Common African Pests and Diseases

of Cassava, Yam, Sweet Potato and Cocoyam

edited by
Robert L. Théberge

The International Institute of Tropical Agriculture

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IITA seeks to develop alternatives to shifting cultivation that will maintain the productivity of the land under continuous cultivation in the humid and subhumid tropics; to develop higher yielding pest and disease resistant varieties of cowpeas, yams and sweet potatoes worldwide; to increase production in maize, rice, cassava and soybeans in Africa; and to strengthen national agricultural research systems by a comprehensive training program and collaborative research.

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FOREWORD

THE major tropical root crops – cassava, yam, sweet potato and cocoyam – are widely grown and mostly used as subsistence staples in tropical and subtropical Africa. They are the major source of energy for well over 200 million people on the continent, and the leaves, except for yams, are often used as a green vegetable. These root and tuber crops are well adapted to diverse soil and environmental conditions, as well as to complex traditional farming systems. However, because of the primarily subsistence nature of these crops, they have historically received little attention from scientists and policy-makers.

On the African continent, pests and diseases are the most serious limiting factors in root crop production – limitations that will increase as populations, and areas under cultivation, increase. The Root and Tuber Improvement Program of the International Institute of Tropical Agriculture (IITA) (Ibadan, Nigeria), was established in 1971 to assist in increasing production of these crops. Its objectives are to develop improved varieties and populations of cassava, sweet potato, yam and cocoyam, with high stable yields, resistance to major diseases and insect pests and nematodes, wide adaptability, good storage characteristics and high consumer acceptance.

The program is also active in training scientists and technicians from national root and tuber research programs throughout the humid and subhumid zones of Africa and elsewhere.

Through these training programs and through the active cooperation and collaboration of national program personnel, the results of IITA research are adapted and transmitted to the farmers.

It is hoped that the results of research and study included in this handbook will be useful to all those who labor to increase food crop production in the tropics.

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INTRODUCTION

Common African Pests and Diseases of Cassava, Yam, Sweet Potato and Cocoyam describes the most common fungal, bacterial, insect and mite problems associated with the cultivation of these four major tropical root crops. While some problems are of major economic importance, others do not present major constraints to production.

The incidence and the distribution of the various pests (fungal, bacterial, nematode, insect or mite) associated with these root crops are based upon literature reviews and personal communication, as well as personal observations.

This publication is intended as a pictorial guide for growers of cassava, yam, sweet potato and cocoyam in order to help identify production constraints often associated with these four root crops. The information on the symptoms for the various tuber crop diseases allows for the implementation of appropriate control strategies once the problem is correctly identified.

The integration of several control measures – cultural, biological, chemical – may prove to be most effective. The International Institute of Tropical Agriculture (IITA) places particular emphasis on developing root crop varieties that are resistant to or tolerant of the major economic diseases. In general, crop rotation, sanitation, resistant varieties, vector control and the use of clean planting materials are sound approaches in controlling plant disease. The cost of any control measure, whether used singly or in combination, should be less than the increased value of the crop, to be economically feasible, as well as readily adaptable by the small-holder farmers who constitute the major producers of food in Africa.

CASSAVA (*Manihot esculenta*)

THERE are well over 200 *Manihot* species, of which *Manihot esculenta* Crantz is the most important from a nutritional and economic point of view. The crop is commonly referred to as cassava, manioc, madioca, tapioca and yuca. The plant is a dicotyledon belonging to the Euphorbicaceae family. Cassava typically grows as a shrub, and may reach a height of up to 4 meters for some varieties. A cassava crop is propagated vegetatively by stem cuttings, and storage roots average 5–10 tubers per plant.

Cassava is native of Latin America and was introduced to the African continent by Portuguese traders in the late 16th century. Today, cassava is grown on an estimated 80 million hectares, in 34 African countries. It is an important crop in subsistence farming as it requires few production skills or inputs, is drought tolerant and produces reasonable yields under adverse conditions. The tubers, which are mainly composed of starch, and the leaves, which are consumed as a green vegetable in certain regions, contain cyanogenic glucosides (HCN). Bitter varieties must be processed (by a combination of peeling, soaking, fermenting, grinding, drying and cooking according to local custom) before either the roots or leaves can be safely consumed.

Africa's average cassava tuber yield of 6.0 t/ha is low in comparison to the world average of 8.3 t/ha. This poor yield is primarily a result of heavy losses due to disease and pest infestation.

DISEASE: African cassava mosaic disease, cassava mosaic virus

RANGE: Continental Africa and Southern India.

PATHOGEN: Paired or bonded particles averaging 20 × 30 nm belonging to the geminivirus group.

VECTOR: Whitefly (*Bemisia tabaci* Genn.).

HOST: *Manihot* spp. Other genera have been reported but not confirmed.

Symptoms: Differ due to cultivar, viral strain(s) and/or environmental factors. Characteristic intermingled patches of normal, light green or yellow to white patches are present on the leaf (photo 1). These chlorotic areas may vary in size from small flecks or spots to the entire leaf being affected. At times, chlorosis may be limited to the basal portion of the leaf. During early leaf development, chlorotic areas fail to keep pace with normal leaf tissue, resulting in leaflet size reduction, puckering and overall distortion (photo 2).

Spread: The virus is transmitted by the whitefly (*Bemisia tabaci* Genn.) vector (photo 3) under natural field conditions principally by means of infected planting materials (cuttings). Environmental factors favoring the development and fecundity of the whitefly enhance the spread of the disease.

Losses: 20% to 90%. Dependent upon cultivar, viral strain(s) and environmental factors. Cassava mosaic disease is one of the most important factors limiting production in Africa.

PHOTO 1

PHOTO 3

PHOTO 2

DISEASE: **Cassava bacterial blight**
RANGE: Major cassava-growing areas worldwide.
PATHOGEN: *Xanthomonas campestris* (Pammel) Dowson pv. *manihotis* (Arthaud-Berthet) Starr (gram-negative, non-sporing motile single polar flagellated bacterium).
HOST: *Manihot* spp.

Symptoms: Infected plants can easily be identified by localized, angular, water-soaked areas of discolored, diseased leaf tissue (photo 4), leaf blighting, wilting, defoliation, vascular discoloration, exudation, and die-back (photo 5). Not all leaves of the plant are initially infected but as the areas of affected tissue enlarge and coalesce, blighting results followed by wilting and leaf loss.

Due to the systemic nature of this disease a characteristic brownish discoloration of the vascular system can easily be detected in both stems and roots. Under severe attack rapid defoliation occurs, leaving the bare stems, commonly referred to as 'candlesticks,' in the field (photo 6).

During the early morning hours when periods of high relative humidity occur, bacterial exudations can readily be observed on the lower surfaces of infected leaves (photo 7), and on the petioles and stems of highly susceptible varieties (photo 8).

PHOTO 4

PHOTO 5

Spread: Primarily by infected cuttings. Secondary spread is apparently favored during the wet season via rain splashing and by insects which engender the bacterial ooze. A high correlation between the amount of rainfall and disease incidence/severity has been reported.

Losses: Range from 20% to 100% depending upon cultivar, bacterial strain and environmental conditions.

PHOTO 6

PHOTO 7

PHOTO 8

DISEASE: Cassava angular leafspot
RANGE: Worldwide.
PATHOGEN: *Xanthomonas campestris* pv. *cassavae* (Wiehe and Dowson). Similar to, but believed to be a different strain than *X. campestris* pv. *manihotis.*
HOST: *Manihot* spp.

Symptoms: Can easily be confused with cassava bacterial blight. Laboratory isolation techniques are necessary for positive identification. The disease is non-systemic and therefore, unlike cassava bacterial blight, is restricted to the leaf. Angular leaf spots appear water-soaked and, depending on host/pathogen interaction, may have lesions with yellowish borders (photo 9). During periods of high relative humidity, bacterial exudations are easily observed oozing from infected leaf tissues (photo 10).

Spread: Primarily via diseased cuttings. During the wet season the bacteria are splashed to neighboring leaves/plants and penetrate through stomata and wounds.

Losses: Losses due to cassava angular leafspot have not been quantified, but are believed to be negligible.

PHOTO 9

PHOTO 10

DISEASE: Cassava anthracnose disease

RANGE: Major cassava-growing areas worldwide.

PATHOGEN: *Colletotrichum gloeosporioides* f. sp. *manihotis* Henn. (Penz.) Sacc. *Glomerella manihotis* Chev.

VECTOR: *Pseudotheraptus devastans* Dist. (Coreid).

HOST: *Manihot* spp., *Coffea arabica*, *Carica papaya*, *Capsicum annuum* L., and *Jatropha multifada* L.

Symptoms: Of the several fungi that have been reported on cassava, *Colletotrichum* attacks mainly the stem. Cassava anthracnose disease is typically characterized by stem, twig and fruit cankers, leaf spotting and tip dieback (photo 11). Slightly depressed oval lesions (1.5 × 1 cm) on young stems are first symptoms of the disease. A patch of greenish tissue found in the center of newly developing lesions, quickly turns dark brown (photo 12). On older stems, raised fibrous lesions eventually develop into deep cankers, which cause stems to be brittle (photo 13). On highly susceptible varieties sunken lesions develop upward, the growing tips die back, and the leaves become distorted.

Spread: A sap-sucking insect, *Pseudotheraptus devastans* Dist. (photo 14) is believed to be responsible in part for disease spread.

Losses: No attempt has been made to correlate disease incidence and severity with yield loss. However, stems of inferior quality do not establish well and, as a consequence, yields are reduced.


PHOTO 11


PHOTO 12


PHOTO 13


PHOTO 14

DISEASE: Cassava brown leafspot
RANGE: Worldwide.
PATHOGEN: *Cercosporidium henningsii* Allesch.
HOST: *Manihot* spp.

Symptoms: Restricted to older leaves, lesions do not appear until plants are 5 to 6 months. Susceptibility/resistance differs among cultivars. Both the upper and lower leaf surfaces are affected. Brownish lesions on the upper leaf surface tend to be round with definite borders (photo 15). On the lower leaf surface, the lesions take on a brownish-gray color. As the lesions expand and coalesce they become more angular as a result of being delimited by small leaf veins (photo 16). Infected leaves in time become yellow, dry and drop (photo 17). High temperature and humidity favor disease development.

Spread: Conidia are borne on conidiophores, which are formed in clusters through stomata. The spores are easily dislodged by wind and may be carried long distances. Although the spores usually need free water for germination/penetration, periods of heavy dew appear to be sufficient for disease establishment.

Losses: In areas having greater than 120 mm of rain, cassava brown leafspot may cause a reduction in yield up to 20%.

PHOTO 15

PHOTO 16

PHOTO 17

DISEASE: **Cassava white leafspot**
RANGE: Cassava-growing areas worldwide
PATHOGEN: *Cercospora caribaea* Cif.
HOST: *Manihot* spp.

Symptoms: Cassava whitespot disease is less common than cassava leaf blight. The lesions are smaller, circular and sunken on both leaf surfaces. The first symptoms of the disease are circular chlorotic areas on the leaf (photo 18). In time, small (1.7 mm) white to brownish-yellow lesions can be readily observed on the upper leaf surface. Lesions on the lower leaf surface are more irregular in appearance. White leaf spots, depending upon varietal interaction, may have purplish borders surrounded by a yellowish halo (photo 19).

Spread: Spores are readily and easily spread by wind. Sporulation is abundant during periods of high temperature and high relative humidity.

Losses: Losses due to cassava white leafspot appear to be minimal, but this remains to be quantified.

PHOTO 18

PHOTO 19

DISEASE: Cassava leaf blight
RANGE: Worldwide
PATHOGEN: *Cercospora vicosae* Muler and Chupp.
HOST: *Manihot* spp.

Symptoms: Usually appear on older leaves of maturing plants, about 9 months. The lesions are large and can cover up to 50% of the leaflet (photo 20). No distinct borders are associated with these lesions. The large leaf spots are diffuse, light brown to tan and cause crinkling and/or leaf distortion where they occur. Under warm and humid conditions favoring disease development, severe defoliation may result. As the disease progresses the leaves become chlorotic and fall (plate 21). Cassava leaf blight occurs at the same time as cassava brown leafspot and cassava white leafspot.

Spread: Primarily by wind dispersal. The conidia are easily detached and can be dispersed far distances. Free water is needed for germination and penetration. Warm periods and sufficient dew conditions favor disease development.

Losses: Although severe defoliation can occur in susceptible varieties, yield reductions are believed to be minor.

PHOTO 20

PHOTO 21

DISEASE: Cassava tuber rot
RANGE: Cassava growing areas worldwide.
PATHOGEN: *Sclerotium rolfsii* Sacc.
HOST: *Manihot* spp. and numerous other genera.

Symptoms: The most common disease associated with cassava tuber roots is due to *Sclerotium rolfsii* Sacc. The fungus can attack roots and tubers at all stages of development and is readily recognized by the appearance of a white mycelial growth on infected tubers and roots (photo 22). Small sclerotia, which are compact masses of hyphae measuring roughly 1.0 mm in diameter, are often associated with this disease (photo 23). The fungus is ubiquitous and survives well in the soil as a saprophyte on various plant debris. Sclerotia are able to survive long periods of unfavorable environmental conditions. During the early stages of disease development the symptoms are easily overlooked. As the fungus develops and penetrates the tubers, the plants begin to show mild wilting symptoms.

Spread: The resting bodies, or sclerotia, are easily carried by run-off water. Because the fungus is ubiquitous in soils and survives well on a wide range of plant debris, it is not easily eradicated.

Losses: Have never been assessed. The fungus appears infrequently and for the most part on older plants. Its impact is not economically important.

PHOTO 22

PHOTO 23

DISEASE: Cassava soft root rot
RANGE: Worldwide
PATHOGEN: *Phytophthora* spp., *Pythium* spp. and *Fusarium* spp.
HOST: *Manihot* spp. and numerous other genera.

Symptoms: Usually expressed under wet soil conditions and cooler temperatures. Depending on the amount of soil inoculum, the rotting can take from several days to weeks. Typically many of the smaller feeder roots are dead and necrotic brown lesions are present on older roots. As the roots begin to decay, they, in turn, infect the tubers (photo 24). In time the entire plant becomes wilted, defoliates and dies. Infected roots and tubers emit pungent foul odors. Overly matured cassava varieties are more susceptible to this type of rot.

Spread: Usually as zoospores, which swim well in soil water and are attracted to the roots of susceptible plants. More mycelia and zoospores are produced during wet periods and, as a consequence, spread to other plants.

Losses: Up to 80% is possible under wet and cool conditions favoring disease development.

PHOTO 24

DISEASE: Cassava dry root rot
RANGE: Worldwide
PATHOGEN: *Armillariella mellea* (Vahl.) Pat., *Rosellinia necatrix* Prill. and other genera.
HOST: *Manihot* spp. and numerous other genera.

Symptoms: The disease usually occurs on land which has recently been cleared of trees and shrubs. Infected tubers are typically covered with thick strands of hyphae (photo 25). Infected plants wilt but do not shed their leaves. In time the drooping leaves and the entire plant dehydrate, turn brown, and take on a scorched appearance (photo 26).

Spread: *Armillariella* is worldwide in its distribution and is one of the most common fungi occurring in forest soils. The major means of spread is through rhizomorphs or direct root contact. Rhizomorphs are easily carried and spread by farm equipment.

Losses: Not economically important. Disease incidence is very low and occurs only in newly developed deforested land.

PHOTO 25

PHOTO 26

DISEASE: Root-knot nematodes
RANGE: Tropical and subtropical climates.
PATHOGEN: *Meloidogyne incognita, M. javanica, M. arenaria, M. hapla.*
HOST: Cassava, *Manihot esculenta.*

Symptoms: Galls or knots on the roots, occurring singly, but often coalescing into a string of knots. Sometimes root tips are devitalized and their growth stopped. On more susceptible cultivars, galls of one cm or larger can occur. In severe attacks, the feeder root system is greatly reduced, resulting in stunting and reductions in stem diameter (photo 27), but storage root yield reductions of 17% to 50% can occur without a noticeable decline in plant height. Multiple and repeated infection is common. Root galling normally occurs on the small feeder roots and larger roots (photo 28), but in the more susceptible cultivars storage roots can also be galled and distorted.

Spread: Carried on crop transplants, on muddy shoes and tools, and by rainwater runoff.

Losses: Cassava farms in the Ibadan, Nigeria, area showed a yield reduction of 8.5%. In an experimental plot, storage root reductions of 15% to 40% were indicated, with extreme loss of 98% under heavy infection. The slight reduction in height coupled with the severe reduction in stalk weight provides an inferior planting stake for the following season. Nematode-infected roots are more susceptible to rot organisms.

PHOTO 27

Control: Crop rotations including nematode-resistant crops, where available, are effective. At present, there are no known root-knot nematode-resistant cassava cultivars. Good weed control increases the efficiency of cultural control methods. Root-knot nematodes are effectively killed by nematicides, but the economics of their use needs to be carefully considered.

Other nematodes: Reports in the literature list 45 genera and species of plant-parasitic nematodes as associated with cassava production. Some species such as the root-lesion and spiral nematodes are of importance on some farms, but little is known of most other species.

PHOTO 28

NAME: **Cassava green mites**, two species in Africa – *Mononychellus progresivus, M. tanajoa*
DISTRIBUTION: Cassava belt in Africa and neotropics.
HOST: Cassava and other *Manihot* spp.

Description: Smaller than many spider mites, green in color at a young age turning yellowish as adults (photo 29).

Damage: Proportional to abundance and duration of attack. Damage initially appears as yellowish (chlorotic) 'pinpricks' on the surface of developing and newly formed leaves (photo 30). Symptoms then vary from a few chlorotic spots to complete chlorosis. Heavily attacked leaves are stunted and become deformed (photo 31), severe attacks cause the terminal leaves to die and drop, producing a 'candlestick' (photo 32). Symptoms are very similar to cassava mosaic disease.

Pest status: Severe mite attacks during the dry season result in 20–80% loss in tuber yield.

Biology: Life cycle similar to other spider mites; found on the ventral surface of young leaves throughout the year. Development time from egg to adult is about 14 days. Adult females produce between 20–90 eggs during a lifetime of 3–4 weeks, depending on the quality of the available foliage. Females disperse when subjected to unfavorable conditions by ballooning passively on a silken thread.

Control: Both biological control and host plant resistance are being investigated.

PHOTO 29

PHOTO 30

PHOTO 31

PHOTO 32

NAME: **Cassava red mites,** four species in Africa – *Oligonychus gossypii, Tetranychus telarius, T. neocaledonicus* and *T. cinnabarinus*

DISTRIBUTION: *O. gossypii*: West Africa, Colombia, Venezuela, Costa Rica; *T. telarius*: worldwide in the tropics; *T. neocaledonicus*: Madagascar, Mozambique, Nigeria, India, Brazil and Pacific Islands; *T. cinnabarinus*: southern Africa, neotropics, Asia.

HOST: Cassava and many other cultivated plants.

Description: Visible to the naked eye as red specks. Under magnification, juveniles and adults appear as ovoid bodies with 4 pairs of appendages bristling with hairs (photo 33).

Damage: Symptoms initially appear on the upper surface of fully mature leaves as yellowish (choloritic) 'pinpricks' along the main vein, which may increase to cover the entire leaf, turning the surface reddish, brown or rusty in color. A protective webbing can often be seen. Under severe mite attack, leaves die and drop, beginning with older foliage.

Pest status: Most damage occurs at the beginning of the dry season but is apparently controlled by local natural enemies.

Biology: Typical spider mite life cycle – eggs, larva, protonymph, deatonymph and adult stages. Eggs and active stages can be found on both surfaces of the leaf, where they feed by piercing plant cells with their stylets. Average time from egg to adult is 10 days. Adult females survive for 1–2 weeks and lay from 20–115 eggs.

Control: None recommended.

PHOTO 33

NAME: **Cassava mealybug,** *Phenacoccus manihoti* Matile-Ferrero (Homoptera: Pseudococcidae)
DISTRIBUTION: Originally from South America, where it occurs in Brazil, Paraguay, Bolivia and Argentina. Now found in all cassava-growing areas of Africa except Kenya, the Seychelles, Madagascar, Tanzania, Malawi and Mozambique.
HOST: *Manihot* spp., sweet potato, eggplant, tomato and water leaf, among others.

Description: Live females pinkish in color (photo 34) covered with a fine coating of mealy wax, lateral and caudal filaments very short. Found on stems, leaves and apices. Adult female, 1 to 3 mm in length, 0.7 to 1.5 mm in width when mounted.

Damage: Strong growth disturbances of the terminal shoot, which becomes stunted and deformed (photo 35). Internode length is reduced, causing twisted stems. When attack is very severe, plants die, starting at the plant tips, where the highest *P. manihoti* population is found (photo 36). Tuber losses have been estimated up to 75%. Leaf loss and weakened planting material (stem cuttings) also result. In general, yield losses depend upon age of plant when attacked, length of dry season, severity of attack and general sanitary conditions of the plant (virus, bacterial blight incidence).

Pest status: Found as a severe pest only on cassava in Africa. The species occurs at below injury levels in South America.

PHOTO 34

PHOTO 35

PHOTO 36

Biology: *P. manihoti* is a parthenogenetic species with a life cycle from egg to adult of 33 days at 27°C. The mean adult longevity is 20 days and the average fecundity 440 eggs. It reproduces throughout the year (9 to 11 generations) and its population reaches peak densities during the dry season. During feeding, *P. manihoti* injects a toxin into the cassava plant which produces strong growth disturbances. The species is dispersed passively by wind and through planting material.

Control: *P. manihoti* is not a pest in its area of origin in the neotropics where it is under natural control by parasitoids and predators. *Biological control* – the introduction, multiplication and release of exotic natural enemies – has therefore been the primary approach to solve the problem in Africa. Host plant resistance and cultural practices are also being investigated and sources of resistance have been identified. *Epidinocarsis lopezi*, a parasitic wasp (photo 37) and other species are available from IITA's Africa-wide Biological Control Programme upon request. Indigenous natural enemies, i.e. *Hyperaspis pumila* (photo 38) play a secondary role in biological control.

Early rainy season planting is recommended to allow the cassava plant a good growth before the dry season; a strong plant being more likely to withstand a severe infestation.

Before planting cuttings can either be treated with hot water (52°C for 10 minutes) or dipped into a 0.1% dimethoate solution to kill all insects/mites, and to avoid their transfer into the newly planted field.

PHOTO 37

PHOTO 38

NAME: **Striped mealybug,** *Ferrisia virgata* (Cockerell), **Green mealybug,** *Phenacoccus madeirensis* Pseudococcidae

DISTRIBUTION: Both species have a wide distribution in the tropics. In the case of *P. madeirensis* the systematic position and delimitation to other species is not yet clear, and the distribution therefore not certain.

HOST: Both extremely polyphagous, attacking cassava only occasionally.

Description: Typical whitish mealybugs of a few mm length. *F. virgata* is characterized by a pair of longitudinal dark stripes, long glassy wax threads, and two long tail filaments (photo 39). *P. madeirensis* is very similar to *P. manihoti*, but its body color is greenish white and its egg sacks are much denser than those of the common cassava pest species. In contrast to *P. manihoti*, *P. madeirensis* produces short-lived fragile males with long tail filaments and a pair of milky wings (photo 40).

Damage: Both species suck sap from their host plant, but do not inject any toxin. The attacked plants therefore suffer general symptoms of weakening (photo 41), but do not exhibit distorted growth.

Pest status: On cassava neither mealybug is a serious pest; on cocoa, *F. virgata* can transmit swollen shoot disease.

Biology: *F. virgata* is a parthenogenetic species (i.e. females only), *P. madeirensis* is bisexual. As in all mealybugs, dispersal is accomplished by the crawlers.

Control: On cassava no control is usually required.

PHOTO 39

PHOTO 40

PHOTO 41

NAME: **Cassava scale**, *Aonidomytilus albus*, Diaspididae

DISTRIBUTION: West Africa, East Africa, southern India, Florida and Caribbean, eastern and southern Brazil, central Argentina.

HOST: Mainly cassava, occasionally on *Solanum* and other plants.

Description: A typical diaspine scale with elongate silvery-white cover, 2–2.5 mm long. The brown oval exuvium is at the anterior end of the scale. The insect under the cover is reddish. Male scales are much smaller.

Damage: Covers the lower stem (photo 42) and eventually the leaves, occasionally kills its host.

Pest status: Not a serious pest, but locally abundant on the stem of plants weakened by previous insect attack and drought.

Biology: Females lay their eggs underneath the covering shell. The emerging crawlers are the only mobile stage. They settle permanently, sucking sap through a long stylet. As they molt, the cover increases in asymmetrical rings. Male immatures are similar, but the short-lived adults are fragile winged insects which do not feed.

Control: Control measures are not usually required, since this is typically a secondary pest attacking weak plants.

PHOTO 42

NAME: **Elegant grasshoppers,** *Zonocerus variegatus* L. and *Z. elegans* (Thunb.), Acrididae

DISTRIBUTION: *Z. variegatus*: West to East Africa south of the Sahara; *Z. elegans*: Southern Africa up to Angola and Mozambique.

HOST: A wide range of crop plants mainly in the seedling stage – cocoa, castor, coffee, cotton, sweet potato, but especially cassava and millet.

Description: The nymphs are black with yellow ringed legs and antennae. The adults (3.5 cm long) are dark green, boldly patterned with yellow, black and orange (photo 43).

Damage: Leaves are eaten by nymphs and adults. After the leaves are gone, green stems are consumed, leaving only the white wood (photo 44).

Pest status: When the dry season is prolonged, defoliation in fields next to bush is severe (photo 45).

Biology: Eggs are laid in the soil in the shade under evergreen plants, usually outside cassava fields in masses of froth which harden to form sponge-like packets. Young nymphs emerge at the beginning of the dry season and feed on weeds and shrubs. Usually only fourth instars and adults disperse into cassava fields.

Control: Control of freshly hatched nymphs is the easiest and most economical way, but requires a community effort. The bands of freshly hatched nymphs can easily be detected and treated with insecticide or poisonous bait.

PHOTO 43

PHOTO 44

PHOTO 45

YAM (*Dioscorea* spp.)

THERE are between 300 and 600 species of *Dioscorea*, of which only a few are edible. The four most commonly cultivated are the water yam (*Dioscorea alata* L.), yellow yam (*D. cayenensis* Lam.), common or Chinese yam (*D. esculenta* [Lour.] Burk.) and white yam (*D. rotundata* Poir). *D. cayenensis* and *D. rotundata* are indigenous to West Africa; *D. alata* and *D. esculenta* are native to Asia. *D. rotundata* is the most important species of yam in Africa, followed by *D. cayenesis*.

Although considered a perennial species, yams are grown as an annual crop. The underground stem tuber is the economically important part of the plant and also the planting material. Yam is adapted to fairly high rainfall areas with distinct dry seasons of not more than 5 months.

In some parts of Africa, because of the plant's economic importance and relative drought tolerance, yams are replacing non-traditional crops such as maize, soybean and millet. In other areas, where labor is a limiting factor, yam is being replaced by other root crops such as cassava and sweet potato. Over two-thirds of the world's yam production comes from Africa – an estimated 22 million metric tons on 2.3 million hectares.

DISEASE: Yam mosaic disease, yam mosaic virus

RANGE: Major yam-growing areas of West and Central Africa.

PATHOGEN: Potyvirus (Flexuous filamentous particles measuring approximately 785 nm).

VECTOR: Aphids (*Aphis gossypii* Glover, *A. craccivora* Koch., *Rhopalosiphum maidis* Fitch and *Toxoptera citricidus* Kirk.) = *A. citricola*.

HOST: *Dioscorea cayenensis* Lam., *D. esculenta* (Lour.) Burk., *D. Rotundata* Poir. and other related species.

Symptoms: Disease symptoms vary due to host/pathogen interaction – a fact which confuses disease identification. Typically, mosaic patterns and chlorosis occur. Under severe attacks the plants appear stunted. Symptoms of the white (*D. rotundata*) and yellow (*D. cayenensis*) yams may also show leaf distortion, shoestring vein clearing (photo 46), green vein banding (photo 47), mottling and stunting.

Spread: Principally by means of infected planting materials. Environmental conditions favoring the development and fecundity of the aphid vectors are also believed to favor disease incidence/severity.

Losses: Yield reductions due to yam mosaic virus remain to be quantified. Although the disease is widespread, the virus does not appear to cause significant constraints to yam production.

PHOTO 46

DISEASE: Water yam chlorosis, *Dioscorea alata* **chlorosis virus**

RANGE: Western and Central Africa.

PATHOGEN: Suspected potyvirus (Flexuous filamentous particle averaging 750 nm).

VECTOR: Unknown, probably aphid(s).

HOST: *Dioscorea alata* L.

Symptoms: A wide range of symptoms can be observed during all stages of plant development. Typical symptoms include chlorosis, flecking, vein-clearing, puckering (photo 48), necrosis (photo 49), and scorching (photo 50). It has not been unequivocally proven that the '*Dioscorea alata* chlorosis virus' is the causal agent of water yam scorch. However, a strong correlation exists between scorching and infection by the virus. Under severe infections, overall scorching results in the death of the entire plant (photo 51). Although young water yam plants can be easily infected by sap inoculation with 'yam mosaic virus' as described for *D. rotundata* and the virus particles readily recovered, under natural field conditions water yams do not become infected with this particular virus. Another virus is believed to induce disease symptoms in *D. alata*.

Spread: Suspected to be by means of aphid vector(s). This however, remains to be confirmed. Primarily via diseased tubers.

Losses: Total yield reductions of 100% have been observed in water yams believed to be infected by a potyvirus.

PHOTO 48

PHOTO 49

PHOTO 50

PHOTO 51

DISEASE: **Yam bacterial rot**
RANGE: Worldwide.
PATHOGEN: *Erwinia carotovora* (Jones) Holland
HOST: *Dioscorea* spp.

Symptoms: Mainly problematic in storage. The first symptom to appear is the oozing from infected tubers. Bacteria dissolve the cell walls causing a watery soft rot. The liquid rot appears off-white to brown in color and emits a distinctive pungent odor.

Periods of increasing relative humidity and cooler temperatures favor disease development.

Spread: The disease is easily disseminated by splashing rain and the numerous insects that are drawn to the pungent odor. Yams that are not promptly removed from the storage area can serve as an inoculum source for yam tubers stacked beneath (photo 52).

Losses: Losses can be dramatic if proper sanitary and insect control measures are not undertaken.

PHOTO 52

DISEASE: Yam storage rot

RANGE: Worldwide.

PATHOGEN: *Fusarium* spp., *Rhizopus nodosus*, *Rosellinia* spp., *Botryodiplodia theobromae* Pat., *Aspergillus* spp., *Penicillium* spp., and numerous other fungi and bacteria.

VECTOR: Insects and man.

HOST: *Dioscorea* spp. and other genera.

Symptoms: Postharvest diseases result mainly from wounding and bruising during harvesting or transporting of the tubers. Because yam tubers contain a high percentage of water, they are an excellent host for numerous microorganisms. Once they become infected, they are open to attack by other pathogens. Typical symptoms include dry rots (photo 53) and soft rots (photo 54). At times mycelia can easily be seen growing on the surface (photo 55).

Spread: Principally by wind, rain and insects. Periods of high temperature and high humidity are favorable for disease development.

Losses: Vary from season to season but are considerable if the tubers have been wounded and/or bruised.

PHOTO 53

PHOTO 54

PHOTO 55

DISEASE: Yam, lesion and root-knot nematodes
RANGE: West Africa, the Caribbean basin, Brazil, and India.
PATHOGEN: *Scutellonema bradys* (Steiner and Le Hew) Andrassy, *Pratylenchus* spp. Filipjev, *Meloidogyne* spp.
HOST: *Dioscorea rotundata*, *D. cayenensis*, *D. alata*, *D. bulbifera*, *D. dumetorum* and *D. esculenta*.

Symptoms: The yam nematode (photo 56) is found in the roots and tubers and in the soil. Yam nematodes feeding in the tubers causes a breakdown of cell walls producing small brown cavities in the tissue just under the skin (photo 57). Initially small light-yellow lesions develop, these later turn dark brown, and in advanced stages the lesions coalesce to form a continuous layer of dark, dry-rot tissue, which can become extensive (photo 58).

Cracks in the tuber skin vary from slight to deep and numerous. Tuber malformation and the flaking off of epidermal layers occur in severe infestations.

Lesion nematode attack symptoms are similar, showing tissue discoloration, dry rot and deep cracks in the surface tissue.

Root-knot nematode symptoms appear as light to heavy galling of yam roots and knobby or bumpy tuber surfaces (photo 59) which are often covered with excessive rooting.

PHOTO 56

PHOTO 57

Spread: The nematodes are persistent in the soil and may be increased or maintained in numbers by alternate host crops in rotation. New lands become infested by the planting of seed yam infected with nematodes.

Losses: The yam and lesion nematodes cause little if any reduction in plant growth but the edible portion of the yam is reduced. The root-knot nematodes severely stunt yam seedlings and reduce tuber yields. Disfigured tubers suffer a drastic loss in market value, and tuber rot in storage may be 100% for yam and lesion nematodes.

Control: The nematodes can be effectively controlled where precautions are taken to plant nematode-free seed pieces on new land or land where nematodes have been controlled through crop rotation.

PHOTO 58

PHOTO 59

NAME: **Yam tuber beetles,** *Heteroligus* spp.
DISTRIBUTION: Tropical Africa.
HOST: *Dioscorea* spp. and roots of some cereal crops.

Description: Adults are brown or black with 2 dorsal outgrowths (photo 60). *H. meles* measures 23–33 mm long; *H. appius* is smaller, 21–23 mm. The larva is creamy-white to greyish and curved, 15–45 mm long.

Damage: Yam tuber beetles make feeding holes of varying shapes on the yam tuber, often shortly before harvest, resulting in low tuber marketability. Yam setts are also attacked after planting and the vegetative development of the plants can be limited.

Pest status: Severe damage to yam tubers. Economic yield losses occur only in West Africa where yams are grown on a large scale.

Biology: Females, *H. meles*, lay eggs in moist soil in swampy breeding sites. The larvae feed on decaying organic matter and grass roots. Development is completed in 4–5 months. The adults them embark on a 'feeding migration' to the yam-growing area. For *H. appius*, feeding and breeding take place in yam heaps. The beetles fly to damp areas only to enter into a state of quiescence or reduced activity. Both adults and larvae feed on yam setts.

Control: Beetle damage can be reduced by applying, at planting time, such insecticides as Thiodan, BHC, Actellic (Pirimiphos-methyl) and carbofuran.

PHOTO 60

NAME: **Stored yam beetles**, *Araecerus fasciculatus* (De Geer), *Carpophilus dimidiatus* (Fabricius) *C. freemani* and *Palorus subdepressus*

DISTRIBUTION: Widely distributed throughout the world especially in tropical and subtropical regions.

HOST: Yam and several other stored plant products (cassava, maize, coffee, etc.).

Description: *A. fasciculatus* is a small dark brown beetle (photo 61) covered with a mottled, light and dark-brown pubescence. The three last segments of the antennae are enlarged. *Carpophilus* spp. are flat, oval and pale to dark-brown. *P. subdepressus* is reddish-brown. The sides of the front of the head extend backward to conceal the front portion of the eyes.

Damage: These beetles infest yam in storage. They make small feeding holes and the adults as well as the larvae tunnel through the tubers. The tissue of infested tubers become dark brown, and the product thus damaged is commercially unattractive. Yam tubers damaged during harvest are more easily attacked.

Pest status: Severe beetle infestations may result in a loss of yam tubers, which may be completely reduced to a black powder, especially when stored for long time.

Biology: Limited information is available.

Control: Tubers should not, as much as possible, be damaged during harvest or transportation to the yam barn. The barn or storage room should be regularly treated with an insecticide such as malathion or Gammalin 20.

PHOTO 61

NAME: **Yam leaf beetles,** *Crioceris livida* and *Lema armata*
DISTRIBUTION: Africa, especially West Africa.
HOST: *Dioscorea* spp.

Description: The adult *C. livida* is red-brownish to black; the hard wings or elytras are yellow to brown with black spots. The larvae of both species are shiny and thick and resemble small slugs. They are protected by a black shiny secretion.

Damage: Young larvae cluster on vine tips. Both larvae and adults feed on yam leaves and tender growing points (photo 62), causing vine dieback and defoliation. The damage is most noticeable after the onset of the rains.

Pest status: Yam leaf beetles are minor pests of yams. The damage is generally localized.

Biology: Female beetles lay the eggs in clusters on the underside of the leaves. The larvae are soft-bodied and protected by the slimy secretion. They are destroyed by heavy rains. Pupation takes place in the soil and the total development requires 3–4 weeks.

Control: Usually not required. If necessary, yam plants can be sprayed with BHC at the recommended dose.

PHOTO 62

SWEET POTATO (*Ipomoea batatas*)

THE sweet potato (*Ipomoea batatas* [L.] Lam.), a member of the Convolvulaceae family, originated in Central America and is now a widely grown and important staple food in many parts of the tropics and sub-tropics worldwide. Owing to the greater distribution and importance given to this crop, a larger number of sweet potato varieties exist than for cassava, yam or cocoyam. Varieties differ widely in tuber flesh color, tuber skin color and texture, tuber shape and foliar morphology as well as other agronomic characteristics.

Although the crop is grown primarily in relatively high rainfall areas, some varieties are known to be drought tolerant. Vine cuttings are used as planting material. In certain parts of Asia and Africa, sweet potatoes are replacing yams due to quicker returns with less effort.

The Food and Agriculture Organization's 1983 *Production Yearbook* estimates about 5 million tons of sweet potatoes were grown in Africa on 812,000 hectares – 2 per cent of the world's production on 10 per cent of the area.

DISEASE: **Sweet potato virus disease**

RANGE: Nigeria. A similar disease has been observed in Ghana, Togo, Benin, Gabon, Sao Tome, Rwanda and Costa Rica.

PATHOGEN: Two-component virus complex (Flexuous filamentous rods).

HOST: *Ipomoea batatas* (L.) Lam and other members of the Convolvulaceae.

VECTOR: Whitefly (*Bemisia tabaci* Genn.) and aphids (*Myzus persicae* Sulz., *Aphis gossypii* Glover and, *A. citricola* V.d.G. = *Toxoptera citricidus* Kirk.).

Symptoms: Both viral components are necessary for symptom expression. The aphid-transmitted component is a potyvirus. The whitefly-transmitted component also appears to be a potyvirus, but this remains to be confirmed. Typical symptoms include vein clearing, chlorosis, puckering (photo 63), leaf strapping, leaf curling (photo 64), and/or stunting (photo 65). Plants infected with the aphid-borne component alone are symptomless. The virus is aphid-transmitted in a nonpersistent manner. Unlike the aphid-transmitted component, the whitefly-vectored component can produce mild ringspots in older leaves.

Spread: Unless both vectors are present either together or separately during the growing season, as well as factors favoring their development and fecundity, spread is minimal. The principal means of spread is through the use of diseased planting materials (tubers or vine slips).

Losses: Reports vary and depend upon cultivar and environmental factors.

PHOTO 63

PHOTO 64

PHOTO 65

DISEASE: Sweet potato scab

RANGE: Far East, Pacific Islands, Brazil, Sierra Leone and Nigeria.

PATHOGEN: *Elsinoe batatas* (Saw.) Viegos and Jenkins.

HOST: *Ipomoea* spp.

Symptoms: Small circular, light to dark brown lesions appear principally on the lower leaf surface. The foliage becomes much reduced and distorted. Under severe conditions both leaf petioles and the stems (vines) also are infected and become misshaped and twisted (photo 66). Lesions on the petioles and vines are elongated. The terminal growing points on individual vines become necrotic and fail to develop. Infected plants grow upright instead of creeping.

Spread: Usually by wind and rain splashing. Cooler temperature and high humidity favor disease development and sporulation.

Losses: Have not been quantified but are believed to be substantial.

PHOTO 66

DISEASE: Concentric ring spot
RANGE: Sweet potato-growing areas worldwide.
PATHOGEN: *Septoria bataticola* Taub.
HOST: *Ipomoea* spp.

Symptoms: The first symptoms appear as small brown flecks on the foliage, which quickly develop into distinct light tan to beige lesions. As the lesions enlarge, well marked concentric rings (photo 67) are formed as a result of fluctuations between night and day temperatures and relative humidities. Under favorable conditions for growth and development of the fungus, lesions coalesce causing defoliation. Severe infestations result in the total collapse of the vines (photo 68).

Spread: Both wind and rain help in spore dispersal. Sporulation, which occurs on the lower leaf surface (photo 69), is abundant under favorable conditions.

Losses: Because the disease occurs late in the growing season, losses are reported to be negligible.

PHOTO 67

PHOTO 68

PHOTO 69

DISEASE: Root-knot nematodes
RANGE: Tropical and subtropical climates.
PATHOGEN: *Meloidogyne incognita, M. javanica, M. arenaria, M. hapla.*
HOST: Sweet potato, *Ipomoea batatas.*

Symptoms: Knots or galls. Secondary invaders often cause rotting on the fine feeder roots. Storage roots are deformed, scarred and cracked, with the flesh just under the skin discolored in spots by adult females, eggs and affected cells. Usually the nematodes penetrate no more than 4 to 6 mm.

Spread: Carried to new locations on roots used for transplants and by the movement of infested soil, tools and machinery.

Losses: Reductions of 20% to 30% and greater may occur, depending on cultivar grown, soil and environment.

Control: Care can be taken in the
(1) provision of nematode-free seedstock roots or the use of vine cuttings taken above the soil line,
(2) selection of fields free of the nematodes, and
(3) the use of resistant varieties of sweet potato, as well as other resistant rotation crops, to minimize nematode population buildup.

Over 50 nematode-resistant sweet potato varieties have been identified through screening germplasm (photo 70).

PHOTO 70

NAME: **Sweet potato butterfly,** *Acraea acerata*
DISTRIBUTION: East, West and parts of Central Africa.
HOST: *Ipomoea* spp.

Description: The butterfly has orange wings with brown margins. The caterpillars are 25 mm long, greenish-black and covered with branching spines.

Damage: The caterpillars feed on the leaves (photo 71). Young caterpillars feed on the upper leaf surface, while older larvae eat the whole leaf lamina except the primary midribs. Complete defolation may result from heavy attacks. The damage occurs in the dry season.

Pest status: Serious pest of sweet potato in East Africa and the eastern part of Zaire (Kivu state).

Biology: Eggs are laid in batches of 100–150 on both surfaces of the leaves. The larvae are gregarious in a protective webbing during the first 2 weeks. Then they become solitary and hide from the sunlight on the ground during the day. The larvae stage lasts 21–25 days and the total development requires 35–43 days.

Control: Sweet potato fields should be observed for *A. acerata* damage early in the dry season. The caterpillars can be destroyed when they are still in their webbing. Early planting and harvesting enable the crop to escape heavy attacks. If necessary sweet potato can be treated with fenitrothion or fenthion.

PHOTO 71

NAME: **Sweet potato weevils**, *Cylas* spp.

DISTRIBUTION: *C. formicarius formicarius* is found in eastern Africa, Asia and Australia, and *C. formicarius elegantulus* in the Americas. *C. puncticollis* occurs only in West and Central Africa.

HOST: *Ipomoea* spp.

Description: Adult resembles an ant. *C. puncticollis* (photo 72) is completely blue-black, 7–8 mm long. *C. formicarius* (photo 73), 5–6 mm long, is black with brown thorax, legs and antennae.

Damage: Adult weevils attack leaves and vines, but the most serious damage is caused when adults and larvae tunnel through the tubers, resulting in subsequent rot due to bacteria and fungi. Damage continues in storage.

Pest status: *Cylas* spp. are the most damaging insect pests of sweet potato, causing crop losses of 12–90%.

Biology: The eggs are laid in hollows in the stems or into the tubers. Total development takes 38–43 days, usually inside the tubers.

Control: Early planting and harvesting, use of insect-free planting material and re-ridging, about 30 days after planting, are recommended. Tubers to be stored should not be damaged either by weevils or by harvesting. They should be cured in the open weather for about three days and then stored in underground pits lined with dry mulching material.

PHOTO 72

PHOTO 73

COCOYAM (*Colocasia* spp. and *Xanthosoma* spp.)

THE term cocoyam refers to two members of the Araceae family that are staple foods for many developing countries in Africa, Asia and the Pacific. The two genera of cocoyam are *Colocasia* and *Xanthosoma*, of which the most commonly cultivated species, *C. esculenta* (L.) Schott and *X. sagittifolium* Schott, are grown extensively in the humid tropics. *C. esculenta* is often referred to as taro, dasheen (believed to be a mispronunciation of French 'de Chine' meaning 'from China'), eddoe and old cocoyam. *X. sagittifolium* is referred to commonly as tannia, yautia, ocumo, or new cocoyam. The major distinction between the two genera is based upon leaf morphology – the leaves of *Xanthosoma* spp. are typically hastate while those of *Colocasia* tend to be peltate.

Cocoyam can survive under both water-logged and upland conditions. *Xanthosoma* is resistant to nematode attack. Both the leaves and corms are edible, and in several cultures the plant plays an important role in ceremonial rituals.

The major problem in cocoyam utilization is that the leaves and corms contain oxalic acid in the form of needle-shaped crystals, which produce a bitter taste and throat irritation. Cooking removes the acrid crystals.

PHOTO 74

DISEASE: Bacterial leaf necrosis

RANGE: West Africa, India, Latin America, and Pacific Islands.

PATHOGEN: *Xanthomonas campestris* (Pammel) Dowson.

HOST: *Xanthosoma* spp., *Colocasia* spp., and other genera within the Araceae.

Symptoms: Initial symptoms are marginal necrotic areas separated from apparently normal leaf tissue by a bright yellow chlorotic border (photo 75). The initial point of entry is believed to be via hydathodes where water of guttation accumulates. Torn leaves also provide areas of entry.

The bacteria multiply and enter the plant's vascular system causing vascular necrosis. As the disease progresses, it ramifies the entire leaf, which becomes dry and brittle. A slower, gradual necrosis of the petiole follows.

In taro (*X. sagittifolium*) the bacteria is restricted to the leaf margin (photo 76).

Spread: Is not well understood but is believed to be a result of wind and rain splashing. Insects have also been observed feeding on diseased tissue, which may aid in bacterial dissemination.

Losses: Have been reported to be severe but remain to be quantified.

PHOTO 75

PHOTO 76

DISEASE: ***Sclerotium* or southern blight**
RANGE: Worldwide.
PATHOGEN: *Corticum rolfsii* (Sacc.) Curzi = (*Sclerotium rolfsii*) Sacc.
HOST: *Colocasia* spp., *Xanthosoma* spp. and numerous genera of various families.

Symptoms: The disease initially develops on older petioles at the soil surface. A white mycelial growth can be readily observed on infected petioles and corms. Eventually small circular compact masses of hyphae (sclerotia averaging one mm in diameter) develop (photo 77). The fungus is ubiquitous in soil and survives well as a saprophyte on various plant debris. Under favorable periods of moist warm soil conditions the fungus attacks the corms. Corm rot is usually shallow, mainly occurring just beneath the hyphal matt. When the corm becomes infected, the entire plant wilts and eventually dies (photo 78).

Spread: Sclerotia as resting bodies survive well in the soil. Because they are light, they can easily float and be carried away by rain water. The fungus also survives well on plant debris.

Losses: Total yield reductions (100%) in some areas have been attributed to this disease.

PHOTO 77

PHOTO 78

DISEASE: ***Phytophthora* leaf blight**
RANGE: Worldwide.
PATHOGEN: *Phytophthora colocasiae* Rac.
HOST: *Colocasia* spp. and *Xanthosoma* spp.

Symptoms: Not expressed until overcast rainy periods when day and night temperatures average 27°C and 22°C respectively. Under favorable conditions entire stands can be blighted within 7 to 10 days. Characteristic small lesions averaging 1.5 mm in diameter are the first symptom of the disease. The lesions quickly enlarge and coalesce. Growth rings are formed (photo 79) due to temperature and relative humidity fluctuations between night and day. Exudations or secretions appear on the lower leaf lesions. Initially the secretions are off-white in color but quickly turn tan to dark brown as they dry (photo 80).

The entire above ground plant can succumb to the disease and corms in turn may be infected. The rotting corm is pinkish to light brown in color (plate 81).

Spread: Spore dissemination is mainly due to wind.

Losses: Vary from 20% to 100% depending on cultivar and environmental factors.

PHOTO 79

PHOTO 80

PHOTO 81

DISEASE: *Cladosporium* leaf spot

RANGE: Major cocoyam growing areas worldwide.

PATHOGEN: *Cladosporium colocasiae* Sawada.

HOST: *Xanthosoma* spp. and *Colocasia* spp.

Symptoms: Characteristic superficial circular brownish lesions averaging 2.0 cm in diameter on newly developing and older leaves (photo 82). On the lower leaf surface the lesions are somewhat larger and diffused. The disease is slow in developing. In time, the entire leaf becomes covered with numerous lesions (photo 83), turns yellow and eventually dies (photo 84). Because of its superficial nature, *Cladosporium* leafspot has also been termed 'false' or 'ghost' spot. Although it is commonly found in most fields, the disease has not been reported in Africa.

Spread: Conditions such as high relative humidity for several days favor sporulation. Spore dissemination is primarily by wind.

Losses: Because of the superficial nature of the disease, no economic losses have been reported.

PHOTO 82

PHOTO 83

PHOTO 84

DISEASE: Cocoyam root rot blight complex (Apollo disease)

RANGE: Worldwide.

PATHOGEN: *Pythium myriotylum* Drechsler, *Pythium* spp., *Fusarium solani* (Mart.) Sacc. and *Rhizoctonia solani* Kühn.

HOST: *Colocasia* spp. and *Xanthosoma* spp.

Symptoms: Apollo disease is extremely destructive to aroids planted in poorly drained soils. Infected plants often wilt under periods of high solar radiation and are slow in developing. Rotted roots are the most characteristic symptom. The entire root system is destroyed except for a few apparently healthy roots nearest the soil surface (photo 85). In time the plant succumbs to the disease (photo 86). The interior of the corm becomes a soft mass of disassociated cells. The corky layer of the corm remains intact until the interior of the corm has completely deteriorated (photo 87). Warm moist soil conditions favor disease development. The roots can easily be infected at any age.

Spread: Principally by zoospores. These biflagellated mobile spores swim freely in soil water and are attracted to susceptible hosts.

Losses: High when the soil is warm and moist for prolonged periods.

PHOTO 85

PHOTO 86

PHOTO 87

DISEASE: ***Leptosphaerulina* leafspot**
RANGE: Worldwide.
PATHOGEN: *Leptosphaerulina trifolii* (Rostrup) Peteak.
HOST: *Colocasia* spp. and *Xanthosoma* spp.

Symptoms: Leafspots appear as irregularly shaped lesions averaging 1.5 cm in diameter. The lesions are characteristically off-white to beige with a purplish margin, which is less pronounced in *Colocasia* spp. (photo 88). A distinct chlorotic yellow halo surrounds the lesion in *Xanthosoma* spp. (photo 89). Numerous spots are present on the leaf, some of which become tattered as the centers of the lesions dry, become brittle and are torn away.

Spread: Mainly by wind, rainwater, and heavy dews.

Losses: Yield reductions due to *Leptosphaerulina* have yet to be quantified.

PHOTO 88

PHOTO 89

DISEASE: Concentric leafspot
RANGE: Worldwide.
PATHOGEN: *Colletorichum gloeosporioides* Penz.
HOST: *Colocasia* spp., *Xanthosoma* spp. and other genera within the Aracea.

Symptoms: Lesions averaging 2.5 mm are present on the leaf as circular spots. The leaf spots are chestnut brown in color and have characteristic concentric growth rings (photo 90). The lesions, which are surrounded by a chlorotic yellow halo, are not numerous but are well scattered. Under favorable temperatures and relative humidity (RH) several fungal fruiting structures (ascervuli) can easily be found within the concentric rings (photo 91).

Spread: Mainly by wind and splashing rain.

Losses: The disease is not considered to be a major production constraint. As a result no yield reductions have been associated with this disease.

PHOTO 90

PHOTO 91

Scientific and Common Names

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continued from inside front cover

Development (World Bank) and the United Nations Development Programme (UNDP). The CGIAR consists of about 50 donor countries, international and regional organizations and private foundations.

IITA receives support through the CGIAR from a number of donors including Australia, Belgium, Canada, Denmark, Ford Foundation, France, Federal Republic of Germany, India, International Bank for Reconstruction and Development, International Fund for Agricultural Development (IFAD), Italy, Japan, The Netherlands, Nigeria, Norway, Rockefeller Foundation, Sweden, United Kingdom and the United States of America. In addition, other donors provide funds to IITA to support specific research and training programs.

Cover Illustrations

front left: cassava mosaic disease
front right: water yam chlorosis
front inset: cassava mealybug
back left: cocoyam bacterial leaf necrosis
back right: sweet potato concentric ring spot
back inset: African sweet potato weevil

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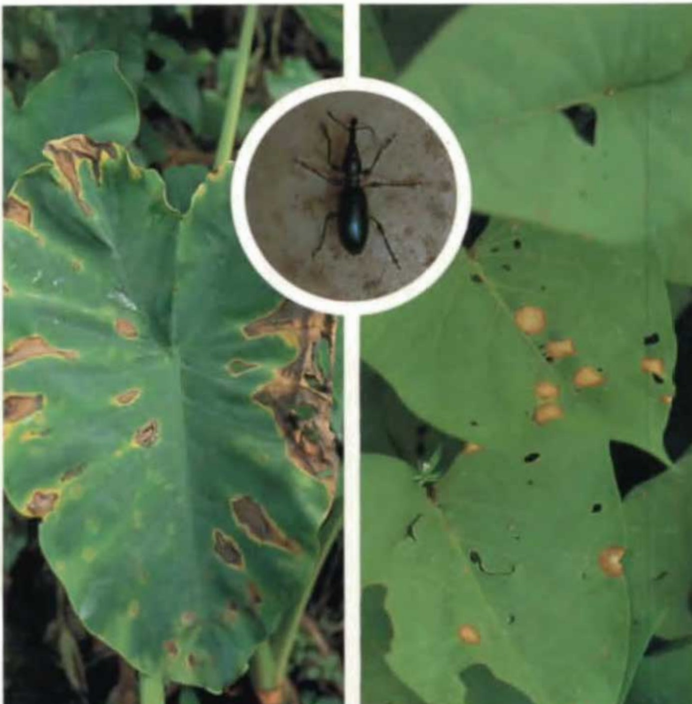

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