled and stunted. Leaf production ceases and the plants rot and die.
Alomae has been recorded from Solomon Islands and Papua New Guinea.
Giant taro, *Alocasia macrorrhizos*, is also a host.

Treatment: **38**

COLOCASIA ESCULENTA

TARO

ARACEAE

***Colocasia* bobone disease (?) rhabdovirus =CBDV (Fiji strain)**

Unnamed

Site of infection: L

Importance of the disease: √

Symptoms

Leaf veins, especially those at the margins, become yellow. Usually, only two or three leaves show symptoms before apparently healthy leaves are produced. Occasionally, extensive areas of yellowing occur between the veins on leaves which are stunted and distorted. Initially, these plants may look similar to those with alomae, but they recover from the disease and do not die.

Treatment: **39**

Photo: Grahame Jackson

Photo: Grahame Jackson

Photo: Grahame Jackson

Photo: Bill Zeitler

Photo: Grahame Jackson

Photo: Grahame Jackson

Colocasia bobone disease (?) rhabdovirus

CBDV & dasheen bacilliform (?) badnavirus

CBDV (Fiji strain)

COLOCASIA ESCULENTA

TARO

ARACEAE

Dasheen mosaic potyvirus
=DMV

Dasheen mosaic

Site of infection: L

Importance of the disease: √

Symptoms

Pale yellow to green patches on the leaves, characteristically as feather-like patterns along the veins, especially near the leaf margins. Occasionally, yellow and green patterns occur over the entire leaf surface, which may appear narrow, with a distorted margin. Usually, two or three leaves show symptoms and then apparently healthy leaves are produced.
Giant taro, *Xanthosoma* and giant swamp taro, as well as many ornamental species, including *Caladium*, *Dieffenbachia* and *Philodendron*, are hosts.

Treatment: **45**

COLOCASIA ESCULENTA

TARO

ARACEAE

Dasheen mosaic potyvirus
=DMV (severe strain)

Dasheen mosaic

Site of infection: L

Importance of the disease: √√

Symptoms

Pale green to yellow patterns on small, stunted and severely distorted leaves. Some leaves are reduced to strap-like structures without lobes, or are entirely absent. Pigmented varieties show a loss of colour. Plants fail to recover from infection, in contrast to those with the common strain of dasheen mosaic virus, but they do not die. Corms are small.
This disease has been recorded only from French Polynesia.

Treatment: **46**

CORDIA ALLIODORA

LAUREL

BORAGINACEAE

Phellinus noxius

Brown root and collar rot

Site of infection: T,R

Importance of the disease: √√√

Symptoms

Symptoms depend on the age of the trees when they are attacked. Young trees frequently die rapidly after infection; those that are older, and thus larger, may remain partially affected for years. Basal heart rot may develop, making them more susceptible to windthrow. Invariably, a thick, dark fungal growth containing soil particles covers the roots. This may spread upwards around the collar and trunk forming a prominent brown or black 'stocking'. Bracket-like fruit bodies sometimes form on affected logs and stumps, especially those of indigenous trees. Many other forest and plantation species are hosts, including *Swietenia macrophylla*, *Tectona grandis*, cocoa and coffee.

Treatment: **100**

Photo: Grahame Jackson

Photo: Leon Mu

Photo: Mike Ivory

Photo: Grahame Jackson

Photo: Leon Mu

Photo: Mike Ivory

Dasheen mosaic potyvirus

Dasheen mosaic potyvirus (severe strain)

Phellinus noxius

CUCUMIS MELO

MELON

CUCURBITACEAE

Colletotrichum orbiculare
=Colletotrichum lagenarium

Anthracnose

Site of infection: L,Fr,S

Importance of the disease: √√

Symptoms

On the leaves, small, brown, circular spots with a yellow halo; later, enlarging, becoming round to oval, dark brown to black, often centred on the veins. Spots also occur on the vines. On the fruit, circular, pale brown, sunken spots with raised margins, often more common on the lower half of the fruit. Spots up to 30 mm diam., but often merging to cover extensive areas of the fruit. Pink to orange spore masses occur on the spots during wet weather. Secondary rot-causing organisms may completely destroy the fruit. Many other species of cucurbits are hosts, including cucumber and watermelon.

Treatment: **36**

CUCUMIS SATIVUS

CUCUMBER

CUCURBITACEAE

Corynespora cassiicola

Leaf spot

Site of infection: L

Importance of the disease: √√

Symptoms

Numerous small, round, up to 4 mm diam., or irregular-shaped, cream-coloured spots. The leaves dry out and fall prematurely.
The fungus is probably a secondary invader of rotting fruits of papaya and tomato.

Treatment: **42**

CUCUMIS SATIVUS

CUCUMBER

CUCURBITACEAE

Didymella bryoniae
=Ascochyta cucumis

Gummy stem blight

Site of infection: L

Importance of the disease: √√√

Symptoms

Marginal leaf rots, expanding rapidly and causing large areas of decay resulting in premature defoliation. Numerous black spore-containing structures develop on the periphery of the lesions.

Treatment: **47**

Photo: Kohler Collection

Colletotrichum orbiculare

Photo: Grahame Jackson

Photo: Eric McKenzie

Corynespora cassiicola

Photo: Grahame Jackson

Photo: Grahame Jackson

Didymella bryoniae

CUCUMIS SATIVUS

CUCUMBER

CUCURBITACEAE

Pseudoperonospora cubensis

Downy mildew

Site of infection: L

Importance of the disease: √√√

Symptoms

Angular to round yellow areas occur on the upper leaf surface, later merging and becoming brown. In wet weather, downy growth develops on the under surface of the leaves, and they dry out and die. Fruits are not directly affected, but those that form are small and do not ripen properly.
Many other cucurbits are hosts, including melon, pumpkin, squash and watermelon.

Treatment: **116**

CUCUMIS SATIVUS

CUCUMBER

CUCURBITACEAE

Pythium spp.

Cottony leak

Site of infection: Fr

Importance of the disease: √

Symptoms

Watery soft rot with masses of white cottony fungal growth on fruit in contact with the soil. The disease is commonly caused by *P. aphanidermatum* and *P. deliense*.
The fungi also cause a pre- and post-emergence damping-off in seedlings of many plant species. *P. aphanidermatum* causes a corm rot of taro and cottony leak on beans (lower photograph).

Treatment: **121**

CUCUMIS SATIVUS

CUCUMBER

CUCURBITACEAE

Sphaerotheca fuliginea
=Oidium sp.

Powdery mildew

Site of infection: L,S,Fr

Importance of the disease: √√

Symptoms

White powdery growth on leaves, stalks and flowers. At first, small, circular, white powdery patches, mostly on the lower surface. Affected leaves gradually turn yellow, then brown, dry out and die.
Only the *Oidium* or conidial form is known from the Pacific Islands.
Many other species of cucurbits are hosts, including melon (lower photograph), pumpkin, squash and zucchini, as well as legumes and members of the Asteraceae.

Treatment: **130**

Photo: DPI Collection

Photo:Wolfgang Gerlach

Photo: Grahame Jackson

Photo: DPI Collection

Pseudoperonospora cubensis

Photo: DPI Collection

Pythium spp.

Photo: Kohler Collection

Sphaerotheca fuliginea

CUCURBITA PEPO

ZUCCHINI

CUCURBITACEAE

Zucchini yellow mosaic potyvirus

Zucchini yellow mosaic

Site of infection: L,Fr

Importance of the disease: √√√

Symptoms

Severe yellow-green patterns, usually with distortions and blisters on the leaves and fruits. Often the plants fail to set fruit, and those that form are small.
Other cucurbits are also hosts: pumpkin (lumps and mottle patterns on the fruits and mosaics on the leaves—lower photograph); squash (fruits small in size with yellow blotches and rings); and watermelon.

Treatment: **155**

CYRTOSPERMA CHAMISSONIS

GIANT SWAMP TARO

ARACEAE

Radopholus similis

Corm rot

Site of infection: S,R

Importance of the disease: √√

Externally, corms look as if they have been bored by insects with 5–20 mm diam. holes, 10–20 mm deep. Beneath, the tissues show a brown superficial rot, occasionally extending as narrow channels deep into the centre of the corm. Often, roots show considerable decay, but generally the leaves appear healthy.
Many crops are hosts, including banana, bele, ginger, legumes, maize and yams.

Treatment: **123**

DAUCUS CAROTA

CARROT

APIACEAE

Alternaria dauci

Blight

Site of infection: L

Importance of the disease: √√

Symptoms

At first, dark grey to brown spots, angular, with yellow margins on leaves and petioles. Older leaves are attacked initially, but spores from these spread to younger foliage which rapidly blackens, withers and dies.
Another disease, caused by *Cercospora carotae*, produces similar symptoms: circular tan or grey spots on the leaves and leaf stalks, which merge and develop into a blight during humid weather.

Treatment: **7**

Photo: Kohler Collection

Photo: DPI Collection

Photo: Semisi Pone

Zucchini yellow mosaic potyvirus

Photo: Grahame Jackson

Photo: Grahame Jackson

Radopholus similis

Photo: Kohler Collection

Photo: DPI Collection

Alternaria dauci

DAUCUS CAROTA

CARROT

APIACEAE

Alternaria radicina
=Stemphylium radicinum

Root rot

Site of infection: R

Importance of the disease: √

Symptoms

Slightly sunken necrotic spots over the surface of the root, covered in a rust-brown matting of fungal growth in which spores develop. As the decay spreads, the areas of rot deepen and the roots become unfit for consumption.

Treatment: **7**

DAUCUS CAROTA

CARROT

APIACEAE

Athelia rolfsii
=Sclerotium rolfsii

Basal rot

Site of infection: C,R

Importance of the disease: √√

Symptoms

At first, spreading white fans of fungal growth over the root and base of the leaves; later, characteristic small white to light brown sclerotia, 1–2 mm diam., form within the growth, at or immediately below soil level. Plants invariably die from infection.
A wide range of cultivated plants and weeds are hosts, including beans, cucurbits, sweet pepper, sweet potato, taro and tomato.

Treatment: **11**

DIOSCOREA ALATA

GREATER YAM

DIOSCOREACEAE

Glomerella cingulata
=Colletotrichum gloeosporioides

Anthracnose

Site of infection: L,S

Importance of the disease: √√√

Symptoms

Small brown spots, some with yellow haloes on the young leaves, enlarging as the leaves expand. Sometimes the spots merge, forming large irregular blotches. Infected leaves fall prematurely. Mature leaves show brown pinpoint infections which do not penetrate to the other leaf surface. Pink to orange spore masses occur on the spots during wet weather. During long periods of rain, and on susceptible varieties, leaves and vines blacken rapidly and die. New shoots may develop and plants may produce several small tubers as a consequence. In the Caribbean, the fungus has been reported to cause a shallow tuber rot.
Many other plants are hosts, including avocado, coffee, eggplant, mango, papaya, sweet pepper and tomato.

Treatment: **62**

Photo: Kohler Collection

Alternaria radicina

Photo: Kohler Collection

Photo: Kohler Collection

Athelia rolfsii

Photo: Grahame Jackson

Photo: Grahame Jackson

Glomerella cingulata

DIOSCOREA SPP.

YAMS

DIOSCOREACEAE

Goplana australis

Rust

Site of infection: L

Importance of the disease: √

Symptoms

Pale yellow pustules, mostly on the under surface of the leaf in groups, 2–4 mm diam. Pale brown, circular spots with pale green-yellow haloes occur on the upper leaf surface.

Treatment: **64**

DIOSCOREA SPP.

YAMS

DIOSCOREACEAE

Goplana dioscoreae

Rust

Site of infection: L

Importance of the disease: √

Symptoms

Symptoms are similar to those of *G. australis*. Yellow pustules occur on both leaf surfaces, but especially on the upper surface, often in groups.

Treatment: **65**

DIOSCOREA SPP.

YAMS

DIOSCOREACEAE

Guignardia dioscoreae
=Phyllosticta dioscoreae

Leaf spot

Site of infection: L

Importance of the disease: √

Symptoms

Leaf spots circular or irregular, up to 10 mm diam., light brown with a dark brown or black border and yellow halo. The black fruiting bodies of the fungus are usually scattered in the centre of the spots.

Treatment: **66**

Photo: Eric McKenzie

Goplana australis

Photo: Eric McKenzie

Goplana dioscoreae

Photo: Kohler Collection

Guignardia dioscoreae

DIOSCOREA SPP.

YAMS

DIOSCOREACEAE

Pratylenchus coffeae

Tuber rot

Site of infection: R

Importance of the disease: √√

Symptoms

Dark brown dry rots, 5–20 mm deep, beneath the tuber skin. Externally, the skin may flake and crack, showing the rot beneath. In heavy infestations, the rots may cover the entire tuber. The disease can be particularly severe during storage, resulting in the loss of planting material for next season's crop. Sometimes, other microorganisms invade the damaged areas and assist in the destruction.

Treatment: **109**

ELAEIS GUINEENSIS

OIL PALM

ARECACEAE

Cadang-cadang-like viroid

Orange spotting

Site of infection: L

Importance of the disease: √

Symptoms

Numerous bright orange spots, 2–3 mm diam., on all except the youngest three to four fronds. Palms are stunted, and bunches and nuts are reduced in size and number.
Previously this condition was known as genetic orange spotting and was not considered to be a disease.

Treatment: **20**

FRAGARIA x *ANANASSA*

STRAWBERRY

ROSACEAE

Rhizopus stolonifera

Soft rot or leak

Site of infection: Fr

Importance of the disease: √

Symptoms

Rapidly developing soft wet rot covered by cottony white fungal growth. As the rot progresses, small white, stalked, fruiting bodies are produced, becoming black as they mature. Enzymes produced by the fungus break down the cells, and the contents released often have a fermented or acidic smell, hence the other name of 'leak' for the disease.
The disease is important only after harvest, and affects a wide range of soft fruit in transit and storage. Root crops are also attacked.

Treatment: **124**

Photo: John Bridge

Pratylenchus coffeae

Photo: John Randles

Photo: John Randles

Cadang-cadang-like viroid

Photo: Kohler Collection

Rhizopus stolonifera

FRAGARIA x ANANASSA

STRAWBERRY

ROSACEAE

Sphaerotheca macularis
=Oidium sp.

Powdery mildew

Site of infection: L,Fl,Fr

Importance of the disease: √√

Symptoms

White patches of fungal growth develop, sometimes covering the entire leaf, causing it to roll and curl upwards. Purple or reddish blotches may also occur. On the fruit, a white powdery covering develops, the surface of the fruit hardens, and cracks appear.

Treatment: **131**

GERBERA SP.

GERBERA

ASTERACEAE

Fusarium oxysporum f. sp. *gerberae*

Fusarium wilt

Site of infection: S,R

Importance of thee disease: √

Symptoms

Infection of the vascular tissues of the roots and stem base, leading to a wilt and eventual death of the foliage.

Treatment: **59**

GLADIOLUS SP.

GLADIOLUS

IRIDACEAE

Fusarium oxysporum f. sp. *gladioli*

Wilt

Site of infection: S,R

Importance of the disease: √

Symptoms

Infection of the roots leads to a rot of the corm and eventually a wilt and death of the plant.

Treatment: **55**

Photo: DPI Collection

Photo: Kohler Collection

Sphaerotheca macularis

Photo: Kohler Collection

Fusarium oxysporum f. sp. *gerberae*

Photo: Kohler Collection

Photo: Kohler Collection

Fusarium oxysporum f. sp. *gladioli*

GLYCINE MAX

SOYBEAN

FABACEAE

Sclerotinia sclerotiorum

Stem rot

Site of infections: S,R

Importance of the disease: √√√

Symptoms

Small, water-soaked, pale or dark brown spots on the stems and branches, sometimes girdling them and causing the foliage to wilt and die. Under high humidity, the roots are covered with thick mats of the fungus within which numerous sclerotia develop. These, the resting structures of the fungus, are at first white, 2–10 mm long, and later black and hard. Sclerotia occur both inside and outside the stem.
This is a serious disease of soybean which is capable of destroying entire plantations. It is a disease of importance in temperate climates. The fungus can survive for a long time in the soil and has a wide host range, including beans, cabbages, carrot, celery, lettuce, potato and tomato.

Treatment: **127**

HELIANTHUS ANNUUS

SUNFLOWER

ASTERACEAE

Sclerotinia fuckeliana

Stem rot

Site of infection: S,Fl,Fr

Importance of the disease: √

Symptoms

A rot of the top of the stem which causes the plant to droop. Internally, the vascular tissues are completely destroyed by the fungus. The flowers and seeds may also be attacked. Large, black, irregular-shaped sclerotia develop on the areas of rot.

Treatment: **127**

HIBISCUS ROSA-SINENSIS

HIBISCUS

MALVACEAE

Balanophora fungosa

Plant parasite

Site of infection: R

Importance of the disease: √

Symptoms

A parastic plant that lives on the roots of other plants.

Treatment: **12**

Photo: Kohler Collection

Sclerotinia sclerotiorum

Photo: Kohler Collection

Photo: Kohler Collection

Sclerotinia fuckeliana

Photo: Kohler Collection

Balanophora fungosa

HORDEUM VULGARE

BARLEY

POACEAE

Pyrenophora graminea
=Drechslera graminea

Leaf stripe

Site of infection: L

Importance of the disease: √√

Symptoms

At first, small yellow spots on seedling leaves resulting from seedborne infections; later, on mature leaves, the spots develop into long yellow to light brown stripes with brown margins and pale yellow centres. The leaves dry out and die prematurely. Severe seedling infection may result in the death of plants or stunting.

Treatment: **122**

IPOMOEA AQUATICA

KANGKONG, WATER SPINACH

CONVOLVULACEAE

Albugo ipomoeae-aquaticae

White rust, White blister

Site of infection: L,S,Fl

Importance of the disease: √

Symptoms

White or pale yellow blisters on the underside of the leaves, and on the stems and flowers. Often the blisters join together.
Sweet potato and ornamental species of Convolvulaceae are also hosts.

Treatment: **4**

IPOMOEA AQUATICA

KANGKONG, WATER SPINACH

CONVOLVULACEAE

Cercospora ipomoeae

Leaf spot

Site of infection: L

Importance of the disease: √

Symptoms

Circular to irregular leaf spots, up to 5 mm diam., red-brown on the upper surface, grey on the lower surface, with yellow haloes. The centres of the spots sometimes fall out.
Sweet potato and some ornamental Convolvulaceae are hosts.

Treatment: **27**

Photo: Kohler Collection

Pyrenophora graminea

Photo: Eric McKenzie

Albugo ipomoeae-aquaticae

Photo: Eric McKenzie

Cercospora ipomoeae

IPOMOEA BATATAS

SWEET POTATO

CONVOLVULACEAE

Elsinoe batatas

Scab

Site of infection: L,S

Importance of the disease: √√√

Symptoms

Small brown, round to oval 'scabby' leaf spots, 3 mm long and 1 mm wide, mostly along the midrib and veins, becoming lighter with age. Often the scabs join together, forming lesions several cm long. Pinpoint spots occur on the leaf blades between the veins. On the petioles, spots are 1–5 mm long, and slightly sunken. In severe attacks, leaf blades are small, curled, with deeply torn edges, and petioles are short, twisted and erect.

Treatment: **49**

IPOMOEA BATATAS

SWEET POTATO

CONVOLVULACEAE

Pseudocercospora timorensis

Leaf spot

Site of infection: L

Importance of the disease: √

Symptoms

Leaf spots brown, circular to irregular on the upper surface, sometimes with a light brown centre. On the lower surface, the spots are ill-defined, brown or grey. Usually, the spots occur on mature leaves.
Other *Ipomoea* species are hosts.

Treatment: **112**

IPOMOEA BATATAS

SWEET POTATO

CONVOLVULACEAE

Phytoplasma
=Mycoplasma-like organism

Little-leaf, Witches' broom disease

Site of infection: L,S,R

Importance of the disease: √√√

Symptoms

At first, yellowing of veins on leaves which otherwise appear normal. Leaves become progressively smaller until they are about an eighth the size of those that are healthy. They become yellow, occasionally rolled upwards at the margins, puckered, and in some varieties more rounded than normal. Diseased stems are short, with as little as 10 mm between leaves, and erect. Side shoots develop and plants become bushy. Tubers, if produced, are pencil-thin. Diseased plants are often smothered by those that are healthy.
Several wild species of *Ipomoea* (morning glory) are hosts.

Treatment: **106**

Photo: Grahame Jackson

Photo: Brian Thistleton

Elsinoe batatas

Photo: Eric McKenzie

Pseudocercospora timorensis

Photo: Grahame Jackson

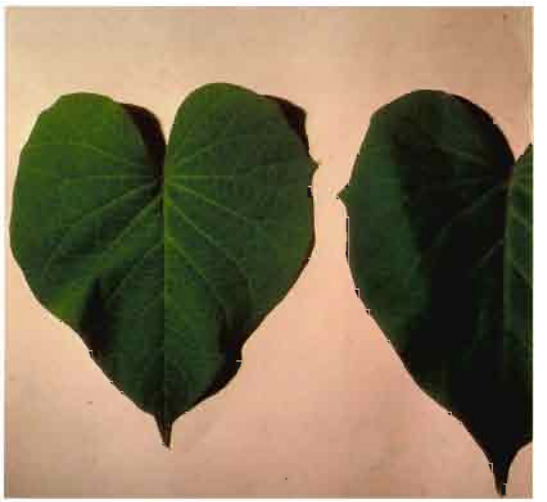

Photo: Grahame Jackson

Phytoplasma (Little-leaf disease)

ISCHAEMUM INDICUM

BATIKI BLUE GRASS

POACEAE

Curvularia ischaemi

Eye spot

Site of infection: L

Importance of the disease: √

Symptoms

Small spots, 0.5–1 mm diam., grey with a red to purple border.

Treatment: **44**

LACTUCA SATIVA

LETTUCE

ASTERACEAE

Bremia lactucae

Downy mildew

Site of infection: L

Importance of the disease: √√√

Symptoms

Light green to yellow, round to angular spots on the upper leaf surface, merging and later turning brown, soft and slimy. On the under surface, a white fungal growth containing the spore masses develops under humid conditions. This is an important disease capable of causing the rapid destruction of the plant.

Treatment: **18**

LACTUCA SATIVA

LETTUCE

ASTERACEAE

Cercospora longissima

Leaf spot

Site of infection: L

Importance of the disease: √√

Symptoms

Round to irregular leaf spots, grey-brown with small, pale grey centres. Spores develop on both sides of the leaf. The spots often merge, killing large areas of the leaf, making it unfit for consumption.

Treatment: **25**

Photo: Eric McKenzie

Curvularia ischaemi

Photo: Kohler Collection

Photo: Kohler Collection

Bremia lactucae

Photo: Kohler Collection

Photo: Kohler Collection

Cercospora longissima

LACTUCA SATIVA

LETTUCE

ASTERACEAE

Sclerotinia sclerotiorum

Collar rot

Site of infection: L,S,C

Importance of the disease: √√

Symptoms

Damping-off, wilt, and a watery soft rot. Wilts begin to appear during mid-season or later. Watery soft rots occur at the base of the stem at ground level, spreading into the head and causing a general collapse of the leaves. Cottony mats of the fungus cover the rots and give rise to irregular-shaped sclerotia which are white at first, then black, 2–10 mm diam.
Many other vegetables are hosts, including beans, carrot, sweet pepper and tomato.

Treatment: **127**

LACTUCA SATIVA

LETTUCE

ASTERACEAE

Pseudomonas **spp.**

Bacterial rots

Site of infection: L,S

Importance of the disease: √

Symptoms

Several bacterial species may be involved, causing leaf spotting, vascular browning and soft rots, especially during hot and wet weather. Symptoms develop as the plants mature. A section through the stem may show rots in the vascular tissues where leaves are attached, and oozing foul-smelling rots at the collar.

Treatment: **114**

LACTUCA SATIVA

LETTUCE

ASTERACEAE

Physiological disorder

Tipburn

Site of infection: L

Importance of the disease: √√

Symptoms

Browning and drying out at the margins of the inner heart leaves. Symptoms vary with variety, with some showing symptoms on all the leaves. The exact cause is unknown, but thought to be associated with environmental conditions. It is more likely to occur when cool, wet weather is followed by dry, sunny periods. The disease may appear suddenly when the plants are near maturity and cause severe losses.

Treatment: **136**

Photo: Kohler Collection

Sclerotinia sclerotiorum

Photo: Kohler Collection

Photo: Kohler Collection

Pseudomonas spp.

Photo: Kohler Collection

Physiological disorder (Tipburn)

LACTUCA SATIVA

LETTUCE

ASTERACEAE

Lettuce mosaic potyvirus

Lettuce mosaic

Site of infection: L

Importance of the disease: √√

Symptoms

Light and dark green patches on the leaves, puckering, necrotic spots, yellowing and sometimes browning of the veins. Plants are stunted, yellow, with the tops of leaves rolling downwards, and unmarketable. An important disease, with varieties differing in reaction to the virus.

Treatment: **72**

LUPINUS ALBUS & L. ANGUSTIFOLIUS

LUPIN

FABACEAE

Colletotrichum lindemuthianum

Anthracnose

Site of infection: L,Fr

Importance of the disease: √√

Symptoms

Dark streaks on the lower leaf surface, and circular dark brown sunken spots on pods, bordered by a ring of white fungal growth, and a brown watery margin. The centre of the spots becomes pink during wet weather as spore masses develop. Seedlings are also attacked from seedborne infections of the fungus. Cowpea, French bean (lower photograph), and soybean, as well as other legumes, are hosts.

Treatment: **35**

LUPINUS ALBUS & L. ANGUSTIFOLIUS

LUPIN

FABACEAE

Sclerotinia minor

Stem rot

Site of infection: S,R

Importance of the disease: √

Symptoms

Dark brown spots on the stems and a rot of the roots. A thick white fungal growth covers affected areas in which sclerotia are produced. These are white at first and then black, 0.5–1 mm diam. The sclerotia also occur inside the stems.

Treatment: **126**

Photo: DPI Collection

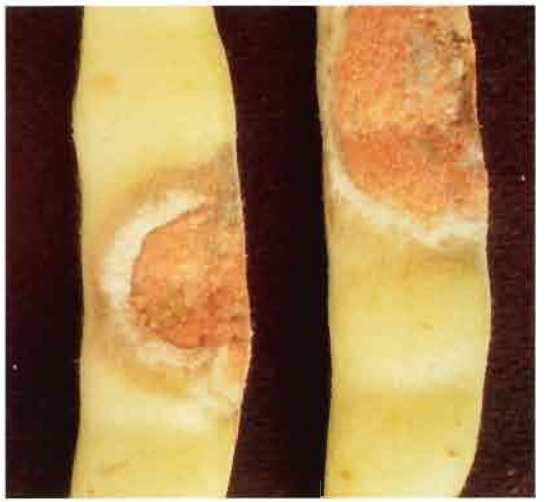

Photo: Kohler Collection

Photo: Kohler Collection

Photo: Kohler Collection

Lettuce mosaic potyvirus

Photo: DPI Collection

Colletotrichum lindemuthianum

Photo: Kohler Collection

Sclerotinia minor

LYCOPERSICON ESCULENTUM

TOMATO

SOLANACEAE

Alternaria solani

Early blight

Site of infection: L,S,Fr

Importance of the disease: √√√

Symptoms

Small, pinpoint to 6 mm, circular to angular brown leaf spots with concentric ridges, giving a characteristic target spot appearance. The spots merge and leaves wither and fall prematurely. Similar spots occur on the stems, but they are darker and more elongated. On the fruits, the spots are dark brown or black, sunken, extending over part or all of the fruit. The rots become covered in black spore masses of the fungus. Other plants are hosts, including potato and tomato.

Treatment: **7**

LYCOPERSICON ESCULENTUM

TOMATO

SOLANACEAE

Athelia rolfsii
=Sclerotium rolfsii

Basal rot

Site of infection: C,R

Importance of the disease: √√√

Symptoms

Roots and collar regions are decayed and plants wilt. A characteristic of the disease is the production of pale brown sclerotia, 1–2 mm diam., amongst white fungal growth at the base of the stem and on plant debris in the soil.
A wide range of cultivated plants and weeds are hosts, including beans, carrot, cucurbits, sweet pepper, sweet potato and taro.

Treatment: **11**

LYCOPERSICON ESCULENTUM

TOMATO

SOLANACEAE

Fulvia fulva
=Cladosporium fulvum

Tomato leaf mould

Site of infection: L

Importance of the disease: √√

Symptoms

Pale yellowish-green blotches on the upper leaf surface with pale areas below. Light grey spore masses form on the lower surface, becoming greenish-purple or brown later. Infected areas often merge and the leaf turns brown and withers, but usually remains attached to the plant. The disease appears first on the lower leaves and spreads upwards during cool wet periods.

Treatment: **54**

Photo: Kohler Collection

Photo: Kohler Collection

Photo: Kohler Collection

Alternaria solani

Photo: DPI Collection

Athelia rolfsii

Photo: Eric McKenzie

Photo: Eric McKenzie

Fulvia fulva

LYCOPERSICON ESCULENTUM

TOMATO

SOLANACEAE

Leveillula taurica
=Oidiopsis taurica

Powdery mildew

Site of infection: L

Importance of the disease: √√

Symptoms

Spots mainly on the underside of the leaf, at first yellow, later light brown. Symptoms are similar to those caused by leaf mould. Unlike other powdery mildew fungi, *Leveillula* does not grow on the surface of the leaf and it is difficult to see the spore masses of the fungus.
Chili, eggplant and sweet pepper are also hosts.

Treatment: **73**

LYCOPERSICON ESCULENTUM

TOMATO

SOLANACEAE

Thanatephorus cucumeris
=Rhizoctonia solani

Fruit rot, Stem canker

Site of infection: S,C,R

Importance of the disease: √√

Symptoms

Brown, circular, slightly sunken spots up to 25 mm diam. on the fruits, with concentric light and dark brown rings. As the fruits ripen, cracks appear in the rots and a brown fungal growth develops. Fruits near soil level are more susceptible to attack. Root and collar rot also occur and cause plants to wilt. In wet weather, white fungal growth covers the base of the stem.

Treatment: **135**

LYCOPERSICON ESCULENTUM

TOMATO

SOLANACEAE

Pseudomonas solanacearum

Bacterial wilt

Site of infection: L,S,R

Importance of the disease: √√√

Symptoms

If the disease develops slowly, lower leaves droop, leaflets curl downwards and adventitious roots develop along the stem; later the plants wilt. More commonly, plants turn slightly yellow and wilt suddenly. Internally, the vascular tissues and surrounding areas are brown. If a piece of the stem is placed in water, a white bacterial ooze streams from the cut surface. This is a diagnostic test for the disease.
Many plants are hosts, including eggplant, peanut, potato and sweet pepper.

Treatment: **115**

Photo: DPI Collection

Leveillula taurica

Photo: Kohler Collection

Photo: Kohler Collection

Thanatephorus cucumeris

Photo: Kohler Collection

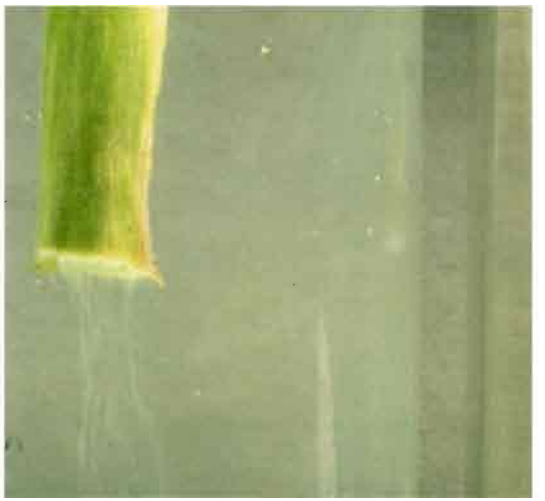

Photo: Kohler Collection

Pseudomonas solanacearum

LYCOPERSICON ESCULENTUM

TOMATO

SOLANACEAE

Xanthomonas campestris **pv.** ***vesicatoria***

Bacterial spot

Site of infection: L,S,Fr

Importance of the disease: √√√

Symptoms

Small, dark brown to black, irregular-shaped greasy spots on the leaves. Where infection is severe, leaves turn yellow and fall. On the fruit, small, raised, circular black spots with a water-soaked margin. The spots enlarge as the fruit increases in size becoming slightly sunken. Only the outer skin is affected.

Treatment: **154**

LYCOPERSICON ESCULENTUM

TOMATO

SOLANACEAE

Physiological disorder

Blossom-end rot

Site of infection: Fr

Importance of the disease: √√

Symptoms

Water-soaked spots at the flower end of the green fruit, enlarging, darkening and collapsing to form large black sunken areas. Secondary organisms invade the tissues. The disorder is caused by sudden reductions or irregular fluctuations in soil moisture levels. It is more common in light sandy soils. There is little agreement on nutritional factors which might contribute to the disorder.

Treatment: **17**

LYCOPERSICON ESCULENTUM

TOMATO

SOLANACEAE

Physiological disorder

Sun scald

Site of infection: Fr

Importance of the disease: √

Symptoms

On green fruit, when foliage is sparse due to defoliation by, for example, early blight. Fruits become yellow and ripen unevenly, or the injured areas become white and blistered, lose water, and develop flat, grey sunken paper-like spots. These areas may be invaded by secondary organisms and develop rots.

Treatment: **134**

Photo: Grahame Jackson

Photo: DPI Collection

Xanthomonas campestris pv. *vesicatoria*

Photo: Kohler Collection

Physiological disorder (Blossom-end rot)

Photo: Kohler Collection

Photo: Kohler Collection

Physiological disorder (Sun scald)

LYCOPERSICON ESCULENTUM

TOMATO

SOLANACEAE

Phytoplasma
=Mycoplasma-like organism

Big bud

Site of infection: L,S,Fl,Fr

Importance of the disease: √√

Symptoms

Stems become erect, short, thick and purple; flower buds become swollen, with green petals—hence the name of the disease—and normally dormant axillary buds develop shoots. Leaflets are small, curled upwards and yellowish-green or purple. Green fruits are hard, tough and woody.
Similar symptoms occur on potato, and many legumes are also hosts.

Treatment: **107**

MALUS x DOMESTICA

APPLE

ROSACEAE

Physiological disorder

Internal browning

Site of infection: Fr

Importance of the disease: √

Symptoms

From the outside, fruits appear healthy, but when cut show a browning of the flesh which deepens on exposure to the light. The disorder may be due to low storage temperatures during transport (low temperature breakdown), or to excess carbon dioxide in the storage atmosphere (brown heart).

Treatment: **70**

MANGIFERA INDICA

MANGO

ANACARDIACEAE

Glomerella cingulata
=Colletotrichum gloeosporioides

Anthracnose

Site of infection: L,Fl,Fr,S

Importance of the disease: √√√

Symptoms

Small black irregular-shaped spots on the leaves, sometimes restricted by the veins, but often expanding to form large areas that dry and fall out. New leaf flushes are especially susceptible to attack. In wet weather, infection of the flowers may lead to a blossom blight, resulting in low fruit set. On fruits, pinpoint infections expand as the fruits ripen, forming dark brown to black spots with pink spore masses developing at the centre.
Many other plants are hosts, including avocado, coffee, eggplant, papaya, sweet pepper, tomato and yams.

Treatment: **62**

Photo: DPI Collection

Photo: Kohler Collection

Phytoplasma (Big bud)

Photo: Kohler Collection

Physiological disorder (Internal browning)

Photo: Eric McKenzie

Photo: Eric McKenzie

Glomerella cingulata

MANGIFERA INDICA

MANGO

ANACARDIACEAE

Stigmina mangiferae
=Cercospora mangiferae

Angular leaf spot

Site of infection: L

Importance of the disease: √√

Symptoms

Spots at first scattered, black, circular to angular, up to 6 mm diam., surrounded by a wide greenish zone. Later, spots may merge forming large black areas. During wet weather the disease causes yellowing of the foliage and early leaf fall.

Treatment: **132**

MANGIFERA INDICA

MANGO

ANACARDIACEAE

Oidium sp.

Powdery mildew

Site of infection: L,Fl,Fr

Importance of the disease: √

Symptoms

White, powdery fungal growth over the shoots, flowers and young fruit. Fruits fall prematurely. On older fruits, brownish scabby areas may develop due to earlier infections. (*Oidium* sp. is the asexual stage of *Erysiphe* spp. and other powdery mildews).

Treatment: **87**

MANGIFERA INDICA

MANGO

ANACARDIACEAE

Xanthomonas campestris pv.
mangiferaeindicae

Black spot

Site of infection: L,S,Fr

Importance of the disease: √√

Symptoms

Black, angular, raised spots between the veins on the leaves, often with yellow haloes. The spots merge, destroying large areas of the leaf. Spots also occur on the leaf stalks and, on the stems, may lead to gum-filled cankers. On the fruits, black oval to irregular-shaped raised spots develop. These may join together, and cracks may form from which sap emerges.
Symptoms are similar to anthracnose and also to those of *Stigmina*, except the spots are more angular and they appear raised at the margins.

Treatment: **152**

Photo: Eric McKenzie

Photo: Kohler Collection

Stigmina mangiferae

Photo: Kohler Collection

Photo: Kohler Collection

Oidium sp.

Photo: Kohler Collection

Photo: Kohler Collection

Xanthomonas campestris pv. *mangiferaeindicae*

MANIHOT ESCULENTA

CASSAVA

EUPHORBIACEAE

Glomerella cingulata
=Colletotrichum gloeosporioides

Anthracnose

Site of infection: L,S

Importance of the disease: √

Symptoms

Leaf spots on young leaves, petioles and stems, causing partial or total defoliation and loss of tuber yield. Black shiny dots of the fruit bodies of the fungus commonly occur on the leaf spots. The disease appears to be much more serious in African than Pacific countries.
Many other plants are hosts, including avocado, coffee, eggplant, mango, papaya, sweet pepper, tomato and yams.

Treatment: **62**

MANIHOT ESCULENTA

CASSAVA

EUPHORBIACEAE

Mycosphaerella henningsii
=Cercosporidium henningsii

Brown leaf spot

Site of infection: L

Importance of the disease: √

Symptoms

Circular leaf spots, up to 15 mm diam., becoming angular and limited by veins, brown on upper surfaces with dark borders, sometimes surrounded by indistinct haloes. On the underside, the spots are grey with less distinct borders. The centres of the spots dry, crack and may fall out. The disease usually occurs on the older, lower leaves.

Treatment: **84**

MANIHOT ESCULENTA

CASSAVA

EUPHORBIACEAE

Periconia manihoticola

Anthracnose

Site of infection: L

Importance of the disease: √

Symptoms

Leaf spots, round, up to 10 mm diam., with small pale centres, brown borders, and wide greyish-purple haloes, often merging.

Treatment: **93**

Photo: Kohler Collection

Photo: Kohler Collection

Glomerella cingulata

Photo: Eric McKenzie

Mycosphaerella henningsii

Photo: Kohler Collection

Photo: Kohler Collection

Periconia manihoticola

MANIHOT ESCULENTA

CASSAVA

EUPHORBIACEAE

Xanthomonas campestris **pv.** *manihotis*

Cassava bacterial blight

Site of infection: L,S,Fr

Importance of the disease: √√√

Symptoms

Initially, angular water-soaked spots, more clearly seen on the lower leaf surface, sometimes with yellow haloes above, rapidly expanding and turning brown. Leaves wilt, dry out and fall. Leaf stalks are also attacked, leading to infection of stems and branch dieback. Pale yellow droplets form on the spots and ooze from cracks in the stems. Spots also occur on the fruits and seeds.

Treatment: **153**

MANIHOT ESCULENTA

CASSAVA

EUPHORBIACEAE

Cassava green mottle nepovirus

Cassava green mottle

Site of infection: L

Importance of the disease: √√

Symptoms

Faint or distinct yellow and green patterns, often on puckered leaves with distorted margins. Symptoms are most noticeable on the youngest leaves. Usually, plants recover to give slightly stunted, but otherwise apparently healthy shoots. Occasionally, plants remain severely stunted, without producing edible roots or, if formed, they are small, and woody when cooked. Reported only from the island of Choiseul in Solomon Islands.

Treatment: **21**

MEDICAGO SATIVA

LUCERNE

FABACEAE

Uromyces striatus

Rust

Site of infection: L

Importance of the disease: √√

Symptoms

Round or irregular-shaped pustules, mostly on the underside of the leaf. Infected leaves turn yellow and fall.

Treatment: **142**

Photo: Grahame Jackson

Photo: Grahame Jackson

Photo: Kohler Collection

Photo: Grahame Jackson

Photo: Grahame Jackson

Photo: Kohler Collection

Xanthomonas campestris pv. *manihotis*

Cassava green mottle nepovirus

Uromyces striatus

MOMORDICA CHARANTIA

BITTER MELON

CUCURBITACEAE

Colletotrichum sp.

Anthracnose

Site of infection: L,Fr

Importance of the disease: √

Symptoms

Large, irregular-shaped necrotic blotches on the leaves, flower stalks and fruits, leading to withering and death of the affected parts.

Treatment: **36**

MONSTERA DELICIOSA

SPLIT LEAF PHILODENDRON

ARACEAE

Puccinia paullula

Rust

Site of infection: L

Importance of the disease: √

Symptoms

Leaf spots, round, yellow to orange, either isolated or joining together. The spots are smooth on the upper surface of the leaf, and powdery below, due to the production of spores.

Treatment: **118**

MUSA SP.

BANANA

MUSACEAE

Cordana musae

Cordana leaf spot

Site of infection: L

Importance of the disease: √

Symptoms

Large leaf spots, up to 100 mm, pale brown or yellow, oval or diamond-shaped, usually surrounded by a yellow halo. The spots occur on and between the veins. Often the entire edge of the leaf may be infected with an uneven, zigzag, yellow band separating diseased from green tissues. Infections often occur on leaf spots caused by the black-cross fungus, *Phyllachora musicola*, or leaf blotches associated with *Deightoniella torulosa*.

Treatment: **40**

Photo: Kohler Collection

Colletotrichum sp.

Photo: Kohler Collection

Puccinia paullula

Photo: Kohler Collection

Cordana musae

MUSA SP.

BANANA

MUSACEAE

Fusarium oxysporum f. sp. *cubense*

Fusarium wilt, Panama disease

Site of infection: S,R

Importance of the disease: √√√

Symptoms

Leaf margins turn yellow, then brown, and the leaf tissue dies towards the midrib; older leaves wilt and hang down around the pseudostem. Occasionally, on some varieties, the stems split. Internally, the water-conducting strands of the stem, leaf and bunch stalks turn yellow, red, brown or black. If bunches develop they rarely fill properly. Suckers may also show similar symptoms. The roots decay and the plants collapse and die.

Treatment: **58**

MUSA SP.

BANANA

MUSACEAE

Guignardia musae
=Phyllosticta musarum

Freckle

Site of infection: L,Fr

Importance of the disease: √

Symptoms

Raised black pinpoint spots occurring in groups on the upper surface of the leaves and also on the fruit. The spots contain the fruiting bodies of the fungus.

Treatment: **67**

MUSA SP.

BANANA

MUSACEAE

Marasmiellus inoderma

Stem rot

Site of infection; L,S,R

Importance of the disease: √√

Symptoms

Outer leaf sheaths and leaf blades wither and decay, leaves are slow to emerge and are stunted. White or pink fungal growth commonly occurs between the leaf sheaths, and in wet weather mushrooms develop on the pseudostem and on debris on the soil. The roots may also be attacked.
Coconut (embryo and basal shoot rot), maize and rice (root rots), and taro (shallow corm rot) are also hosts.

Treatment: **78**

Photo: DPI Collection

Fusarium oxysporum f. sp. *cubense*

Photo: DPI Collection

Guignardia musae

Photo: Kohler Collection

Marasmiellus inoderma

Photo: DPI Collection

Photo: DPI Collection

Photo: Eric McKenzie

MUSA SP.

BANANA

MUSACEAE

Mycosphaerella fijiensis
=Paracercospora fijiensis

Black Sigatoka, Black leaf streak

Site of infection: L

Importance of the disease: √√√

Symptoms

Red-brown streaks, initially 1–5 mm long and 0.25 mm wide, on the underside of the third or fourth leaf, gradually forming elongated spots with grey or light brown centres and dark brown or black margins. Yellow zones occur between diseased and healthy tissues. In severe attacks, spots do not occur, but large areas of the leaf turn black, dry out and wither. A characteristic of the disease is the occurrence of streaks in bands several cm wide on either side of the midrib; sometimes the streaks are more numerous at the tips and edges of the leaves.

Treatment: **83**

MUSA SP.

BANANA

MUSACEAE

Mycosphaerella musicola
=Pseudocercospora musae

Sigatoka, Yellow Sigatoka

Site of infection: L

Importance of the disease: √√√

Symptoms

Yellowish streaks, at first on the third or fourth leaf, 3–4 mm long and 1 mm wide, enlarging into elliptical grey spots with a dark brown border, up to 15 mm long and 5 mm wide. In wet weather, the spots merge to form large, grey-brown, dry, dead areas and the leaves collapse prematurely and hang down around the pseudostem. At harvest, few leaves remain and the bunches are small and ripen early.
In most islands of the Pacific, *M. musicola* appears to have been replaced by *M. fijiensis*.

Treatment: **85**

MUSA SP.

BANANA

MUSACEAE

Phyllachora musicola

Black-cross

Site of infection: L

Importance of the disease: √

Symptoms

Black four-pointed stars, up to 60 mm long, most prominent on the lower surface of older leaves, with the long axis of the star parallel to the leaf veins. The spots are scattered or sometimes occur in large groups. Spores develop on the dark lines. Sometimes, *Cordana musae* leaf spots are centred on the black-cross lesions.

Treatment: **102**

Photo: Grahame Jackson

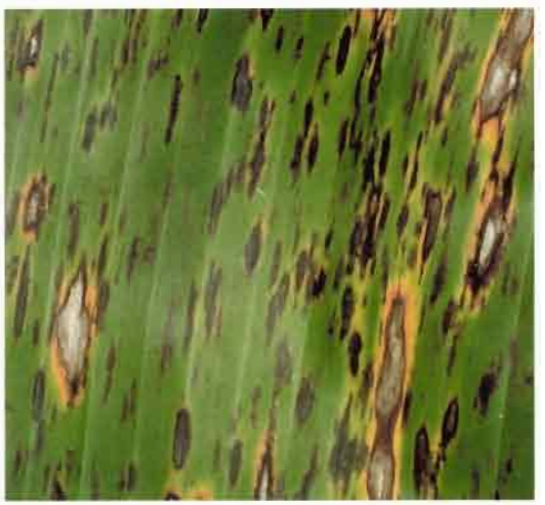

Photo: Eric McKenzie

Mycosphaerella fijiensis

Photo: Kohler Collection

Mycosphaerella musicola

Photo: Brian Thistleton

Photo: Brian Thistleton

Phyllachora musicola

MUSA SP.

BANANA

MUSACEAE

Uredo musae

Rust

Site of infection: L

Importance of the disease: √

Symptoms

Pustules on both sides of the leaf surface, but more numerous on the lower surface, often associated with small dark streaks up to 3 mm long. The streaks sometimes merge to form speckled blotches. Early symptoms are similar to those of yellow Sigatoka.

Treatment: **139**

MUSA SP.

BANANA

MUSACEAE

Verticillium theobromae

Cigar end rot

Site of infection: Fr

Importance of the disease: √

Symptoms

Firm rot, spreading slowly, up to 20 mm, along the fruit, beginning from a flower infection. Affected areas blacken and shrink; later, they become covered with the spores of the fungus and resemble the ash of a cigar—hence the name of the disease. The tissues inside the fruit develop a dry rot, with a sharp margin between diseased and healthy tissues.

Treatment: **149**

MUSA SP.

BANANA

MUSACEAE

Erwinia spp.

Wilt

Site of infection: L,S

Importance of the disease: √

Symptoms

Wilting and death of leaves before the fruit has ripened. The centre of the pseudostem rots, with some discolouration of the vascular tissues of the outer leaf sheaths, sometimes extending into the stalk of the fruit. The disease has been identified on a local variety in the Federated States of Micronesia, although a similar condition is reported from Marshall Islands. *E. chrysanthemi* and *E. carotovora* have been isolated from affected plants.

Treatment: **53**

Photo: Grahame Jackson

Uredo musae

Photo: Kohler Collection

Verticillium theobromae

Photo: Eric McKenzie

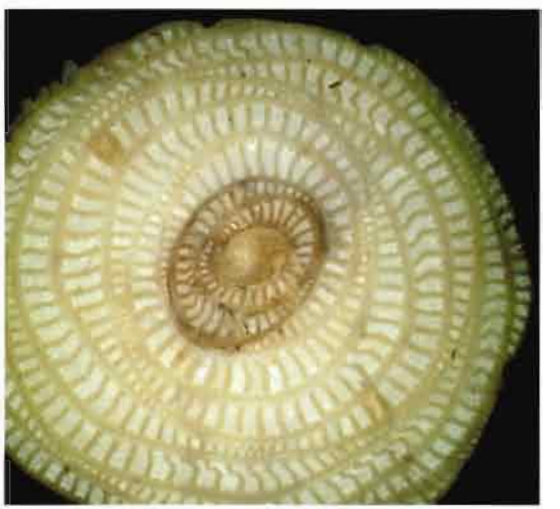

Photo: Eric McKenzie

Erwinia spp.

MUSA SP.
BANANA
MUSACEAE

Radopholus similis

Radopholus root rot

Site of infection: S,R

Importance of the disease: √√√

Symptoms

Reddish-brown or black rots, often several cm long, on the root, sometimes with cracks. The areas of rot are at first outside the vascular tissues; later, they spread throughout the root, causing total decay. As the nematode burrows into the corm, black spots with red margins develop. These rots, known as 'blackheads', may extend up to 20 mm into the corms. Plants are weakened by the root attack and are readily blown over during storms.
Many crops are hosts, including bele, giant swamp taro, ginger, legumes, maize and yams.

Treatment: **123**

MUSA SP.
BANANA
MUSACEAE

Banana bunchy top nanavirus

Banana bunchy top

Site of infection: L,S

Importance of the disease: √√√

Symptoms

Initially, dark green dots and streaks, up to 25 mm in length, on the veins of leaves otherwise of normal appearance. The dark lines continue into the midrib as 'hooks'. Yellowing of the veins may also occur. Subsequent leaves show the same symptoms and are progressively smaller, erect and brittle, with pale ragged necrotic margins. The stunted leaves become bunched—hence the name of the disease. Symptoms can appear on plants of all ages. If they occur at an early stage of development, plants fail to produce fruit.

Treatment: **13**

MUSA SP.
BANANA
MUSACEAE

Banana streak badnavirus

Banana streak

Site of infection: L

Importance of the disease: √√

Symptoms

Broken or continuous chlorotic streaks and narrow lesions, either scattered or in bands on the leaves. The streaks and lesions become necrotic, producing black-streak patterns as the leaves age. Initially, they appear similar to those caused by cucumber mosaic cucumovirus. Infected plants may be smaller than normal and less vigorous, with small bunches. In some African countries, dieback and internal necrosis of the pseudostem occur.

Treatment: **14**

Photo: John Bridge

Photo: Grahame Jackson

Photo: John Thomas

Photo: DPI Collection

Photo: DPI Collection

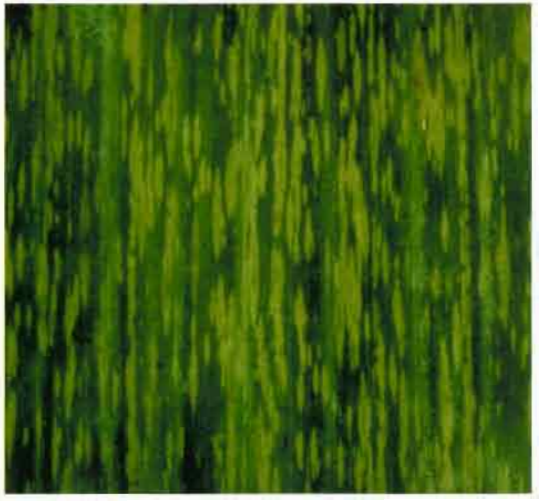

Photo: John Thomas

Radopholus similis

Banana bunchy top nanavirus

Banana streak badnavirus

MUSA SP.

BANANA

MUSACEAE

Cucumber mosaic cucumovirus

Banana mosaic

Site of infection: L

Importance of the disease: √

Symptoms

Yellow streaks or flecks, sometimes with mild distortions. Usually, symptoms occur on a few leaves only, after which apparently healthy leaves are produced.
Many crop plants and weeds are hosts, including cucurbits, legumes and members of the Solanaceae, for example, tomato and potato.

Treatment: **43**

ORYZA SATIVA

RICE

POACEAE

Magnaporthe salvinii
=Nakataea sigmoidea

Stem rot

Site of infection: L,S

Importance of the disease: √√

Symptoms

Small, black irregular spots on the outer leaf sheath near the waterline. As the spots enlarge, the leaf sheath is partially or completely decayed and small black sclerotia form in the rotted tissues. Subsequently, the fungus invades the stem and the plant collapses. Dark fungal growths and sclerotia occur inside the stem.

Treatment: **74**

PASPALUM DILATATUM

PASPALUM, DALLIS GRASS

POACEAE

Cerebella andropogonis

Site of infection: Fr

Importance of the diseases: √

Symptoms

Brown-black spore masses with deep folds, developing on grass spikelets infected with ergot fungi (*Claviceps* spp.), and preventing the formation of ergot sclerotia.
Many grasses are hosts.

Treatment: **28**

Photo: DPI Collection

Cucumber mosaic cucumovirus

Photo: Kohler Collection

Magnaporthe salvinii

Photo: Kohler Collection

Cerebella andropogonis

PASSIFLORA EDULIS

PASSIONFRUIT

PASSIFLORACEAE

Alternaria alternata

Brown spot

Site of infection: L,S,Fr

Importance of the disease: √√

Symptoms

Small spots with yellow or light-orange haloes on the leaves, up to 6 mm wide. Spots on the fruit have light brown centres with greasy, water-soaked margins, usually less than 10 mm diam.

Treatment: **5**

PASSIFLORA EDULIS

PASSIONFRUIT

PASSIFLORACEAE

Alternaria passiflorae

Brown spot

Site of infection: L,S,Fr

Importance of the disease: √√

Symptoms

Brown spots, up to 10 mm diam., on the leaves, often extending along the veins and drying out in the centre. On the stems, spots are up to 30 mm long, and when they occur at the leaf axils may kill the vine, resulting in dieback. On the fruit, the spots are light brown, round, and sunken; they often merge, covering large areas, and produce red-brown spore masses.
Brown spot of fruit and leaves in Hawaii, Niue, Vanuatu and Western Samoa is associated with *A. alternata*. In Hawaii, this species has displaced *A. passiflorae*, and may also have done so in the other countries.

Treatment: **5**

PASSIFLORA EDULIS

PASSIONFRUIT

PASSIFLORACEAE

Glomerella cingulata
=Colletotrichum gloeosporioides

Anthracnose

Site of infection: L,Fr

Importance of the disease: √√

Symptoms

White spots, up to 5 mm diam., on the leaves and fruits, developing into larger wrinkled rots on the fruits after harvest and covering part or all of the surface. On purple passionfruit, the spots are raised. Black fruiting bodies occur within the spots and the pink spore masses of the fungus become obvious during wet weather.
Many other plants are hosts, including avocado, coffee, eggplant, mango, papaya, sweet pepper, tomato and yams.

Treatment: **62**

Photo: DPI Collection

Photo: DPI Collection

Alternaria alternata

Photo: DPI Collection

Alternaria passiflorae

Photo: Kohler Collection

Photo: Kohler Collection

Photo: Kohler Collection

Glomerella cingulata

PASSIFLORA EDULIS

PASSIONFRUIT

PASSIFLORACEAE

Passionfruit woodiness potyvirus

Passionfruit woodiness virus

Site of infection: L

Importance of the disease: √√√

Symptoms

Yellow spots, yellow and green mosaic patterns with puckering and crinkling over large areas of the leaf. Fruits are small, deformed, with a thick hard rind, and have a small cavity. Infected plants defoliate and die back. The purple passionfruit is particularly susceptible to the virus.
Wild passionfruit (*P. foetida*) and legumes, including centro, peanut, soybean and siratro are also hosts.

Treatment: **90**

PASSIFLORA QUADRANGULARIS

GRANADILLA

PASSIFLORACEAE

Alternaria passiflorae

Brown spot

Site of infection: L,S,Fr

Importance of the disease: √

Symptoms

Symptoms are similar to those on passionfruit. Light brown, deeply sunken spots develop on the fruits, covered with dark spore masses of the fungus. Internal rots develop, which make the fruits unsuitable for consumption.

Treatment: **5**

PELARGONIUM ZONALE

GERANIUM

GERANIACEAE

Puccinia pelargonii-zonalis

Rust

Site of infection: L

Importance of the disease: √√

Symptoms

Concentric circles of rust-coloured pustules on the lower leaf surface, surrounded by light green haloes, with green spots on the corresponding upper surface. As the disease progresses, the leaves turn yellow, but the affected areas remain green. Plants may become defoliated during severe attacks.

Treatment: **118**

Photo: Grahame Jackson

Photo: Wolfgang Gerlach

Passionfruit woodiness potyvirus

Photo: Kohler Collection

Alternaria passiflorae

Photo: Kohler Collection

Puccinia pelargonii-zonalis

PERSEA AMERICANA

AVOCADO

LAURACEAE

Cephaleuros virescens

Algal leaf spot, Red rust

Site of infection: L

Importance of the disease: √

Symptoms

Circular spots, 2–4 mm diam., green or red-orange, usually on the upper leaf surface. Generally, the infections are of little economic importance, although they can cause premature leaf fall and weaken the tree during severe attacks. This may occur in areas where rainfall is very high.
Many other trees are hosts, including black pepper, breadfruit, citrus, cocoa, guava, mango, and soursop. Two other species, *C. minimus* and *C. parasiticus*, are also present in the Pacific.

Treatment: **23**

PERSEA AMERICANA

AVOCADO

LAURACEAE

Glomerella cingulata
=Colletotrichum gloeosporioides

Anthracnose

Site of infection: L,Fr

Importance of the disease: √√

Symptoms

Small, light brown circular spots on ripe fruit, enlarging rapidly and forming dark brown sunken areas of rot which cause extensive internal decay. In wet weather, these become covered in pink spore masses of the fungus. Similar symptoms develop from wounds made on immature fruit, leading to fruit drop. On leaves, large light brown spots develop which may spread over the entire leaf blade, causing early leaf fall.
Many other plants are hosts, including coffee, eggplant, mango, papaya, sweet pepper, tomato and yams.

Treatment: **62**

PERSEA AMERICANA

AVOCADO

LAURACEAE

Lasiodiplodia theobromae
=Diplodia natalensis

Stem end rot

Site of infection: Fr

Importance of the disease: √

Symptoms

Brown to black fruit rot developing in storage or during transport. The first sign of the disease is a browning at the stem end, after which the rot spreads rapidly through the flesh. After 8–10 days, the skin becomes covered in the black fruiting bodies of the fungus, which sometimes release masses of whitish spores.
Many plants are host to this common wound fungus, including breadfruit, citrus, cocoa and mango.

Treatment: **71**

Photo: Kohler Collection

Photo: Kohler Collection

Photo: Kohler Collection

Photo: Kohler Collection

Cephaleuros virescens

Photo: DPI Collection

Glomerella cingulata

Photo: Kohler Collection

Lasiodiplodia theobromae

PHASEOLUS VULGARIS

FRENCH BEAN

FABACEAE

Glomerella cingulata
=Colletotrichum gloeosporioides

Anthracnose

Site of infection: L

Importance of the disease: √

Symptoms

Round, light brown irregular-shaped spots on the leaves, spreading rapidly over the leaf surface. The spots dry out, the centres fall out, and the leaves drop prematurely. Many other plants are hosts, including avocado, coffee, eggplant, mango, papaya, sweet pepper, tomato and yams.

Treatment: **62**

PHASEOLUS VULGARIS

FRENCH BEAN

FABACEAE

Phaeoisariopsis griseola
=Isariopsis griseola

Angular leaf spot

Site of infection: L,Fr,S

Importance of the disease: √

Symptoms

Angular spots on the trifoliate leaves, up to 3 mm wide, limited by the veins, grey to light brown. On the primary leaves, the spots are up to 15 mm diam., and often zoned. Fungal growth develops on the undersides of both types of spot. Dark sunken spots of varying size also occur on the pods and stems.

Treatment: **97**

PHASEOLUS VULGARIS

FRENCH BEAN

FABACEAE

Uromyces appendiculatus **var.** *appendiculatus*

Rust

Site of infection: L

Importance of the disease: √

Symptoms

Pustules, at first light green; later, as spore masses develop, dark brown, 1–2 mm diam., and surrounded by yellow haloes. The pustules occur on both sides of the leaf. The leaves yellow prematurely, but the areas around the pustules remain green.

Treatment: **141**

Photo: Kohler Collection

Glomerella cingulata

Photo: Kohler Collection

Photo: DPI Collection

Phaseoisariopsis griseola

Photo: Kohler Collection

Uromyces appendiculatus var. *appendiculatus*

PHASEOLUS VULGARIS

FRENCH BEAN

FABACEAE

Meloidogyne spp.

Root-knot nematodes

Site of infection: R

Importance of the disease: √√√

Symptoms

Galls are best seen when roots are washed. Above-ground symptoms are similar to those caused by lack of nutrients or water. Plants may be stunted, yellow and wilt. Symptoms may be particularly severe if infections occur soon after planting. More often they occur at maturity, when plants begin to wilt and die back. In this case, fruit set and fruit formation are also affected. Disease is often worse in sandy and free-draining soils. Infection by root-knot nematodes facilitates the entry of fungal and bacterial pathogens.
Many other plants are hosts, including banana, carrot, cucurbits, ginger (lower photograph), lettuce, okra, pulse crops, tobacco and yam.
Macroptilium atropurpureum is also a host.

Treatment: **79**

PINUS CARIBAEA

CARIBBEAN PINE

PINACEAE

Cassytha filiformis

Parasitic plant

Site of infection: L,S

Importance of the disease: √

Symptoms

The tendrils, which have suckers, wind around and become attached to the host plants. Generally not important, although it may damage plants in the nursery and those newly planted in the field.

Treatment: **22**

PIPER METHYSTICUM

KAVA

PIPERACEAE

Cucumber mosaic cucumovirus

Kava wilt, Dieback

Site of infection: L,S,R

Importance of the disease: √√√

Symptoms

Yellowing of veins and yellow and green patterns on crinkled and puckered leaves. The stems below the infected leaves show brown streaks and/or patches of rot in the vascular and surrounding tissues. Sometimes, internal discoloured areas also occur in stems at soil level and in the roots. Later, after 3–4 weeks, the symptoms in the stems are noticeable externally. Large, black, soft rots develop and these cause the stems to break, often at the nodes. New shoots may develop from the base of the plants and these, too, show symptoms of the disease. Cucumber mosaic virus exists as a number of strains and has a very wide host range, including cucurbits, legumes and solanaceous species.

Treatment: **43**

Photo: John Bridge

Photo: DPI Collection

Meloidogyne spp.

Photo: Kohler Collection

Photo: Kohler Collection

Cassytha filiformis

Photo: Richard Davis

Photo: Richard Davis

Cucumber mosaic cucumovirus

PLUMERIA SPP.

FRANGIPANI

APOCYNACEAE

Coleosporium plumeriae

Rust

Site of infection: L

Importance of the disease: √√√

Symptoms

Pustules occur on the under surface of the leaves, releasing spore masses which cover them in a fine yellow-red layer. The disease occurred for the first time in the Pacific Islands in 1990 and rapidly defoliated susceptible varieties.

Treatment: **33**

PLUMERIA SPP.

FRANGIPANI

APOCYNACEAE

Sooty mould fungi

Sooty mould

Site of infection: L,S

Importance of the disease: √

Symptoms

Brown-black mould on leaves and stems. The fungus does not penetrate the plant; growth is superficial and can easily be scraped off. Fungi causing sooty moulds grow on the secretions of insects, mealybugs, scale insects and aphids, in particular.
Many other plants are hosts, including citrus, guava and mango.

Treatment: **129**

PRUNUS PERSICA

PEACH

ROSACEAE

Fusarium oxysporum

Wilt

Site of infection: S,C,R

Importance of the disease: √√

Symptoms

Root rot and wilt of the foliage. Young plants are particularly susceptible to attack by this soil fungus. The disease is more serious in soils low in organic matter.

Treatment: **57**

Photo: Kohler Collection

Coleosporium plumeriae

Photo: Eric McKenzie

Sooty mould fungi

Photo: Kohler Collection

Fusarium oxysporum

PRUNUS PERSICA

PEACH

ROSACEAE

Tranzschelia discolor

Rust

Site of infection: L,Fr,S

Importance of the disease: √√√

Symptoms

Small, irregular-shaped spots, at first pale yellow, on both sides of the leaf, later brown with yellow haloes and covered on the under surface with brown, powdery spore masses. Infected leaves turn yellow and fall; normally this occurs from the base of a shoot towards the tip. On the fruits, light brown, circular, sunken spots up to 5 mm wide. Spots may merge and develop cracks. Small pale to dark brown, slightly raised cankers may develop on the new shoots.
The taxonomy of this fungus is uncertain; two forms are recognised: *T. pruni-spinosae* on wild species of *Prunus* and *T. discolor* on cultivated varieties.

Treatment: **137**

PSIDIUM GUAJAVA

GUAVA

MYRTACEAE

Glomerella cingulata
=Colletotrichum gloeosporioides

Anthracnose, Dieback, Fruit rot

Site of infection: S,Fr

Importance of the disease: √√

Symptoms

Bands of blackening on the fruits, extending around the central parts, with the upper and lower parts remaining green at first. Later, white, orange or pink fungal growth becomes visible on the rot. Fruits of all stages are susceptible. Infection of young stems results in dieback. Guavas are often severely attacked by fruit flies and it is possible that anthracnose is associated with damage caused by these insects.
Many other plants are hosts, including avocado, eggplant, mango, papaya, sweet pepper, tomato and yams.

Treatment: **62**

PSIDIUM GUAJAVA

GUAVA

MYRTACEAE

Pestalotiopsis disseminata

Fruit rot

Site of infection: L,Fr

Importance of the disease: √√

Symptoms

On the fruits, maroon rots beginning at the stalk end, rapidly expanding, and surrounded by folds of wrinkled skin. Fruiting bodies of the fungus form on the rots and these are at first white and then brown. Fruits can be totally destroyed by the attack. The fungus is also associated with grey leaf lesions.

Treatment: **96**

Photo: Kohler Collection

Photo: Kohler Collection

Tranzschelia discolor

Photo: Eric McKenzie

Photo: Eric McKenzie

Glomerella cingulata

Photo: Kohler Collection

Pestalotiopsis disseminata

RAPHANUS SATIVUS

RADISH

BRASSICACEAE

Albugo candida

White rust

Site of infection: L

Importance of the disease: √√

Symptoms

Pustules on leaves and petioles, at first round, smooth, white and shiny, 1–2 mm diam.; later, powdery on the under surface when the spores are released. The pustules may merge to form larger patches. Severe attack results in distorted leaves which wilt and die.
Chinese cabbage and radish, as well as many cruciferous weeds, are also hosts.

Treatment: **3**

RAPHANUS SATIVUS

RADISH

BRASSICACEAE

Xanthomonas campestris pv. *campestris*

Bacterial root rot, Black rot

Site of infection: L,S,R

Importance of the disease: √

Symptoms

Internally, a blackening of the vascular tissues of the roots, spreading to surrounding tissues.
Many other crucifers are hosts, often producing characteristic yellowish V-shaped areas at the leaf margin in which the veins are clearly visible. The blackened veins may extend into the petiole and stem.
This bacterium is more commonly associated with black rot of cabbage (lower photograph), cauliflower, Chinese cabbage and other crucifers.

Treatment: **150**

SACCHARUM EDULE

DURUKA

POACEAE

Sugarcane Fiji disease fijivirus

Fiji disease

Site of infection: L,S

Importance of the disease: √√

Symptoms

Galls on the veins, on the underside of the leaf blade, on midribs, and on the outside of the leaf sheath, varying in length from less than 1 mm to 50 mm, and 2–3 mm wide. The galls are green at first, later, greenish-white. Infected plants have a grasslike appearance: leaves are dark green, stiff and short, and plants also look as if they have been grazed by animals.
Other *Saccharum* species, including sugarcane (lower photograph), are hosts.

Treatment: **133**

Photo: Kohler Collection

Albugo candida

Photo: Kohler Collection

Photo: DPI Collection

Xanthomonas campestris pv. *campestris*

Photo: Robin Palmer

Photo: Bureau of Sugar Experiment Stations

Sugarcane Fiji disease fijivirus

SACCHARUM OFFICINARUM

SUGARCANE

POACEAE

Ceratocystis paradoxa
=Chalara paradoxa

Pineapple disease

Site of infection: S

Importance of the disease: √√

Symptoms

A disease of planting setts. Reddening on stems, followed by black areas of rot with a characteristic pineapple smell. Buds fail to grow, and those that do die back or remain stunted. Banana, coconut and pineapple are also hosts.

Treatment: **24**

SACCHARUM OFFICINARUM

SUGARCANE

POACEAE

Deightoniella papuana

Veneer blotch

Site of infection: L

Importance of the disease: √

Symptoms

Leaf spots, initially small, oval, light green to pale yellow with a thin red-brown margin. Later, they become surrounded by a succession of 2–12 spots, each with a light green interior, becoming light brown, and outlined by a 0.5–1 mm wide dark red border.

Treatment: **48**

SACCHARUM OFFICINARUM

SUGARCANE

POACEAE

Elsinoe sacchari
=Sphaceloma sacchari

White rash, White speck

Site of infection: L

Importance of the disease: √

Symptoms

White oval spots, usually on the upper leaf surface, midribs and leaf sheaths, up to 3 mm long and 1 mm wide, with red-brown margins. Sometimes, the spots merge to form long narrow streaks.

Treatment: **51**

Photo: Bureau of Sugar Experiment Stations

Ceratocystis paradoxa

Photo: Grahame Jackson

Deightoniella papuana

Photo: Eric McKenzie

Elsinoe sacchari

SACCHARUM OFFICINARUM

SUGARCANE

POACEAE

Glomerella tucumanensis
=Colletotrichum falcatum

Red rot

Site of infection: L,S

Importance of the disease: √√

Symptoms

Small red oval spots on the midrib of the upper leaf surface, developing pale yellow to white centres, sometimes merging to cover the length of the leaf. Similar spots also occur on the leaf blades. Stems are affected by internal red rots with white patches, usually seen only when they are cut open. As the rots develop, the canes are easily broken.
Maize, sorghum and some grasses are also hosts.

Treatment: **63**

SOLANUM TUBEROSUM

POTATO

SOLANACEAE

Alternaria solani

Early blight, Target spot

Site of infection: L,S

Importance of the disease: √√√

Symptoms

Oval or angular leaf spots, at first 3–4 mm diam., later, up to 20 mm, dark brown to black with concentric zones and yellow haloes—hence one of the common names of the disease. When the spots are numerous the leaves fall prematurely. The disease usually starts on the lower leaves, moving upwards. Spots may develop on the stems and tubers.
Early blight is an important disease on potato and tomato, causing severe defoliation and large yield losses.

Treatment: **7**

SOLANUM TUBEROSUM

POTATO

SOLANACEAE

Thanatephorus cucumeris
=Rhizoctonia solani

Black scurf

Site of infection: L,S

Importance of the disease:√√

Symptoms

Brown, dry sunken spots on the stems, sometimes developing into cankers and causing stunting. Young shoots may be attacked as they grow from the seed piece and killed before emergence. Roots and stolons may also be infected. Brown or black sclerotia form on the tubers and these are firmly attached to the skin, but rots do not develop from them.
Many other plants are hosts, including cabbage, lettuce, legumes, tomato and yams. On seedlings, *R. solani* commonly causes pre- and post-emergence damping-off.

Treatment: **135**

Photo: Eric McKenzie

Glomerella tucumanensis

Photo: Kohler Collection

Photo: Kohler Collection

Alternaria solani

Photo: Kohler Collection

Photo: Kohler Collection

Thanatephorus cucumeris

SOLANUM TUBEROSUM

POTATO

SOLANACEAE

Erwinia spp.

Blackleg, Storage rot

Site of infection: L,S

Importance of the disease: √√

Symptoms

In the field, bacteria within the infected planting sett move into the shoot base, up the stem and into the above-ground parts causing dark brown to black basal stem rots—the blackleg symptom. Plants may wilt in hot weather. Daughter tubers are invaded through the stem end and develop brown wet soft rots. Tubers damaged in storage develop cream to light brown wet soft rots with a strong foul smell.
Three bacteria can cause rots of this kind: *E. carotovora* pv. *carotovora*, *E. carotovora* pv. *atroseptica* and *E. chrysanthemi*. The last two are more common in the tropics.

Treatment: **52**

SOLANUM TUBEROSUM

POTATO

SOLANACEAE

Potato leafroll luteovirus

Potato leafroll virus

Site of infection: L,S

Importance of the disease: √√

Symptoms

On plants grown from infected tubers, leaves become rolled upwards at the margins, beginning on the lower leaves. Tubers, if they develop, may be affected by an internal net browning, but this depends on variety. Plants may be stunted. If plants are infected by aphids, the symptoms appear first on the younger leaves, which become red, rolled and erect.
Tomato is also a host.

Treatment: **108**

SOLANUM TUBEROSUM

POTATO

SOLANACEAE

Phytoplasma
=Mycoplasma-like organism

Purple top wilt

Site of infection: L,S

Importance of the disease: √√

Symptoms

Leaves roll upwards and leaflets become pale yellow, or purple on pigmented varieties. Plants become stiff and erect. Normally dormant buds in the axils of the leaves grow, giving the shoots a bushy appearance. Aerial tubers may form in the leaf axils. Eventually the plants wilt, and at this stage a brown discoloration occurs in the vascular tissues at the base of the stems. The discoloration may extend along the stolons into the daughter tubers. The last stages of the disease can easily be mistaken for wilt associated with *Fusarium* spp.

Treatment: **107**

Photo: Kohler Collection

Erwinia spp.

Photo: DPI Collection

Photo: DPI Collection

Potato leafroll luteovirus

Photo: Kohler Collection

Photo: Kohler Collection

Phytoplasma (Purple top wilt)

TACCA LEONTOPETALOIDES

ARROWROOT

TACCACEAE

Cercospora taccae

Leaf spot

Site of infection: L

Importance of the disease: √√

Symptoms

On mature leaves, round to irregular grey-brown spots surrounded by bright yellow haloes. The spots merge and cause a yellowing and drying of the foliage; consequently tuber development is poor.

Treatment: **25**

THEOBROMA CACAO

COCOA

STERCULIACEAE

Marasmius crinisequi

Horse-hair blight

Site of infection: L,S

Importance of the disease: Nil

Symptoms

Saprophytic. Smooth black fungal threads (rhizomorphs) overrun leaves and stems of living trees. The tangle of threads which develop retains dead leaves. This gives the false impression of excessive leaf fall due to infection by the fungus, but some of the suspended leaves may have matured and fallen due to natural processes.

Treatment:

THEOBROMA CACAO

COCOA

STERCULIACEAE

Oncobasidium theobromae

Vascular streak dieback

Site of infection: L,Fr,T

Importance of the disease: √√√

Symptoms

Scattered green spots against a yellow background on one to two leaves up to 1 m behind the shoot tip. After a few days the leaves fall and those above and below begin to show similar symptoms. Lenticels enlarge, giving the bark a rough appearance. Axillary buds develop. Growth of the diseased shoot slows, symptoms spread to the lateral branches and the tree dies. White spore-producing bodies form from the leaf scars. When diseased stems are split open, a diagnostic brown streaking is present in the vascular tissues.

Treatment: **88**

Photo: Kohler Collection

Photo: Kohler Collection

Cercospora taccae

Photo: Grahame Jackson

Marasmius crinisequi

Photo: Chris Prior

Photo: Chris Prior

Oncobasidium theobromae

THEOBROMA CACAO

COCOA

STERCULIACEAE

Phanerochaete salmonicolor
=Corticium salmonicolor

Pink disease

Site of infection: S,T

Importance of the disease: √√

Symptoms

Branches and trunks are covered in a whitish pink crust which fades to cream with age. Often, the first symptom of the disease is the sudden death of an entire branch, with the brown leaves remaining attached. The bark may crack and gum may form. Spread of the fungus to the jorquette may result in death of the tree.
Many other plants are hosts, including black pepper, citrus, coffee, rubber, tea and some forest trees.

Treatment: **98**

THEOBROMA CACAO

COCOA

STERCULIACEAE

Phellinus noxius

Brown root and collar rot

Site of infection: T,R

Importance of the disease: √√

Symptoms

Roots become encrusted with soil which is held together by the thick brown growth of the fungus. On the trunk, the fungal growth, which may show a white margin, can reach 1.5 m from ground level. Cracks may occur in the bark through which gum may exude, and the wood becomes discoloured and dry. Trees suddenly wilt when the fungus destroys the roots or girdles the trunks. The disease often spreads along the line of trees. Fruit bodies may form several years after the death of the tree, on logs and stumps of forest trees or on those used for shade.
Many other trees are hosts, including coffee, *Leucaena* sp. (lower photograph), mango, oil palm and forest trees.

Treatment: **100**

THEOBROMA CACAO

COCOA

STERCULIACEAE

Phytophthora palmivora

Black pod, Canker, Leaf blight

Site of infection: L,Fr,T

Importance of the disease: √√√

Symptoms

Angular brown spots on leaves and succulent stems, causing a blight of young shoots and seedlings in wet weather. Brown spots on the fruits expand rapidly producing a white fungal growth containing spores behind the margin. Fruits blacken within a few days. Red or brown cankers develop as the fungus grows from the fruit into the branch and trunk. Girdling leads to branch death and dieback.
Many other plants are hosts, including black pepper, breadfruit, coconut, papaya and vanilla.

Treatment: **104**

Photo:Wolfgang Gerlach

Photo: Grahame Jackson

Phanerochaete salmonicolor

Photo: Chris Prior

Photo: Chris Prior

Photo: Grahame Jackson

Phellinus noxius

Photo: Kohler Collection

Photo: Chris Prior

Photo: Chris Prior

Phytophthora palmivora

TRITICUM AESTIVUM

WHEAT

POACEAE

Ustilago tritici

Loose smut

Site of infection: Fl,Fr

Importance of the disease: √√

Symptoms

The flower head, except the stalk, is replaced by smut spore masses. The spores are black, dry and powdery, and they are often blown away by the wind, leaving only the bare stalk and the remains of the flower parts.

Treatment: **145**

VANDA SP.

VANDA

ORCHIDACEAE

Glomerella cingulata
=Colletotrichum gloeosporioides

Anthracnose

Site of infection: L,S

Importance of the disease: √

Symptoms

Large brown blotches on the leaves, often starting at the tips. Flower stalks are also affected. Fruiting bodies of the fungus usually develop in the decayed tissues.
Many other plants are hosts, including avocado, coffee, eggplant, mango, papaya, sweet pepper, tomato and yams.

Treatment: **62**

VANDA SP.

VANDA

ORCHIDACEAE

Phytophthora nicotianae var. *parasitica*
=Phytophthora parasitica

Heart rot

Site of infection: L,S

Importance of the disease: √√√

Symptoms

Leaves at the centre of the plant are easily pulled out and show large, wet, purple-brown or black rots at the base. All parts above the rot are killed.

Treatment: **105**

Photo: Kohler Collection

Photo: Kohler Collection

Ustilago tritici

Photo: Kohler Collection

Photo: Kohler Collection

Glomerella cingulata

Photo: Kohler Collection

Photo: Kohler Collection

Phytophthora nicotianae var. *parasitica*

VANDA SP.

VANDA

ORCHIDACEAE

Sclerotinia sp.

Dry rot

Site of infection: S,C,R

Importance of the disease: √

Symptoms

A dry rot at the collar, leading to the destruction of the plant. White fungal tufts develop and these form into cream or white sclerotia, occurring either singly or in groups.

Treatment: **125**

VANILLA FRAGRANS

VANILLA

ORCHIDACEAE

Fusarium oxysporum

Stem rot

Site of infection: S

Importance of the disease: √√

Symptoms

Yellow spots on the stems, spreading rapidly, becoming slightly sunken and black. Symptoms are similar to those caused by *Phytophthora palmivora* and *Colletotrichum gloeosporioides*. Another *Fusarium*, *F. oxysporum* f. sp. *vanillae*, causes a root-tip rot on roots growing in leaf litter, mulch or soil. Infection does not lead to a wilt because the fungus does not spread through the vascular tissues. Instead, a slow dieback occurs, with new roots developing from the vines continually destroyed as they reach the soil. *Rhizoctonia solani* is associated with these rots.

Treatment: **56**

VANILLA FRAGRANS

VANILLA

ORCHIDACEAE

Glomerella cingulata
=Colletotrichum gloeosporioides

Anthracnose

Site of infection: L,Fr,S

Importance of the disease: √√

Symptoms

Brown, slightly sunken, rapidly expanding spots on leaves, pods and stems. Stem lesions may girdle and kill the vines. In wet weather, the lesions are covered in pink spore masses. Symptoms are similar to those caused by *Phytophthora palmivora* and *Fusarium oxysporum*, and are difficult to diagnose if fruiting bodies are absent.
Many other plants are hosts, including avocado, coffee, eggplant, mango, papaya, sweet pepper, tomato and yams.

Treatment: **62**

Photo: Kohler Collection

Sclerotinia sp.

Photo: Kohler Collection

Fusarium oxysporum

Photo: Kohler Collection

Photo: Kohler Collection

Glomerella cingulata

VANILLA FRAGRANS, V. TAHITENSIS

VANILLA

ORCHIDACEAE

Phytophthora palmivora

Stem rot

Site of infection: L,Fr,S

Importance of the disease: √√√

Symptoms

Rapidly spreading spots, causing pod and leaf fall, stem decay, and blights during wet weather. Symptoms are similar to those of *Fusarium oxysporum*. In French Polynesia, *P. nicotianae* var. *parasitica* and *P. capsici* have also been found associated with vanilla blight.
Many other plants are hosts, including black pepper, breadfruit, cocoa and coconut.

Treatment: **104**

VANILLA FRAGRANS, V. TAHITENSIS

VANILLA

ORCHIDACEAE

Vanilla mosaic potyvirus

Vanilla mosaic virus

Site of infection: L

Importance of the disease: √√

Symptoms

Leaves with yellow and green mosaic patterns and distortions, especially along the margins.

Treatment: **147**

VANILLA FRAGRANS

VANILLA

ORCHIDACEAE

Vanilla necrosis potyvirus

Vanilla necrosis virus

Site of infection: L

Importance of the disease: √√√

Symptoms

Distorted margins and leaf blades of young growth, with sunken yellow or white patches. On the older leaves, black, raised, scab-like spots occur and, later, black lesions develop on the stems. Vines defoliate and die.

Treatment: **148**

Photo: Kohler Collection

Phytophthora palmivora

Photo: Mike Pearson

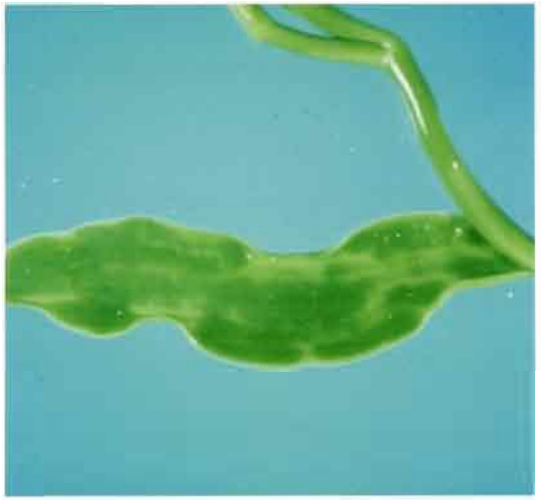

Photo: Bill Zettler

Vanilla mosaic potyvirus

Photo: Mike Pearson

Photo: Mike Pearson

Vanilla necrosis potyvirus

VIGNA UNGUICULATA SESQUIPEDALIS

YARD-LONG BEAN

FABACEAE

***Oidium* sp.**

Powdery mildew

Site of infection: L

Importance of the disease: √√

Symptoms

Superficial sparse, white, powdery growth on one or both leaf surfaces. The fungal growth is often associated with red blotches, usually on the lower leaf surface. Often leaves have dual infections of powdery mildew and rust, *Uromyces vignae* (lower photograph).
Many other species are hosts, including avocado, cucurbits, and papaya. (*Oidium* sp. is the asexual stage of *Erysiphe* spp. and other powdery mildews.)

Treatment: **87**

VIGNA UNGUICULATA SESQUIPEDALIS

YARD-LONG BEAN

FABACEAE

Uromyces vignae

Rust

Site of infection: L

Importance of the disease: √√

Symptoms

Brown or black pustules on both leaf surfaces, in small concentric rings. The pustules also occur on leaf stalks.
Other *Vigna* spp. are hosts, including cowpea and sea bean (*Vigna marina*).

Treatment: **143**

VIGNA UNGUICULATA SESQUIPEDALIS

YARD-LONG BEAN

FABACEAE

Blackeye cowpea mosaic potyvirus

Blackeye cowpea mosaic

Site of infection: L

Importance of the disease: √√

Symptoms

Leaves show green and yellow patterns—mosaics, mottles, and streaks. They also become distorted, with puckered surfaces. Plants are invariably stunted, and pod production is low.
Many other legumes are hosts, including cowpea, French bean and soybean.

Treatment: **16**

Photo: George Wall

Photo: Eric McKenzie

Oidium sp.

Photo: Eric McKenzie

Uromyces vignae

Photo: Grahame Jackson

Photo: Eric McKenzie

Blackeye cowpea mosaic potyvirus

XANTHOSOMA SAGITTIFOLIUM

TANNIA, FIJI TARO, TARO PALAGI

ARACEAE

Dasheen mosaic potyvirus

Dasheen mosaic

Site of infection: L

Importance of the disease: √

Symptoms

Yellow, sometimes grey-green, streaks and blotches on the upper leaf surface, often giving a feather-like pattern along the veins. Occasionally, leaf blades are reduced in size. Usually, two or three leaves show symptoms and then apparently healthy leaves are produced. Corms do not show symptoms, and there is no evidence that the virus causes a loss in yield in any of the edible aroids. Ornamental species may be severely distorted by the virus.
Taro, giant taro and giant swamp taro, as well as many ornamental species such as *Caladium* and *Dieffenbachia,* are hosts.

Treatment: **45**

ZEA MAYS

MAIZE, CORN

POACEAE

Cochliobolus heterostrophus
=Bipolaris maydis

Southern leaf blight

Site of infection: L,Fr,S

Importance of the disease: √√√

Symptoms

Light brown leaf spots with a brown margin, at first elliptical, becoming rectangular, up to 25 mm long and 2–6 mm wide. The spots are at first restricted by the leaf veins, but later they may merge. Leaves dry out and die prematurely.
Spots produced by Race T are larger, spindle-shaped or elliptical, with yellow or yellow-green haloes and dark red-brown borders, occurring on all above-ground parts. A black, felt-like mould may cover the affected kernels.
Sorghum and some grasses are also hosts.

Treatment: **30**

ZEA MAYS

MAIZE, CORN

POACEAE

Gibberella fujikoroi
=Fusarium moniliforme

Kernel rot

Site of infection: L,Fr,S

Importance of the disease: √√

Symptoms

Grey or pinkish-white fungal growth over the grains, developing in storage on cobs that have not been dried properly. The fungus produces a toxin which affects horses and humans.

Treatment: **61**

Photo: Grahame Jackson

Photo: Grahame Jackson

Dasheen mosaic potyvirus

Photo: Eric McKenzie

Cochliobolus heterostrophus

Photo: Kohler Collection

Photo: Kohler Collection

Photo: Kohler Collection

Gibberella fujikoroi

ZEA MAYS

MAIZE, CORN

POACEAE

Peronosclerospora sacchari
=Sclerospora sacchari

Sugarcane downy mildew

Site of infection: L

Importance of the disease: √√

Symptoms

At first, small, round, yellow spots on the leaves leading to pale yellow to white stripes as the fungus becomes systemic. Several stripes may be present on each leaf, often extending the entire length. A white downy fungal growth develops on both leaf surfaces and husks. Plants may be stunted, with poorly developed ears. Sorghum and sugarcane are also hosts.

Treatment: **94**

ZEA MAYS

MAIZE, CORN

POACEAE

Puccinia sorghi

Common maize rust

Site of infection: L,Fr,S

Importance of the disease: √√

Symptoms

Circular pustules, powdery, brown, becoming brown-black as the plant matures. The pustules occur on all above-ground parts, but are most common on the leaves, where they are scattered on both surfaces. In severe cases, the leaves and leaf sheaths turn yellow and die prematurely. Stages of *P. sorghi* occur on *Oxalis* spp. (lower photograph).
P. sorghi is one of two common rusts of maize; the other is *P. polysora*. Pustules of *P. sorghi* are sparse and common on both surfaces of the leaf, whereas those of *P. polysora* occur in groups, mostly on the upper surface. Often, the two rusts occur together requiring microscopic examination to distinguish them.

Treatment: **119**

ZEA MAYS

MAIZE, CORN

POACEAE

Setosphaeria turcica
=Exserohilum turcicum

Northern leaf blight

Site of infection: L

Importance of the disease: √√

Symptoms

Large, usually elliptical, grey or light brown leaf spots, sometimes with dark margins, 25–150 mm, at first on lower leaves. Brown fungal growth containing the spores occurs on the spots, often in concentric zones. The disease causes leaves to dry out and wither.

Treatment: **128**

Photo: Mike Pearson

Photo: Mike Pearson

Peronosclerospora sacchari

Photo: Kohler Collection

Photo: Kohler Collection

Puccinia sorghi

Photo: Kohler Collection

Photo: Kohler Collection

Setosphaeria turcica

ZEA MAYS

MAIZE, CORN

POACEAE

Ustilago zeae
=Ustilago maydis

Boil smut

Site of infection: L,Fr,S

Importance of the disease: √√

Symptoms

Blister-like galls, up to 15 mm diam., splitting open to release black spore masses. All the above-ground parts are susceptible to infection, especially when plants are young. Galls on the leaves remain small, 6–12 mm diam., become dry, hard and do not rupture. Early infection results in stunted plants and even death, but this is uncommon.

Treatment: **146**

ZEA MAYS

MAIZE, CORN

POACEAE

Maize mosaic rhabdovirus

Maize mosaic

Site of infection: L,Fr,S

Importance of the disease: √√√

Symptoms

Yellow spots, short lines, broken to nearly continuous, fine to broad yellow stripes, often centred on the fine veins. Commonly, leaves also show long, broad yellow stripes and these may become necrotic. Stripes also occur on the sheaths, ear husks and stalks. Depending upon the time of infection and variety, plants may remain stunted, with the top of the plant bending to one side. Young plants are most susceptible. A characteristic of the disease is a shortening of the husks which exposes the ears.
Grasses, *Rottboellia* (itchgrass) and *Setaria*, and sorghum are also hosts.

Treatment: **75**

ZINGIBER OFFICINALE

GINGER

ZINGIBERACEAE

Radopholus similis

Rhizome rot

Site of infection: S,R

Importance of the disease: √√√

Symptoms

Small, sunken lesions on the surface of the rhizomes, extending up to 10 mm into the host tissue. The channels become invaded by fungi and other secondary organisms and develop into extensive rots. Above-ground, the foliage is yellow, the topmost leaves withered, and plants are stunted and lack vigour. The number of tillers is reduced. Rots continue to develop in storage, causing significant losses.
Many crops are hosts, including bele, giant swamp taro, legumes, maize and yams.

Treatment: **123**

Photo: Grahame Jackson

Photo: Grahame Jackson

Photo: Robin Palmer

Photo: Mike Pearson

Photo: DPI Collection

Photo: Robin Palmer

Ustilago zeae

Maize mosaic rhabdovirus

Radopholus similis

Control measures

The purpose of this chapter is to help those who have identified a disease to take the necessary steps to bring about its control. Management of a plant disease is often complex, requiring the use of several methods to obtain the degree of control required. But for strategies to be useful they must do more than just control the problem; they must be economical, and of minimal risk to grower, consumer and the environment. The approaches that are commonly used are briefly mentioned below.

Phytosanitary regulations: Some measures are not control techniques as such, but rather precautions to keep serious diseases out of a country or specified area. The measures come in the form of laws and regulations enacted by governments or local legislatures. They are important safeguards against the introduction of pests not yet present, and in some cases the further spread of those that already occur. Of course, legislation cannot guarantee that the entry or spread of unwanted pests will be prevented, but it can be an effective barrier. It is made even more effective if combined with awareness campaigns to encourage the public to take an active part in the process. This is important, as many of the pests of Pacific Island countries have entered with unofficial plant introductions.

Further, the use of local regulations, by-laws and the like, to stop the spread of diseases already present, can be used to advantage in Pacific countries. This is because they consist of islands and natural long-distance movement of pathogens is often prevented by the intervening sea.

Cultural control: The methods under this heading try to reduce the level of the pathogen so that infection is less likely to occur. There are several ways of doing this. Many of the methods are traditional practices that have stood the test of time, for instance, crop rotation, the use of organic manures or other soil amendments, and sanitation. Crop rotation aims to reduce the pathogen by growing non-host plants until it is judged safe to repeat the cropping cycle. Bush-fallows are used to obtain the same effect. Organic manures added to the soil may increase microbes antagonistic to soilborne plant pathogens. Lime and mineral ash are also reported to be beneficial additions to the soil for the control of certain diseases, particularly those that are sensitive to pH. Sanitation includes a number of different techniques: elimination of plant residues from previous crops, either by removal, burning or deep burial; removal of weeds, alternative hosts or volunteer plants that may be reservoirs of infection; roguing or pruning of diseased plant parts; and disinfection of tools and machinery that might spread diseases. A method of a different kind is 'disease avoidance'. In this case, plants are grown ahead of their normal production time, or out of season, when the chance of infection is low.

Genetic control: The use of resistant varieties is one of the most common and important ways of controlling plant diseases. The aim is to prevent infection altogether or to slow disease development to avoid an epidemic. Growing many varieties in the same garden is one of the traditional ways this can be achieved. Each variety is different, and the differences can affect the progress of a disease. But genetic control is not always easy to obtain or sustainable. As food production has increased in response to growing human populations, there has been a trend towards fewer, higher-yielding varieties. This has resulted in the appearance of new virulent strains of pathogens. The loss of crop varieties, and in some cases their wild relatives, has meant that resistance factors may no longer be available for plant breeders to use. To combat these problems, more attempts are being made to conserve crop genetic resources, and different plant breeding approaches are being explored.

Today, many plant breeders try to produce plants with durable, or so-called horizontal, resistance. Often, this is controlled by several genes, each one of which may have only a small effect on the pathogen. The plants produced are not totally resistant or immune to a particular disease, but they are tolerant of infection. This means there is some loss in yield, but it is a reasonable price to pay for lasting disease control. And, because infection still occurs, there is less likelihood that new strains will arise from within the pathogen population. On a different front, plant breeders are collaborating with molecular biologists, who are using modern technologies to manipulate DNA between species to produce varieties with novel kinds of disease resistance.

Chemical control: A large number of pesticides are available to protect plants from infection, or to cure them once infected. Large increases in productivity can be expected if pesticides are used correctly, but for many diseases large gains occur only when chemical control measures are integrated with other methods, such as those discussed above.

Manufacturers' instructions should be scrupulously followed when pesticides are used. This includes applying the suggested dosage, as over-application can damage plant tissues and reduce yields. The frequency of application is also important. And for some products, manufacturers suggest a limit on the number of applications per crop. Too frequent use may promote the very opposite of what is required: control may be lost because strains of the pathogen may develop that are resistant to the pesticide. As a further precaution against this, many systemic chemicals are used with protectant products, either in combination or alternately. The manufacturers' instructions should also be consulted if it is intended to mix fungicides with insecticides. In many cases, they are not compatible.

The correct use of pesticides is also concerned with safety to the user and the environment. Many pesticides are poisonous to humans, birds, fish and many beneficial insects. Users should wear protective clothing, avoid chemical drift and ensure that left-over or unwanted chemicals are disposed of safely. Stocks of pesticides should be kept in a secure place. Each pesticide comes with notes on these aspects, and they should be read carefully and followed in detail.

Most Pacific Island countries have legislation controlling the import of pesticides through registration procedures. The products which are allowed entry, and in some cases their specific uses, have been considered on the basis of efficacy and safety. Often countries rely on information generated for product registration in Australia, the European Union, New Zealand and the USA to arrive at their decisions. For this reason, the chemicals recommended in this chapter are registered for use on the same crops in Australia, New Zealand or the UK. Where countries need specialist advice on, for instance, environmental issues and pesticide use, they can obtain it from the South Pacific Commission or the South Pacific Regional Environment Programme.

The various pesticides recommended in this chapter are sold commercially under different names which can be found in *Agricultural Chemicals Book IV, Fungicides*; *European Directory of Agrochemical Products, Volume 1—Fungicides*; *The UK Pesticide Guide*; *The Pesticides Manual, UK*; *New Zealand Agrochemical Manual*; and *Peskem—Australian Directory of Registered Pesticides and their Uses*. Users can seek advice from suppliers of the products available locally, as well as from their agriculture extension services.

T1 — *ACIDOVORAX AVENAE* subsp. *CITRULLI* **— Citrullus lanatus**
Crop rotation is important. Cucurbits should not be planted on the land where the pathogen has been identified for at least two years. Ensure that seed is certified free from the bacterium. For chemical control: copper fungicides if symptoms are detected early in the growing season.

T2 — *AECIDIUM FRAGIFORME* **— Agathis spp.**
No treatment known.

T3 — *ALBUGO CANDIDA* **— Brassica chinensis, Raphanus sativus**
Cultural control measures include the removal or deep burial of crop debris and volunteer plants, and crop rotation with non-cruciferous plants. Chinese cabbage varieties are susceptible. The resistance of other cabbages and radish is determined by a single dominant gene and may not be reliable. For chemical control: chlorothalonil plus metalaxyl, copper hydroxide, mancozeb, mancozeb plus metalaxyl, or zineb.

T4 — *ALBUGO IPOMOEAE-AQUATICAE* **— Ipomoea aquatica**
Cultural control measures include removal or deep burial of crop debris and volunteer plants. Chemical control is unlikely to be required, but if needed: chlorothalonil plus metalaxyl, copper hydroxide, mancozeb, mancozeb plus metalaxyl, or zineb.

T5 — *ALTERNARIA ALTERNATA* **— Passiflora edulis;** *ALTERNARIA PASSIFLORAE* **— Passiflora edulis, Passiflora quadrangularis**
Yellow passionfruit is more resistant to infection from *A. alternata*, whereas purple passionfruit and hybrids between the two are very susceptible. For chemical control: copper oxychloride, copper oxychloride plus zineb, iprodione, mancozeb or propineb. Coverage of the foliage can be assisted by pruning dead or weak parts of the vines.

T6 — *ALTERNARIA BRASSICICOLA* **— Brassica oleracea var. capitata**
Cultural control measures include the removal of the remains of the previous crop, removal of cruciferous weeds, and crop rotation. The fungus is seedborne, and seed should be treated with hot water (50°–56°C for 10–20 min). For chemical control: copper oxychloride plus zineb, mancozeb or zineb. It is likely that control procedures for bacterial black rot, *Xanthomonas campestris* pv. *campestris*, will also control *Alternaria* leaf spot.

T7 — *ALTERNARIA DAUCI* **— Daucus carota;** *ALTERNARIA SOLANI* **— Lycopersicon esculentum, Solanum tuberosum;** *ALTERNARIA RADICINA* **— Daucus carota**
Cultural control measures include the removal of plant trash left from the previous crop, and crop rotation. Seed treatment is very important for carrot and tomato (soak in thiram or iprodione for 24 h, or in mixtures, e.g. iprodione plus metalaxyl plus thiabendazole, metalaxyl plus thiabendazole, or thiabendazole plus thiram). Grow tomato seedlings in

soil-less mixes or pasteurised soil. The following tomato varieties are reportedly partially resistant: India River, Manapal, Floradel, Floralou, MH–1, Tropic, Strobelee, Floradade. The following Australian potato varieties are partially resistant: Sequoia and Kurrel. Kennebec and Pontiac are highly susceptible. For chemical control: (a) carrot: copper hydroxide, copper oxychloride, mancozeb, metiram or zineb; (b) potato: chlorothalonil, copper hydroxide, copper oxychloride, iprodione, mancozeb, maneb plus zineb, metiram, propineb or zineb; and (c) tomato: chlorothalonil, copper hydroxide, copper oxide, copper oxychloride plus zineb, iprodione, mancozeb, maneb plus zineb, metiram, propineb or zineb.

T8 — *ALTERNARIA PORRI* — **Allium porrum**
Cultural control measures include the removal of trash from the previous crop, and the improvement of plant vigour by providing adequate water and applications of organic or chemical fertilizers. In Kenya, the leek varieties Red Creole and Yellow Creole are reported as highly resistant, whereas Mexican and Burgundy Red are less so. For chemical control: benalaxyl plus mancozeb, chlorothalonil, copper hydroxide, mancozeb, mancozeb plus metalaxyl, or zineb plus metalaxyl.

T9 — *ASPERGILLUS FLAVUS* — **Cocos nucifera**
Rapid and complete drying techniques must be used after harvest in order to limit the spread of the fungus which produces a toxin that is highly dangerous to animal and human health. Storage conditions should be dry and cool. Seed of peanut, maize or onion for sowing can be treated with benomyl or thiram.

T10 — *ASPERGILLUS NIGER* — **Allium sativum**
Usually saprophytic, but important as a post-harvest mould of maize and copra. Rotate onions with other crops, and ensure that storage conditions for the bulbs are dry and cool.

T11 — *ATHELIA ROLFSII* — **Arachis hypogaea, Daucus carota, Lycopersicon esculentum**
Cultural control methods are important, including the removal of plant remains and/or their deep burial before planting; crop rotations; and, in some crops, reducing plant density. Repeated deep tilling may help to reduce the number of sclerotia to levels where infection is no longer possible. The fungus has a very wide host range and crop rotation is not a practical method of control, although bananas appear resistant to attack and maize and cabbages are little affected. Applications of calcium nitrate or urea, or of calcium, nitrogen or ammonium bicarbonate significantly reduce the intensity of outbreaks in contaminated fields. Treating the soil with frequent applications of white coral sand may be beneficial, especially if applied together with well-decomposed manure. Black plastic mulch can reduce disease incidence by preventing the sclerotia from infecting plant stems and lower leaves. Biological control using *Trichoderma harzianum* or *T. viride* is still under investigation. For chemical control: quintozene, or fumigate the soil with metam-sodium or methyl bromide.

T12 — *BALANOPHORA FUNGOSA* — **Hibiscus rosa-sinensis**
Regular physical removal of the parasitic plant is the only method of control.

T13 — BANANA BUNCHY TOP NANAVIRUS — **Musa sp.**
The virus is transmitted by *Pentalonia nigronervosa*, an aphid specific to *Musa* sp. It can also be spread by planting infected suckers. Only healthy planting material should be used, taken from nurseries where it is known that the plants are free from the disease. If suckers are taken directly from plantations, they should be taken only from plots free of symptoms of the disease for the previous two years. Regular field surveys are necessary to detect infected plants. Once found, they should be removed immediately,

but only after the plants, including the suckers, have been thoroughly treated. Kerosene, mineral oil or conventional insecticides, such as malathion, demeton-S-methyl, dimethoate or monocrotophos, can be used to destroy the aphids. When removing the plants, ensure that the entire mat is dug out to prevent regrowth of diseased suckers. There are no known resistant commercial banana cultivars and virus resistance is being genetically engineered in several countries including Australia. See SPC Plant Protection Leaflet No. 2 for further details on this pathogen and its control.

T14 — BANANA STREAK BADNAVIRUS — **Musa sp.**
The virus, which exists as a number of strains, occurs in bananas throughout the world and is also found in sugarcane. It is thought to be endemic in the variety Mysore, and is frequently seen on Cavendish bananas. It is transmitted by mealybugs in a semi-persistent manner. It is unlikely to be transmitted on cutting tools or by other mechanical means. The only method of control is to eradicate diseased plants and to use virus-free planting material. The virus is not eliminated by shoot-tip culture. As the virus can occur in plants without causing symptoms, plants in quarantine should be kept under observation for at least nine months.

T15 — *BIPOLARIS INCURVATA* — **Cocos nucifera**
Applications of phosphorus and potassium fertilisers increase the resistance of seedlings to infection. For chemical control: chlorothalonil, copper hydroxide, copper oxychloride, iprodione, mancozeb or zineb.

T16 — BLACKEYE COWPEA MOSAIC POTYVIRUS — **Vigna unguiculata ssp. sesquipedalis**
Use seed certified free from the virus and in cases where infection is low, remove affected plants as soon as symptoms are seen. Avoid planting near established fields that might be a source of the virus.

T17 — BLOSSOM-END ROT — **Lycopersicon esculentum**
This physiological disorder occurs where heavy rains follow a drought, temperatures are unusually high, or plants have underdeveloped root systems in heavy clay soils. Treatment with a solution of calcium chloride as soon as the first symptoms appear may be beneficial. Soil fertility should be checked and a balanced fertilizer applied, if needed. The application of lime to acid soils may be beneficial.

T18 — *BREMIA LACTUCAE* — **Lactuca sativa**
Development of this pathogen is favoured by excessive moisture (rain or irrigation). Plant debris should be removed or dug deeply into the soil after harvest. Many different strains have been recorded and this makes breeding for resistance difficult. The Florida variety FL 49015 is resistant as are (to a lesser extent) the Ithaca varieties, Mesa 659 and Iceberg. The variety Vanguard 75 has a dominant gene for resistance to many different isolates. For chemical control: copper hydroxide, copper oxychloride, mancozeb, mancozeb plus metalaxyl, metiram, or propineb. Treatment with metalaxyl alone is effective, but repeated use can lead to the development of resistant strains.

T19 — BROWN HEART — **Apium graveolens**
This is a physiological disorder often observed in light soils and linked to boron deficiency. The disorder is most marked when fertilizer rich in nitrogen is used.

T20 — CADANG-CADANG-LIKE VIROID — **Elaeis guineensis**
There is no method of treating palms once they are infected, but it is important that they be removed from the plantation as soon as they are diagnosed, as there is evidence that the viroid may spread from them to adjacent healthy palms.

T21 — CASSAVA GREEN MOTTLE NEPOVIRUS — **Manihot esculenta**
Cultural control measures are important, including the removal of infected plants and the selection of cuttings from plants which appear free from symptoms.

T22 — *CASSYTHA FILIFORMIS* — **Pinus caribaea**
Regular physical removal of the parasitic plant is the only method of control. This is not always easy to do as the seeds remain viable in the soil for several years.

T23 — *CEPHALEUROS VIRESCENS* — **Persea americana**
The presence of this alga is often linked to poor cultural conditions, such as excessive or too little shade, mineral deficiencies and poor drainage. If these conditions are corrected, control is usually obtained.

T24 — *CERATOCYSTIS PARADOXA* — **Ananas comosus, Saccharum officinarum**
Careful handling of banana and pineapple fruit is important to avoid damage which may allow entry of this pathogen. Minimising root and trunk wounds on coconut will also reduce the risks of infection. Strict hygiene should be maintained in commercial packing sheds. In particular, diseased leaves and rejected fruit should be collected frequently and destroyed. Planting material of pineapple should be airdried, and that of sugarcane cut from younger parts of the cane, with at least three nodes. For chemical control, treat fruit or planting setts with fungicides: (a) pineapple: dip the base of the fruit in benomyl, prochloraz or triadimefon; (b) banana: dip the fruit in benomyl, carbendazim or thiabendazole; (c) sugarcane: dip the setts in benomyl, carbendazim, flusilazole, prochloraz, propiconazole or triadimefon. On coconuts, minor infections can be treated by cutting out and applying benomyl and wood preservative, but there is a chance of resistant strains developing.

T25 — *CERCOSPORA CAPSICI* — **Capsicum annuum;** *CERCOSPORA LONGISSIMA* — **Lactuca sativa;** *CERCOSPORA TACCAE* — **Tacca leontopetaloides**
These are typically wet-weather pathogens and the most practical control measure is to use fungicides, although crop rotation and the removal of crop debris are likely to contribute to effective control. For chemical control: use thiram on sweet pepper seed; and for field crops, use benomyl, copper hydroxide, copper oxychloride, mancozeb or zineb.

T26 — *CERCOSPORA COFFEICOLA* — **Coffea arabica, Coffea canephora**
The pathogen can be very severe in the nursery, especially if there is insufficient shade, but it is rarely serious in the field as long as the correct cultural techniques are applied. For chemical control: benomyl, copper or dithiocarbamate fungicides.

T27 — *CERCOSPORA IPOMOEAE* — **Ipomoea aquatica**
The pathogen rarely causes a disease which warrants control. If control measures are required on sweet potato, remove crop debris after harvest, and practise crop rotation.

T28 — *CEREBELLA ANDROPOGONIS* — **Paspalum dilatatum**
Often mistaken for smut, this pathogen is of little importance and does not require control.

T29 — *CLADOSPORIUM COLOCASIAE* — **Colocasia esculenta**
Crop rotation and disposal of plant remains give good control. The disease attacks older leaves, and probably has little impact on yield, so chemical control measures are not warranted.

T30 — *COCHLIOBOLUS HETEROSTROPHUS* — **Zea mays**
Cultural control measures involve destroying crop residues and volunteer

plants. Tolerant varieties have been bred against the various strains of the fungus. Against strain T, use maize with normal cytoplasm; against strain O, use varieties with a non-cytoplasmic dominant gene. Seedborne infections can be controlled by hot air (54°–55°C for 17 min), or with a mixture of thiram plus carboxin. For chemical control of field crops, if warranted, use mancozeb.

T31 — COCONUT FOLIAR DECAY NANAVIRUS — **Cocos nucifera**
The virus is spread by *Myndus taffini* which breeds on the roots of *Hibiscus tiliaceus* and in the adult stage migrates to coconut palms. Coconut varieties differ in tolerance to the virus, with both Vanuatu tall and dwarf varieties (and their hybrids) showing resistance. Most introduced varieties are susceptible, but there are considerable differences between them. Malayan Dwarf varieties are very susceptible.

T32 — COCONUT TINANGAJA VIROID — **Cocos nucifera**
This is an important pathogen of coconuts and one of quarantine concern where it is not yet present. The viroid is known only from Guam, but is related to cadang-cadang viroid found in coconuts in the Philippines. There is no known control, although there is some evidence that the variety Javanica Red Dwarf is more tolerant than other tall or dwarf varieties.

T33 — *COLEOSPORIUM PLUMERIAE* — **Plumeria spp.**
If defoliation occurs, it will be necessary to treat the trees with dithiocarbamate or systemic fungicides, e.g. bitertanol or oxycarboxin.

T34 — *COLLETOTRICHUM CAPSICI* — **Capsicum annuum;** *COLLETOTRICHUM CIRCINANS* — **Allium cepa**
Cultural control measures are important, especially the destruction of plant remains from previous crops. Seed treatment of sweet pepper is important, and benomyl or thiabendazole plus thiram can be used. Bulbs of onion should be stored under cool, dry conditions to prevent infection from spores carried on the outside at harvest. Brown-skinned onions are resistant to smudge. For chemical control of foliar infections: chlorothalonil.

T35 — *COLLETOTRICHUM LINDEMUTHIANUM* — **Lupinus albus, Lupinus angustifolius**
Cultural control measures include the destruction of plant trash from previous crops and crop rotations of 2–3 years. Intercropping maize and French bean significantly reduces losses caused by this pathogen. Seed treatment is important and benomyl, thiabendazole plus thiram, or thiram can be used. Alternatively, use certified or approved seed. For chemical control on field crops: mancozeb, metiram or zineb.

T36 — *COLLETOTRICHUM ORBICULARE* — **Cucumis melo, Citrullus lanatus;** *COLLETOTRICHUM* SP. — **Momordica charantia**
Cultural control measures include crop rotation, ensuring good soil drainage, and the destruction of wild cucurbits. The cucumber varieties Calico, Calypso and Marketer are resistant. Seed treatment is important, and thiram can be used. For chemical control of field crops: benalaxyl plus mancozeb, benomyl, copper oxychloride, mancozeb, mancozeb plus metalaxyl, or propineb.

T37 — *COLOCASIA* BOBONE DISEASE (?) RHABDOVIRUS — **Colocasia esculenta**
The virus is present only in Papua New Guinea and Solomon Islands. It occurs alone in plants and causes bobone or with dasheen bacilliform (?) badnavirus resulting in alomae. As such, it is of major quarantine importance to countries yet free from it. If countries wish to import material it should be as pathogen-tested plants, preferably from regional tissue culture laboratories. Control of the virus is difficult, as most plants

are infected. Because of this, roguing plants as they show symptoms is not a practical method of control. In any case, plants invariably recover to produce corms of acceptable size. Varietal differences exist. The virus causes severe symptoms only in a few so-called 'female' varieties; 'male' taro are tolerant, showing only small dark green distorted areas on the leaves. 'Male' taro, however, are susceptible to alomae, whereas 'female' taro are resistant. For chemical control against the planthopper vector, *Tarophagus proserpina*: acephate, dimethoate, endosulfan or malathion. The mirid egg-predator, *Cyrtorhinus fulvus*, has been used to control planthopper populations.

T38 — *COLOCASIA* BOBONE DISEASE (?) RHABDOVIRUS and DASHEEN BACILLIFORM (?) BADNAVIRUS — **Colocasia esculenta**
Where these two viruses occur together in taro (Papua New Guinea and Solomon Islands) they cause alomae, a lethal disease. Dasheen bacilliform (?) badnavirus is widely distributed in Pacific Island countries, but *Colocasia* bobone disease (?) rhabdovirus (alomae strain) is not, and it is of major quarantine importance to countries yet free from it. If countries wish to import material it should be as pathogen-tested plants, preferably from regional tissue culture laboratories. Cultural control measures include the destruction of diseased plants as soon as symptoms appear and siting new plantings away from older crops, especially those already infected. Varieties differ in their resistance to the virus complex, but those that are tolerant, so-called 'female' taro, are susceptible to bobone caused by infection from *Colocasia* bobone disease (?) rhabdovirus. A programme to breed taro with greater tolerance to the virus complex exists in Papua New Guinea. For chemical control against the planthopper vector, *Tarophagus proserpina*: acephate, dimethoate, endosulfan or malathion. See SPC Plant Protection Leaflet No. 8 for further details on these pathogens and their control

T39 — *COLOCASIA* BOBONE DISEASE (?) RHABDOVIRUS (FIJI STRAIN) — **Colocasia esculenta**
Plants infected with the mild strain recover from infection and as there is no indication that yield is affected, control measures are not warranted.

T40 — *CORDANA MUSAE* — **Musa sp.**
Usually of minor importance on Cavendish bananas and control measures are not warranted, but it can defoliate plantains. For chemical control: mancozeb, petroleum oil, propiconazole or zineb. Do not use oil on plantains, since it is phytotoxic. Fungicides used for black Sigatoka control are effective.

T41 — *CORTICIUM PENICILLATUM* — **Cocos nucifera**
If practical, avoid growing coconuts under excessive shade, and cut out and burn affected leaves. It is unusual for this pathogen to cause a disease of importance.

T42 — *CORYNESPORA CASSIICOLA* — **Carica papaya, Cucumis sativus**
Control is generally not warranted on papaya. On cucumber, symptoms can be severe. Destroy crop debris after harvest. Treat seed with thiram. For chemical control: benomyl, copper fungicides or mancozeb.

T43 — CUCUMBER MOSAIC CUCUMOVIRUS — **Musa sp., Piper methysticum**
This is a minor pathogen of banana and control measures are not warranted. On kava, the disease is a major concern. Cultural control measures are important, including the selection of propagating material from plantings free from dieback, and the removal of infected plants immediately symptoms are seen. Aphids are vectors of the virus, but insecticides are not effective in preventing the spread of the disease.

T44 — *CURVULARIA ISCHAEMI* — Ischaemum indicum
Although the host is an important pasture grass, control is impractical, and as yet there no indication of the damage that the fungus does to this grass.

T45 — DASHEEN MOSAIC POTYVIRUS — Colocasia esculenta, Xanthosoma sagittifolium
This virus is spread by aphids and in suckers used for propagation. There is no evidence that the virus reduces corm yield and control measures are not warranted. See SPC Plant Protection Leaflet No. 10 for further details on this pathogen and its control.

T46 — DASHEEN MOSAIC POTYVIRUS (SEVERE STRAIN) — Colocasia esculenta
The virus has been reported only from French Polynesia. As such, it is of major quarantine importance to other countries in the region. If countries wish to import material it should be as pathogen-tested plants, preferably from regional tissue culture laboratories. Plants should be removed as soon as symptoms appear and burnt or buried. It would be beneficial if the plants were first sprayed with an insecticide (acephate, demeton-S-methyl, dimethoate or malathion) to destroy aphid vectors which might otherwise spread the virus.

T47 — *DIDYMELLA BRYONIAE* — Citrullus lanatus, Cucumis sativus
Cultural control measures include the removal or deep burial of crop debris, and crop rotation. After crops of cucurbits, plant beans, cabbage, onion or tomato. To prevent seedborne infections, treat seed with thiram. For chemical control of field crops: benomyl plus mancozeb, copper oxychloride, mancozeb, mancozeb plus metalaxyl, or propineb plus metalaxyl.

T48 — *DEIGHTONIELLA PAPUANA* — Saccharum officinarum
No control is warranted as the damage caused by this pathogen is not thought to affect cane yields.

T49 — *ELSINOE BATATAS* — Ipomoea batatas
Cultural control measures include: crop rotation, selection of propagating material free from the disease or, if this is not possible, the production of disease-free cuttings from tubers planted in nursery beds. Many varieties with tolerance to scab exist in Papua New Guinea and Solomon Islands and, in Tonga, varieties have been bred for resistance. Many of these are available as pathogen-tested tissue cultures from the laboratories of regional organisations. For chemical control: mancozeb. See SPC Plant Protection Leaflet No. 24 for further details on this pathogen and its control.

T50 — *ELSINOE FAWCETTII* — Citrus spp.
In orchards, sanitation is important, including the removal of infected fruit and the pruning of branches before new flushes develop. The disease can be serious in nurseries, particularly on rough lemon seedlings. For chemical control: copper oxychloride plus white oil, copper oxychloride plus zineb, or zineb.

T51 — *ELSINOE SACCHARI* — Saccharum officinarum
No control is warranted as the damage caused by this pathogen is not thought to affect cane yields.

T52 — *ERWINIA* SPP. — Brassica oleracea var. capitata, Solanum tuberosum
Cultural control measures are important. For cabbages, remove infected plants as they occur, remove or deeply bury plant remains after harvest, and practise crop rotation with beans, cucumber and tomato. Avoid harvesting when crops are wet, and clean or sterilise the knife used in harvesting. For potatoes, use certified 'seed'. Cultural measures are also

important, including the regular disinfection of tools used for cutting and handling tubers (use, e.g. chlorine as sodium hypochlorite); avoiding wounding the tubers; and draining the fields to avoid waterlogging. Large applications of nitrogenous fertilizers reduce the damage caused by these pathogens, but may increase the incidence of bacterial wilt on potato caused by *Pseudomonas solanacearum.* Tubers should not be washed after harvest and before storage, and they should be stored under cool, well-ventilated conditions.

T53 — *ERWINIA* SPP. — **Musa sp.**
Cultural control measures are important: remove and destroy plants with the disease, by either burying or burning, as soon as symptoms appear, and select only healthy planting material.

T54 — *FULVIA FULVA* — **Lycopersicon esculentum**
Heavily infected lower leaves should be removed as soon as the first three or four fruit trusses have been picked. Crop residues should be burnt. Tolerant varieties have been bred, but there are several races of the fungus and varieties may not be resistant to them all. For chemical control: carbendazim plus chlorothalonil plus sulphur, chlorothalonil or propineb. Copper fungicides can be used, but they may harden the foliage. See SPC Plant Protection Leaflet No. 15 for further details on this pathogen and its control.

T55 — *FUSARIUM OXYSPORUM* — **Anthurium andreanum, Capsicum annuum;** *FUSARIUM OXYSPORUM* f. sp. *GLADIOLI* — **Gladiolus sp.**
Applications of boron or iron reduce the incidence of attack by promoting internal resistance mechanisms. Good control can also be obtained by applying calcium nitrate and potassium chloride between the rows. For chemical control: benomyl, carbendazim, iprodione, prochloraz or thiabendazole. Where plants are propagated by seeds, biological control is a possibility with the application of *Trichoderma harzianum* or *T. koningii.*

T56 — *FUSARIUM OXYSPORUM* — **Vanilla fragrans**
Stems and leaf infections are best controlled by applications of fungicides: benomyl, captan, carbendazim, mancozeb or thiophanate-methyl. If root infections occur, as reported for *F. oxysporum* f. sp. *vanillae*, avoid cultivation around the roots; ensure the correct level of shade to avoid water stress; apply mulch, especially during the dry season to retain soil moisture; adjust pollination to avoid overbearing; loop vines to stimulate root production and the replacement of those destroyed by infection; and avoid planting on waterlogged soil.

T57 — *FUSARIUM OXYSPORUM* f. sp. COFFEAE — **Coffea arabica, Coffea canephora;** *FUSARIUM OXYSPORUM* — **Prunus persica**
Reduce soil acidity by liming. Disinfect tools and implements with methylated spirits. For chemical control: captan or captafol until the bark has matured.

T58 — *FUSARIUM OXYSPORUM* f. sp. *CUBENSE* — **Musa sp.**
An important disease of quarantine concern to those countries yet free from the pathogen. Within the Pacific Islands, it is present only in Fiji, Guam and Papua New Guinea. If countries wish to import material it should be as pathogen-tested plants, preferably from regional tissue culture laboratories. There are several races, with Race 4 of most concern as it attacks Cavendish varieties which were previously resistant to the pathogen. Cultural control measures are extremely important, including: avoiding poorly drained soils or sites that receive surface water from diseased plantations; avoiding discarding bunch stalks in areas above existing plantations; and, if the bananas are irrigated, ensuring that the source of water is not from below the infected area, or if it is, that a floating intake is used, as the spores sink after a few days. Knives used in

cultural practices should be disinfected with formaldehyde, methylated spirits or sodium hypochlorite, and efforts made to prevent the movement of soil from infected to healthy plantations on ladders, vehicles and people (dip footwear in a copper fungicide/methylated spirit mixture). Where outbreaks occur, diseased plants, and their immediate neighbours, should be destroyed as soon as possible by injection of herbicide, and the remains dug out, bagged, and carefully removed from the plantation and burnt. If only a few plants are affected, treat the diseased stools with basamid and cover with a plastic sheet. Resistance to Race 4 is being sought in Australia.

T59 — *FUSARIUM OXYSPORUM* f. sp. *GERBERAE* — **Gerbera sp.**
The fungus can survive in the soil for over 10 years. Calcium deficiency facilitates survival, especially when this element is unavailable due to high magnesium or phosphorus concentrations. Seedborne transmission is a possibility and seed should be treated with thiram. In the greenhouse, disinfect the soil with methyl bromide. In the field, benzimidazole fungicides are effective if used before the beginning of an outbreak. Resistant varieties exist, but nematode infestations considerably reduce their effectiveness.

T60 — *GANODERMA APPLANATUM* — **Casuarina equisetifolia**
Infected stumps and roots should be removed, the remains burnt and the soil disinfected with formaldehyde if necessary.

T61 — *GIBBERELLA FUJIKOROI* — **Zea mays**
Drying the kernels before storage to a maximum moisture content of 12% prevents the development of the fungus. Resistant varieties are available. For chemical control: benomyl or captan for seed used for sowing.

T62 — *GLOMERELLA CINGULATA* — **Actinidia deliciosa, Agathis spp., Annona squamosa, Anthurium andreanum, Apium graveolens, Aranda sp., Carica papaya, Citrus spp., Coffea arabica, Coffea canephora, Dioscorea alata, Mangifera indica, Manihot esculenta, Passiflora edulis, Persea americana, Phaseolus vulgaris, Psidium guajava, Vanda sp., Vanilla fragrans**
On tree crops, remove dead twigs and branches before flowering. Varietal resistance occurs in some crops, e.g. the yams, Belep, Kinabayo, Oriental and Plimbite. The papaya variety Sunrise Solo is more resistant than Kapoho Solo. For chemical control of tree, field and vegetable crops, treat regularly using copper hydroxide, copper oxychloride, mancozeb or mancozeb plus prochloraz. To protect the flowers, treatments on mangoes should commence as soon as the spikes appear. On ornamentals, use chlorothalonil, copper oxychloride, mancozeb or prochloraz. Resistances to benomyl, thiabendazole and thiophanate-methyl have appeared. After harvest, mangoes can be dipped in benomyl (52°C for 5 min), and then stored at 10°–12°C. A hot-water dip (48°C for 20 min) is effective for control of the pathogen on papaya. On avocado, post-harvest chemical treatment of fruit, and controlled temperature (16°–18°C) during ripening, and subsequent storage (2°–4°C), are critical to the production of commercial-grade fruit. See SPC Plant Protection Leaflet No. 12 for further details on this pathogen and its control on yam.

T63 — *GLOMERELLA TUCUMANENSIS* — **Saccharum officinarum**
Control can be obtained through the use of resistant varieties.

T64 — *GOPLANA AUSTRALIS* — **Dioscorea spp.**
No control is warranted as the damage caused by this pathogen is not thought to affect tuber yields.

T65 — *GOPLANA DIOSCOREAE* — Dioscorea spp.
No control is warranted, as the damage caused by this pathogen is not thought to affect tuber yields.

T66 — *GUIGNARDIA DIOSCOREAE* — Dioscorea spp.
No control is warranted, as damage by this pathogen is not thought to affect tuber yields. It is likely that varieties differ in susceptibility to this pathogen.

T67 — *GUIGNARDIA MUSAE* — Musa sp.
The disease is not of economic importance on the leaves, but infected leaves may act as sources of spores for fruit infections. Destroy infected leaves. Varieties differ in their susceptibility to infection, with Cavendish being resistant. In Hawaii, growers place a paper bag over the newly emerged bunch to prevent spores from the leaves reaching the fruit. For chemical control: dithiocarbamate fungicides. Fungicides used for the control of black Sigatoka will also be effective.

T68 — *HEMILEIA VASTATRIX* — Coffea arabica, Coffea canephora
Resistant lines are available, e.g. Catimor selections derived from the Timor hybrid. Chemical control is possible and copper fungicides are effective. The timing of treatments should be closely linked to the frequency and intensity of rainfall. Systemic fungicides may be applied once 20% of the foliage has become infected. Use oxycarboxin or triadimefon.

T69 — *HIRSCHMANNIELLA MITICAUSA* — Colocasia esculenta
Cultural control measures include crop rotation and the use of clean planting material. Old leaves, roots and soil should be removed and the corm piece inspected to ensure freedom from rots. Varieties differ in their susceptibility to infection. Resistance to the nematode has been detected in wild taro in Solomon Islands, and in hybrids between this and local cultivars. Giant swamp taro is resistant to infection.

T70 — INTERNAL BROWNING — Malus x domestica
The disorder is due to storage of fruit at excessively low temperatures, but still above freezing point. Apple varieties show widely varying degrees of susceptibility.

T71 — *LASIODIPLODIA THEOBROMAE* — Artocarpus altilis, Persea americana
Cultural control measures are important. In avocado, dead leaves, twigs and branches should be removed from the canopy before flowering. Efforts should be made to prevent or protect wounds through which the fungus can enter and infect. In cocoa and other trees, pruning wounds can be sealed with tar mixed with copper fungicides; collar rot of passionfruit associated with the tunnelling of the beetle, *Elytroteinus subtruncatus*, can be treated with insecticides or applications of flowable formulations of thiram; and banana fruit can be dipped in benomyl, carbendazim or thiabendazole to prevent crown and fingertip rots. In papaya, hot-water dips as for anthracnose control (T62) can be effective. See also comments on handling avocado at harvest. For chemical control in avocado: benomyl or thiabendazole. Resistance to these fungicides has been recorded, and imazalil may be used as an alternative.

T72 — LETTUCE MOSAIC POTYVIRUS — Lactuca sativa
The virus is spread by aphids and is also seedborne. Seeds should be certified free from infection. The remains of the crop should be destroyed as soon as possible after harvest. Lettuce varieties show differing degrees of susceptibility, with cos lettuces being more resistant than cabbage types.

T73 — *LEVEILLULA TAURICA* — Lycopersicon esculentum

Many different plants are hosts, so spores are available throughout the year. Certain crops are at risk when moisture levels are high (e.g. eggplant and sweet pepper), while others are only affected during dry conditions (e.g. tomato, lucerne and cotton). Crops at different growth stages should not be placed next to each other. For those crops which are at risk during dry conditions, sprinkler irrigation is recommended. For chemical control: sulphur—but this may cause burning of the leaves and fruit in dry weather—alternatively, benomyl, bupirimate or fenarimol.

T74 — *MAGNAPORTHE SALVINII* **— Oryza sativa**
It is during the cool season that infection from this pathogen is most serious, with overcast periods and light rain providing ideal conditions for its development. Crop residues should be burnt or removed. Resistant varieties are available. Seed treatments are important, and TCMTB is used. For chemical control in established crops: copper fungicides, applied between the time of stem and ear formation.

T75 — MAIZE MOSAIC RHABDOVIRUS **— Zea mays**
Cultural control measures include crop rotation and the elimination of grasses that are alternative hosts of the virus from within and around the planting. Varieties differ in their reaction to infection. For chemical control against the planthopper vector, *Peregrinus maidis,* use insecticides: acephate, malathion or dimethoate.

T76 — *MARASMIELLUS ALBOFUSCUS* **— Cocos nucifera**
Usually not important and no control measures are warranted, although there have been no studies to verfiy this.

T77 — *MARASMIELLUS COCOPHILUS* **— Cocos nucifera**
Grasses are alternative hosts of the fungus and in nurseries they should be controlled. The fungus is seedborne and dipping pared coconuts in phenyl mercury acetate is likely to give control. Reassessment of lethal bole rot previously attributed to this pathogen in Kenya and Tanzania has cast doubt that *Marasmiellus* is the cause. In Solomon Islands, the only other country where the fungus has been reported, a quarantine embargo on the movement of coconuts from the island where the fungus was found, to other parts of the country, is no longer maintained.

T78 — *MARASMIELLUS INODERMA* **— Cocos nucifera, Musa sp.;** *MARASMIELLUS STENOPHYLLUS* **— Colocasia esculenta**
Infections in coconut occur while the nuts are still on the palm and as such they are difficult to prevent. Dips in a variety of fungicides have not given consistent and reliable results. Best control has been obtained with phenyl mercury acetate, but less potentially hazardous fungicides, e.g. benodanil, may also be effective. Local varieties are mostly resistant to attack. Infections on taro are not sufficiently serious to warrant control measures, although removal of diseased plants should be carried out to limit spread. On banana, the removal of infected plants and the use of fertilizers to promote vigorous growth are measures that may be effective against this fungus which is generally difficult to control. Planting material should be selected carefully to ensure it is free of the pathogens.

T79 — *MELOIDOGYNE* SPP. **— Phaseolus vulgaris**
Root-knot nematodes often cause severe infections on susceptible crops and a number of control measures are often necessary to bring about control. Cultural control measures are important. Repeated cultivation kills nematodes in the upper layers of the soil by exposing them to heating and drying by the sun. This is a good method of nematode control in seedbeds. Crops should be removed and destroyed by burning or burying as soon as harvest is over to prevent the nematodes from spreading into

the soil as the plants decay. At least a year should separate susceptible crops, as the eggs can remain viable for several months. Fallows may also be beneficial, with weed-free fallows of 4–6 months usually sufficient to reduce populations considerably. Where it is not acceptable for the land to remain idle for long periods, resistant cover crops can also be planted, e.g. green panic (*Panicum maximum* var. *trichoglume*) and siratro (*Macroptilium atropurpureum*). Resistant varieties are available for many of the crops attacked by nematodes. Peanuts are generally resistant to all the races in the Pacific Islands, and so is the yellow passionfruit. Varieties of bean, cassava, cowpea, sweet potato, tomato and taro are also available with resistance. Vegetative planting material of banana, ginger, potato and yam, without signs of infection, can be treated with hot water at 51°C for 10 min. For chemical control: carbofuran, ethoprophos, fenamiphos, oxamyl, and the fumigants, dazomet and methyl bromide. To be effective, chemical treatments should be combined with the cultural techniques described above.

T80 — *CAPNODIUM CITRI* — **Citrus spp.**
This non-pathogenic fungus develops on the surface of leaves in the sugary exudate of scale insects. Sometimes it grows profusely and restricts photosynthesis. Control is achieved by destroying the scale insects with insecticides (e.g. malathion plus white oil) and controlling ant populations which protect them.

T81 — *MYCOSPHAERELLA ALOCASIAE* — **Alocasia macrorrhizos**
No control measures are required as the disease caused by this pathogen is unlikely to affect corm yield.

T82 — *MYCOSPHAERELLA BERKELEYI* — **Arachis hypogaea**
Cultural control measures include the removal or burial of plant remains, and crop rotation. Varieties differ in susceptibility to infection, and there is evidence of different pathogenic strains. For chemical control: benomyl, cyproconazole, mancozeb or propiconazole. The same fungicides will control early leaf spot. Resistance to benomyl may occur.

T83 — *MYCOSPHAERELLA FIJIENSIS* — **Musa sp.**
The pathogen has replaced *M. musicola*, the cause of yellow Sigatoka disease, in most Pacific Islands. It is more difficult to control. Cultivation practices which lower the humidity and increase ventilation in plantations will help to reduce infection. There is merit in removing diseased leaves, preventing excessive weed cover and limiting sucker development. Soil fertility should be maintained and, if waterlogged, soils should be drained. Most banana varieties grown for export are susceptible, but some plantains have greater tolerance, maintaining at least four leaves until harvest. Pathogen-tested introductions from countries outside the region are under evaluation. For chemical control: oil-in-water emulsions plus benomyl, mancozeb, maneb, propiconazole (or flusilazol) plus mancozeb, or tridemorph. The repeated use of benomyl should be avoided because of the possible appearance of resistant strains. See SPC Plant Protection Leaflet No. 1 for further details on this pathogen and its control.

T84 — *MYCOSPHAERELLA HENNINGSII* — **Manihot esculenta**
Lowering the plant density will reduce the humidity within the plantation and reduce the incidence of infection. Varieties differ in resistance. For chemical control, if warranted: copper fungicides.

T85 — *MYCOSPHAERELLA MUSICOLA* — **Musa sp.**
Cultivation practices which lower the humidity and increase ventilation in plantations will help to reduce infection. These include improved drainage, removal of diseased leaves and the pruning of suckers. Varieties

of the AAA group are very susceptible, whereas plantains, ABB and AAB, are more tolerant. For chemical control, petroleum oil can be used. The disadvantage is that it is somewhat phytotoxic on plantain varieties if it is not applied properly (if the oil is of poor quality, it is used too frequently, or sprays are applied during hot, dry, sunny weather). Alternatively, benomyl, chlorothalonil, copper oxide, mancozeb, propiconazole or zineb can be applied, in oil plus water emulsions. The repeated use of benomyl should be avoided because of the possible appearance of resistant strains.

T86 — *NEOJOHNSTONIA COLOCASIAE* **— Colocasia esculenta**
Although the pathogen can occasionally be severe on some plants and some varieties, it probably causes little yield loss, and no control measures are warranted.

T87 — *OIDIUM* SPP.**— Mangifera indica, Vigna unguiculata ssp. sesquipedalis**
Mango varieties differ in resistance to the pathogen. For chemical control: micronised sulphur, taking care, when using the powder form, to avoid burning the foliage by applying early in the morning, in the evening, or during overcast days. It is likely that benomyl, mancozeb or mancozeb plus prochloraz, used to control anthracnose, will also be effective for powdery mildew control, if applied regularly during blossoming. For chemical control in beans: benomyl or sulphur.

T88 — *ONCOBASIDIUM THEOBROMAE* **— Theobroma cacao**
Cultural control measures are important; they include raising nursery stock away from diseased cocoa, and pruning trees to remove shoots at least 30 cm below discoloured vascular tissues. Varietal differences exist and their selection from amongst the Trinitario cocoa of Papua New Guinea during the epidemics of the 1960s has reduced the pathogen to minor importance. Amelonado is susceptible. Breeding for improved resistance continues in Papua New Guinea.

T89 — PAPAYA RINGSPOT POTYVIRUS **— Carica papaya**
The virus is of major quarantine importance where it is not yet present. Where it is established, it has proven difficult to control. Cultural control measures include the removal of infected plants within the crop, the elimination of wild and volunteer plants within and around the plantation, avoiding unnecessary movement of people and animals within the plantation, and ensuring that plants are spaced adequately to avoid leaves touching each other. Conventional breeding for resistance is being attempted, but has yet to produce fruit of acceptable quality. Some success has been achieved in Taiwan and Hawaii using mild strain resistance. Genetically engineered plants transformed with the coat protein gene of the virus have been produced in Hawaii. Attempts to control the spread of the pathogen by using insecticides to kill aphid vectors have not been effective.

T90 — PASSIONFRUIT WOODINESS POTYVIRUS **— Passiflora edulis**
The virus exists as several strains, which complicates control measures. It is important to ensure that propagating stock is free from infection. Nurseries and surrounding areas should be free of weeds, and plants should be protected against colonisation by aphids, which spread the virus. Cuttings taken from the field for propagation should be carefully selected from plantations free from the disease. Varieties differ in their tolerance to infection, with the purple passionfruit being particularly susceptible. Hybrids, *P. edulis* x *P. edulis* f. *flavicarpa*, are tolerant to most strains, but severe strains exist in Australia which cause considerable damage. A 'mild strain' of the virus has been used commercially.

T91 — *PELLICULARIA KOLEROGA* — **Coffea arabica, Coffea canephora**
Pruning and destruction of plant remains are the most effective methods of control.

T92 — *PENICILLIUM DIGITATUM, PENICILLIUM ITALICUM* — **Citrus spp.**
Ensure that fruit are harvested carefully and not when wet from rain or dew. They should be cut rather than pulled from the tree, to avoid causing wounds. Strict hygiene should be maintained in commercial packing sheds. In particular, diseased leaves and rejected fruit should be frequently collected and destroyed. For chemical control: benomyl, carbendazim, guazatine, imazalil, thiabendazole or thiophanate methyl. There is the possibility of the development of strains resistant to benomyl.

T93 — *PERICONIA MANIHOTICOLA* — **Manihot esculenta**
No control measures are required, as the disease caused by this pathogen is unlikely to affect root yields.

T94 — *PERONOSCLEROSPORA SACCHARI* — **Zea mays**
Cultural control measures include the removal and destruction of infected plants as soon as symptoms appear, avoiding interplanting maize and sugarcane, and for sugarcane, the careful selection of healthy planting setts. The pathogen is usually of minor importance in maize, but is regarded as a threat to sugarcane, although most varieties grown commercially have resistance. For chemical control: metalaxyl for seed treatment of maize.

T95 — *PERONOSPORA PARASITICA* — **Brassica oleracea var. capitata**
The disease is often more important on seedlings than on established plants. It is important to keep nurseries free from susceptible weeds and to destroy crop residues. Resistant varieties exist. For chemical control: chlorothalonil, copper hydroxide, maneb plus zineb, mancozeb plus metalaxyl, or zineb. Ensure that the under surface of leaves is well covered with fungicide.

T96 — *PESTALOTIOPSIS DISSEMINATA* — **Psidium guajava;** *PESTALOTIOPSIS PALMARUM* — **Cocos nucifera**
Improve growing conditions by applying fertilizer and, in coconut nurseries, decrease shade levels. For chemical control: chlorothalonil, copper oxychloride, mancozeb, maneb plus zineb, or zineb.

T97 — *PHAEOISARIOPSIS GRISEOLA* — **Phaseolus vulgaris**
The fungus survives in plant remains between crops and these should be destroyed or deeply buried after harvest. Resistant varieties are available (e.g. Redlands Greenleaf). Seedborne infections are a possibility and seed should be treated with thiram, or thiabendazole plus thiram. For chemical control on field-grown plants: mancozeb or benomyl.

T98 — *PHANEROCHAETE SALMONICOLOR* — **Citrus spp., Coffea arabica, Coffea canephora, Theobroma cacao**
Pruning and the reduction of shade levels are the two most important control measures. Affected branches should be pruned about 30 cm below the affected parts, removed from the plantation and burnt. For chemical control: copper oxychloride or tridemorph. Chemical control and pruning should be applied together.

T99 — *PHELLINUS LAMAENSIS* — **Coffea arabica, Coffea canephora**
Control measures are aimed at preventing the spread of the fungus from infected trees to others in the plantation. Infected trees should be dug out

and removed, preferably burnt. This should be done as soon as symptoms appear. Afterwards, and if practical, a legume ground cover should be established, as this will increase soil organisms antagonistic to *Phellinus*. It is important to inspect the base of the trunk and major roots of adjacent trees to check if they are infected.

T100 — *PHELLINUS NOXIUS* — Artocarpus altilis, Cordia alliodora, Theobroma cacao
The pathogen is difficult to control. By the time symptoms are seen the root system has been extensively damaged and the fungus has invaded the collar region of the trunk. Occasionally, trees can be cured if diseased parts are removed immediately symptoms appear. If this is not the case, it is important to prevent tree-to-tree spread by removing the diseased tree, making sure to extract all roots more than 2.5 cm diam. It is also good practice to expose the base of the trunk and major roots of adjacent trees to check if they are infected. In forestry situations, increased tree spacing, interplanting rows of susceptible trees with those that are more resistant, and delaying planting after clear-felling to allow time for complete decay of woody debris, are all measures that have been considered.

T101 — *PHOMA* SPP. — Colocasia esculenta
These pathogens have not been shown to reduce yields sufficiently to warrant control measures. Taro varieties differ in their susceptibility to shot-hole. In general, infection is more severe in the cooler months of the year.

T102 — *PHYLLACHORA MUSICOLA* — Musa sp.
Cavendish varieties are resistant. Although some plantains are susceptible, damage is unlikely to reduce yield sufficiently to warrant control measures.

T103 — *PHYTOPHTHORA COLOCASIAE* — Colocasia esculenta
This is a disease of major quarantine importance to countries which are yet free from the pathogen. If countries wish to import material it should be as pathogen-tested plants, preferably from regional tissue culture laboratories. Cultural control measures are important, including: the regular removal of infected leaves, the avoidance of planting new crops adjacent to those that are already infected, using planting material free from infection, and using wider-than-traditional plant spacing. Disease-free planting material can be obtained by removing all but three or four of the youngest leaves and checking that the corm piece is free from rot. Dipping the planting material in chlorox, mancozeb, metalaxyl or potassium phosphonate is also recommended, but is probably not necessary if older leaf bases have been removed. Plants are being bred in Papua New Guinea and Solomon Islands for greater tolerance to the disease. For chemical control: copper oxide plus metalaxyl, copper oxychloride, mancozeb, mancozeb plus metalaxyl, or potassium phosphonate. Chemical control should be combined with roguing diseased leaves. See SPC Plant Protection Leaflet No. 3 for further details on this pathogen and its control.

T104 — *PHYTOPHTHORA HEVEAE* — Cocos nucifera; *PHYTOPHTHORA PALMIVORA* — Artocarpus altilis, Cocos nucifera, Theobroma cacao, Vanilla fragrans, Vanilla tahitensis
Cultural techniques are important in the control of these pathogens, including the removal of weeds, adjustment of shade levels (cocoa and vanilla), the regular removal of diseased plant parts (chupons and pods of cocoa, fruit of papaya and breadfruit), and the use of a mulch to cover the soil. It is important to establish plantings on well-drained land. For papaya, the virgin soil technique, i.e. taking soil from areas where papaya has never been grown and using it to fill the planting holes, has been used

to good effect in replant areas. Varietal resistance is important in cocoa, with tolerance in Amelonado and some Trinitario clones, whereas Criollo varieties are very susceptible. Differences also exist in the reaction of coconut varieties to infection. For chemical control: copper fungicides, copper oxide plus metalaxyl, mancozeb plus metalaxyl, or potassium phosphonate. The latter has been used successfully as a trunk injection for the control of black pod and canker in cocoa. See SPC Plant Protection Leaflet No. 7 for further details on this pathogen and its control.

T105 — *PHYTOPHTHORA NICOTIANAE* var. *PARASITICA* — **Carica papaya, Citrus spp., Vanda sp.**
Cultural techniques are important in the control of this pathogen, including the removal of dead trees and fallen fruit, the choice of well-drained sites, avoiding damage to the collar region during weeding and other horticultural operations, and the use of ground covers or mulches. If detection is early, cankers on citrus can be scraped away and the wounds covered, initially, with the fungicides listed below and, later, with tar. If the plantations are irrigated, it is important that water not touch the trunk. Varietal control is possible in citrus with the use of bitter orange rootstocks, but they are often susceptible to citrus tristeza closterovirus. *Poncirus trifoliata* rootstocks are relatively tolerant of *Phytophthora* infection. For chemical control: aluminium phosetyl, potassium phosphonate or mancozeb plus metalaxyl applied as a paint or spray to the trunk. For soil fumigation after the removal of dead trees: formaldehyde, methyl bromide or metam-sodium.

T106 — PHYTOPLASMA — **Ipomoea batatas**
The pathogen is spread by the leafhopper, *Orosius lotophagorum ryukyuensis*, but more importantly through the use of cuttings taken from diseased plants. Destruction of diseased plants, careful selection of planting material and the removal of alternative hosts are all important control measures. Varietal resistance has not been reported. Introductions of germplasm should be limited to plants derived from meristems and indexed for mycoplasma-like organisms and virus infections. For chemical control against insect vectors: acephate, carbaryl, dimethoate or malathion. See SPC Plant Protection Leaflet No. 19 for further details on this pathogen and its control.

T107 — PHYTOPLASMA —**Lycopersicon esculentum, Solanum tuberosum**
Keep plantings and surrounding areas free from weeds. Remove infected plants as soon as symptoms are seen. For chemical control on tomato, against leafhopper, *Orosius argentatus,* vectors: dimethoate, endosulfan or malathion.

T108 — POTATO LEAFROLL LUTEOVIRUS — **Solanum tuberosum**
Avoid growing crops next to potato or tomato plantings that are older and possibly infected with the virus. Remove weed hosts, such as *Datura* spp. and *Physalis* spp. Use certified seeds. For chemical control of aphid vectors: acephate, demeton-S-methyl, dimethoate, endosulfan or malathion.

T109 — *PRATYLENCHUS COFFEAE* — **Dioscorea spp.**
Cultural control measures are important, including the careful selection of planting setts free of rot, and crop rotation. Tubers should be regularly inspected during storage and those with surface rots removed and eaten rather than kept for propagation.

T110 — *PSEUDOCERCOSPORA ABELMOSCHI* — **Abelmoschus esculentus**
The pathogen is not considered to cause sufficient damage to warrant control measures. If blemish-free leaves are required, use benomyl, copper fungicides or mancozeb.

T111 — *PSEUDOCERCOSPORA COLOCASIAE* — Colocasia esculenta
The pathogen is not considered to cause sufficient damage to warrant control.

T112 — *PSEUDOCERCOSPORA TIMORENSIS* — Ipomoea batatas
The pathogen usually infects older leaves and, as it is unlikely that it reduces root yield, control measures are not considered necessary. Varieties are likely to differ in their susceptibility to infection.

T113 — *PSEUDOEPICOCCUM COCOS* — Cocos nucifera
The disease is usually present on older leaves and as such is not thought likely to reduce yields. If control measures are warranted, improve nutrition and growing conditions.

T114 — *PSEUDOMONAS* SPP. — Lactuca sativa
The bacteria are soilborne and survive in crop residues. Soft rots are favoured by hot, wet weather. In the field the bacteria are spread between plants in water droplets. Cultural control measures are important. Remove plants as soon as symptoms develop; avoid harvesting when plants are wet; disinfect knives used for cutting plants; after harvest remove crop residues or dig them in deeply; and practise crop rotation. If crops are irrigated, use furrow or trickle irrigation rather than overhead applications.

T115 — *PSEUDOMONAS SOLANACEARUM* — Capsicum annuum, Lycopersicon esculentum
Control is difficult as the bacterium has a wide host range (some weeds may even be infected without showing symptoms), and it can survive in the soil for several years, making crop rotation of limited value. The bacterium can also be seedborne (sweet pepper and soybean). Amending the soil with urea (200 kg N/ha) and CaO (5 t/ha) 3 weeks before transplanting tomato seedlings has proved beneficial where soil pH is slightly acid to neutral. A package of control measures has been developed for control of the bacterium on potato, incorporating rotations with maize, weed control using herbicides, and soil amendments using urea and CaO. Varietal control is a possibility for tomato and eggplant, with selections having been made in Australia (Scorpio, Redlands, Summertaste, Redlander), Fiji (Alton) and Western Samoa. Resistance often breaks down under conditions of high temperatures and rainfall. The Peruvian potato varieties Caxamarca and Molinera are tolerant. Use of certified potato 'seed' is important in disease control strategies. In nurseries, use soil-less mixes or pasteurised soil. For chemical control: methyl bromide in greenhouse situations; disinfect tools with formaldehyde, methylated spirits or sodium hypochlorite after use on infected crops.

T116 — *PSEUDOPERONOSPORA CUBENSIS* — Cucumis sativus
The disease is windborne, and crops at different stages of growth should not be placed next to each other. To minimise the time that leaves are wet from dew or rain, crops should not be grown too densely. Overhead irrigation should be avoided. Varietal resistance exists in melon and watermelon (e.g. Chilton, Gulfcoast, Gulfstream, Planters Jumbo and Rio Gold), and cucumbers (Green Gem and Hybrid Sprint are resistant, as are Ashley, Cherokee, Burpless and Pixie—but the last four are susceptible to *Sphaerotheca fuliginea*). For chemical control: benalaxyl plus mancozeb, chlorothalonil plus fenarimol, copper hydroxide, copper oxychloride, mancozeb, mancozeb plus metalaxyl, or propineb plus metalaxyl.

T117 — *PUCCINIA ARACHIDIS* — Arachis hypogaea
Varieties differ in their resistance to the rust. Seedborne infections are important and can be controlled by thiram. For chemical control in the field: bitertanol, chlorothalonil, cyproconazole, mancozeb or propiconazole.

T118 — *PUCCINIA THALIAE* — Canna indica; *PUCCINIA PAULLULA* — Monstera deliciosa; *PUCCINIA PELARGONII-ZONALIS* — Pelargonium zonale
For chemical control: bitertanol, chlorothalonil, copper oxychloride, copper oxychloride plus zineb, oxycarboxin or thiram.

T119 — *PUCCINIA SORGHI* — Zea mays
Destroy volunteer plants before sowing. Varietal resistance exists (e.g. Suwan 1), but there are many races of the pathogen. Some super-sweet corn varieties are very susceptible. For chemical control: copper plus zineb, maneb or mancozeb.

T120 — *PYTHIUM* SPP. — Colocasia esculenta
Cultural control measures are important, including: (a) the removal of soil, roots and outer leaves from planting material taken from infected fields; (b) ensuring land is not liable to flooding or poorly drained and, for wetland taro, plants are not grown in stagnant water; (c) the removal of diseased plants immediately symptoms appear; and (d) the use of a fallow period or, if this is not practical, planting alternative crops. The use of fertilizers to promote vigorous plant growth can lessen the impact of disease. Varietal tolerance has been reported in several Pacific Island countries and pathogen-tested plants can be obtained from regional tissue culture laboratories. For chemical control: captan, metalaxyl or potassium phosphate as pre-plant dips on planting setts. The use of these chemicals in field plantings may be beneficial, but their effect is unproven. See SPC Plant Protection Leaflet No. 20 for further details on this pathogen and its control.

T121 — *PYTHIUM* SPP. — Cucumis sativus
Cultural control measures include: (a) thorough preparation of land to assist the decomposition of plant remains; (b) careful site selection to avoid poorly drained soil; (c) adjusting sowing density to avoid overcrowding; (d) preventing overwatering of seedlings; and (e) avoiding fruit coming into direct contact with soil with e.g. plastic mulches. Fruit grown commercially should be dry when packed and stored under cool, well-ventilated conditions. For chemical control: thiram for seed treatment to prevent damping-off.

T122 — *PYRENOPHORA GRAMINEA* — Hordeum vulgare
Resistant varieties are available. Seed treatment is important and fuberidazole plus triadimenol plus imazalil, or guazatine plus imazalil can be used.

T123 — *RADOPHOLUS SIMILIS* — Cyrtosperma chamissonis, Musa sp., Zingiber officinale
Cultural control measures are important. For ginger, rotate with crops of *Colocasia* taro, or cassava, or fallow the land. Avoid land previously planted to banana. Planting material should be carefully inspected and any with signs of rot rejected. Trim the planting material of the other two crops to ensure that the corm tissues are free from rots (giant swamp taro), or black or discoloured spots (banana). For banana, other techniques have been developed: the trimmed suckers are dipped in hot water (53°–54°C for 20–25 min) and planted in land that has been fallowed for at least 2 years, or planted with cover crops, such as green panic, *Panicum maximum* var. *trichoglume*, or a mixture of this grass and siratro, *Macroptilium atropurpureum*. For hot-water treatment of ginger use 48°C for 20 min or 51°C for 10 min. For chemical control: carbofuran, ethroprophos, fenamiphos or oxamyl. See SPC Plant Protection Leaflet No. 5 for further details on this pathogen and its control.

T124 — *RHIZOPUS STOLONIFERA* — Fragaria x ananassa
Overripe fruit should be removed at every harvest. Careful handling of the fruit after harvest and strict hygiene in the packing shed will also help to control the pathogen. Fruit should be cooled as soon as possible after harvest. For chemical control: benomyl or chlorothalonil. Treatments for powdery mildew are likely to be effective against this transit rot pathogen.

T125 — *SCLEROTINIA* SP. — Vanda sp.
For chemical control: benomyl, iprodione or vinclozolin.

T126 — *SCLEROTINIA MINOR* — Lupinus albus, L. angustifolius
Cultural control measures are important: destroy the remains of previous harvests or bury them deeply in the soil and rotate with resistant crops (cereals, onion and sweet potato). Avoid excessive applications of nitrogenous fertilizers. For chemical control: benomyl, iprodione, thiram or vinclozolin as foliar sprays and quintozene as a pre-plant soil treatment.

T127 — *SCLEROTINIA SCLEROTIORUM* — Glycine max, Lactuca sativa; *SCLEROTINIA FUCKELIANA* — Helianthus annuus
Cultural control measures are important: destroy crop remains of previous harvests or bury them deeply in the soil, rotate with resistant crops (cereals, onion and sweet potato), use low plant densities, and apply recommended fertilizers to ensure vigorous plant growth. Varietal resistance exists in sunflower, and the soybean varieties Ace, Corsoy, Hodgson and Maple Arrow. Soybean varieties Maple Presto and McCall also have useful tolerance. For chemical control: thiram as a seed treatment; and benomyl, iprodione, thiabendazole or vinclozolin as foliar sprays; and quintozene as a pre-plant soil treatment.

T128 — *SETOSPHAERIA TURCICA* — Zea mays
Cultural control measures include the destruction of volunteer plants and crop residues before sowing, and crop rotation. Differences exist between varieties in their tolerance to infection. For chemical control: thiram as a seed treatment.

T129 — SOOTY MOULD FUNGI — Plumeria spp.
For chemical control of insects: acephate, carbaryl, demeton-S-methyl, dimethoate, malathion, or malathion plus white oil.

T130 — *SPHAEROTHECA FULIGINEA* — Carica papaya, Cucumis sativus
A wide range of weeds and crops are hosts, so inoculum is available throughout the year. Vigorous crop growth should be encouraged through the use of appropriate fertilisers. Tolerant varieties of cucumber (Green Gem and Hybrid Sprint), melon (Chilton, Gulfcoast, Gulfstream, Planters Jumbo and Rio Gold) and watermelon are available, but the resistance may not be durable as it is controlled by a dominant gene. For chemical control: benomyl, carbendazim, dimethirimol, sulphur, triadimefon or triadimenol. Sulphur can burn the leaves, and resistance to the systemic products may develop.

T131 — *SPHAEROTHECA MACULARIS* — Fragaria x ananassa
The fungus survives on diseased ratoon crops, and these should be removed between seasons. Also, avoid overlapping crops. High humidity favours infection, while dry conditions encourage growth and sporulation of the fungus. For chemical control: benomyl or triadimefon, but strains resistant to these fungicides have been reported. Sulphur or dinocap can be used as alternatives.

T132 — *STIGMINA MANGIFERAE* — Mangifera indica
Rain or heavy dew favour outbreaks. Control measures recommended for anthracnose are likely to be effective. For chemical control: benomyl, copper oxychloride, mancozeb, or prochloraz plus mancozeb.

T133 — SUGARCANE FIJI DISEASE FIJIVIRUS — **Saccharum edule**
Major epidemics of this disease in sugarcane have occurred in Australia and Fiji. They have only been brought under control by the selection of disease-free planting material, regular roguing of infected plants, and the use of resistant varieties. Heavily infected crops may be ploughed out. *S. edule* is susceptible. For chemical control of leafhopper vectors, *Perkinsiella* spp., if economically acceptable, dimethoate, endosulfan or malathion.

T134 — SUN SCALD — **Lycopersicon esculentum**
The disorder is due to fruits receiving excessive and damaging amounts of sunlight due to defoliation by, e.g. leaf pathogens. If they are controlled, the disorder will be prevented.

T135 — *THANATEPHORUS CUCUMERIS* — **Brassica oleracea var. capitata, Lycopersicon esculentum, Solanum tuberosum**
Cultural control measures are important, including the elimination of plant remains after harvest, good drainage, avoiding plant injury, and ensuring optimum plant nutrition. To prevent pre- and post-emergence damping-off use soil-less potting mixtures or pasteurised soil. Contact between fruit and the soil should be avoided by using plastic mulches or by staking (tomato and beans). For chemical control: benomyl or thiram as a seed treatment; quintozene as a pre-plant soil treatment; soil fumigation with methyl bromide or metam-sodium (tomato); formaldehyde, phenyl mercury acetate, sodium hypochlorite or quintozene as dips of 'seed' pieces (potato and yam).

T136 — TIPBURN — **Lactuca sativa**
This physiological disorder is favoured by high diurnal temperatures causing excessive water loss. No cropping technique has given control, although fertilizer rich in phosphorus with moderate amounts of nitrogen and potassium may be beneficial. In greenhouses, it is important to be able to manipulate ventilation and shade in order to control temperatures.

T137 — *TRANZSCHELIA DISCOLOR* — **Prunus persica**
For chemical control: chlorothalonil, copper oxychloride, mancozeb, thiram, or zineb plus oil.

T138 — UNKNOWN — **Carica papaya**
Within the region served by the SPC, the disease has only been reported from New Caledonia, where it causes severe damage. Symptoms are similar to those of dieback in Australia which is thought to be caused by a phytoplasma (mycoplasma-like organism). No control measures are known. Trees may recover if they are cut back below the dead area.

T139 — *UREDO MUSAE* — **Musa sp.**
This is not an important pathogen and specific control measures are unnecessary. The fungicides used against yellow or black Sigatoka diseases will control leaf rust, although sprays of oil alone, or extended spraying with benomyl, may encourage the occurrence of the pathogen.

T140 — *UREDO* SP. — **Chrysanthemum leucanthemum**
For chemical control: bitertanol, chlorothalonil, copper oxychloride, copper oxychloride plus zineb, oxycarboxin or thiram.

T141 — *UROMYCES APPENDICULATUS* var. *APPENDICULATUS* — **Phaseolus vulgaris**
Remove or bury plant remains deeply after harvest and use rotations of more than two years between bean crops. Intercropping beans with maize significantly reduces the incidence of infection. Varietal differences exist. For chemical control: bitertanol, copper hydroxide, mancozeb, metiram, oxycarboxin or zineb.

T142 — *UROMYCES STRIATUS* — **Medicago sativa**
Frequent cutting or grazing reduces the impact of the pathogen. Two strains exist and mixtures of lucerne varieties are available with resistance.

T143 — *UROMYCES VIGNAE* — **Vigna unguiculata ssp. sesquipedalis**
Destroy crop remains after harvest. For chemical control: carboxin or thiram as a seed treatment, and bitertanol, copper hydroxide, mancozeb, metiram or oxycarboxin as foliar sprays.

T144 — *UROMYCLADIUM TEPPERIANUM* — **Acacia spirorbis**
No treatment known.

T145 — *USTILAGO TRITICI* — **Triticum aestivum**
Varietal differences exist. For chemical control: carboxin plus imazalil plus thiabendazole.

T146 — *USTILAGO ZEAE* — **Zea mays**
Crop rotation is important as the pathogen is soilborne. It is also seedborne and seed should be treated with TCMTB, or thiram plus carboxin. In home gardens, remove and burn the infected plants before the galls rupture. Maintain well-balanced soil fertility and avoid mechanical damage to the plants during cultivation. Varietal differences exist, with most hybrids having a reasonable degree of resistance.

T147 — VANILLA MOSAIC POTYVIRUS — **Vanilla fragrans, Vanilla tahitensis**
Cultural control measures are important, including the use of propagating material from plantings free from symptoms of the disease, removal of infected plants immediately symptoms appear, disinfection of pruning knives with formaldehyde, methylated spirits or sodium hypochlorite, and washing hands with soap after working on plants that are diseased. Maintain weed control in plantations to reduce aphid populations which might otherwise spread the virus.

T148 — VANILLA NECROSIS POTYVIRUS — **Vanilla fragrans**
Control measures are identical to those for vanilla mosaic virus.

T149 — *VERTICILLIUM THEOBROMAE* — **Musa sp.**
Usually of minor importance and control measures are not warranted. Hand removal of the floral remains about 10 days after bunch emergence is practised in some countries. For chemical control: copper fungicides either sprayed or dusted over the fruit, or thiabendazole as a post-harvest dip.

T150 — *XANTHOMONAS CAMPESTRIS* pv. *CAMPESTRIS* — **Raphanus sativus**
An important disease of quarantine concern in those countries yet free from the bacterium. Cultural measures are important in the control of the pathogen, including ensuring seedlings are not overcrowded, the removal of susceptible weeds, the removal or deep burial of crop remains immediately after harvest, and crop rotation. If crops are irrigated, it is best to avoid overhead systems. Seedborne infections are important and can be controlled by treating the seed in host water (45°C for 25–30 min

or 50°C for 15–25 min). The cabbage varieties Beauty, Hi-Yield and Hybrid 33 have some resistance to infection. For chemical control: copper hydroxide, beginning on seedlings in the nursery, especially if seed treatment has not been applied.

T151 — *XANTHOMONAS CAMPESTRIS* pv. *CITRI* — Citrus spp.
An important disease of quarantine concern to those countries yet free from the bacterium. Eradication attempts have been successful in some countries. Once established the pathogen is difficult to control. Cultural methods of control are important, including pruning of branch cankers and planting windbreaks around orchards to prevent the pathogen spreading in wind-driven rain, as well as reducing physical damage which might assist entry of the bacterium. Lemons, mandarins and seedless limes are more resistant than grapefruit and oranges. For chemical control: copper fungicides.

T152 — *XANTHOMONAS CAMPESTRIS* pv. *MANGIFERAEINDICAE* — Mangifera indica
An important disease of quarantine concern to those countries yet free from the bacterium. Cultural control measures are important. It is essential that seedlings and grafted plants are free from infection. Do not establish nurseries near mango plantings and select scion wood from disease-free trees. Treat propagating material with copper fungicides. Establish new plantings in areas protected from strong winds and provide windbreaks around and within the orchard. Varietal differences exist. In Australia varieties Carabao, Early Gold, Kensington, Nam Dok Mai and Sensation have resistance. For chemical control: copper oxychloride (except during flowering).

T153 — *XANTHOMONAS CAMPESTRIS* pv. *MANIHOTIS* — Manihot esculenta
An important disease of quarantine concern to those countries yet free from the bacterium. Cultural control measures include the destruction of plant remains after harvest, the selection of cuttings for propagation from disease-free plants, crop rotation and avoiding planting crops of different ages adjacent to each other. Varieties differ in their tolerance to the bacterium, and some with resistance, bred at international agricultural research centres, are available as pathogen-tested plantlets from regional tissue culture laboratories.

T154 — *XANTHOMONAS CAMPESTRIS* pv. *VESICATORIA* — Lycopersicon esculentum
An important disease of quarantine concern to those countries yet free from the bacterium. Cultural control measures include the destruction of plant remains after harvest, crop rotation (at least 2 years), and the removal of alternative hosts, weeds included. Varietal differences exist in sweet pepper. Seedborne infections are important and can be controlled in tomato by treating seed in hot water (50°C for 25 min.) For sweet pepper, seed should be obtained certified free of the pathogen. For chemical control in field crops: chlorothalonil, copper hydroxide, copper oxide, copper oxychloride, or copper oxychloride plus zineb.

T155 — ZUCCHINI YELLOW MOSAIC POTYVIRUS — Cucurbita pepo
The virus is spread by aphids, and some crucifers act as reservoirs of infection. Cultural control measures include the roguing of alternative hosts and the destruction of residues as soon as the crop has been harvested. Overlapping crops should be avoided, particularly when

growing zucchini. Reflective mulches have been used with some success when combined with applications of insecticide, such as demeton-S-methyl, endosulfan or malathion, to kill the aphids. Insecticides alone have little effect. Best control has been attained using a mild strain of the virus which is now in commercial use in several countries (France, Guam, USA, and some Pacific Islands).

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