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Cassava diseases in Africa reviewed

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Systematic identification of the diseases of cassava, coupled with a breeding programme and rigorous selection of varieties for disease resistance, forms an important part of the work of IITA. At stake is the supply of a major energy food for millions of people who depend on a crop which is frequently decimated by diseases of bacterial, fungal and viral origins.

Left: *Cassava mosaic disease causes leaves to be reduced in size, misshapen, and twisted, with bright yellow areas separated by normally green areas to produce a mosaic pattern.*
Centre: *Tan-coloured circular lesions with a distinct dark border on the upper surface of leaves indicate the presence of brown leaf spot.*
Right: *Symptoms of the white leaf spot disease are characterised by circular and angular snow white or cream lesions.*

Cassava (*Manihot esculenta*, Crantz) is grown throughout the lowland tropics and yields an estimated 100 million tonnes of roots annually, about half of which are produced in Africa. The largest cassava producing countries in Africa are Zaire (10 million t/year) and Nigeria (7·3 million t/year) where approximately 100 million people depend on the crop for a major portion of their calorie intake: some 38 other African countries also have cassava as a staple food. The crop is particularly valued because it is drought tolerant, it is able to grow on unproductive soils, and some varieties have potentially high yields. Unfortunately the crop is susceptible to several diseases; the Root and Tuber Improvement Programme of the International Institute of Tropical Agriculture (IITA), Ibadan, therefore assigned high priority to cassava research. A considerable amount of information on cassava diseases has been generated in the last five years and this article highlights the present state of knowledge of the principal economic diseases in Africa.

The major cassava diseases are caused by viruses, bacteria, fungi and other agents of unknown identity. Although cassava mosaic disease (CMD) is one of the most widespread diseases, cassava bacterial blight (CBB), cassava anthracnose, cercospora leaf spot and cassava root rot diseases are also of considerable importance because of their potential to reduce yields. There are other cassava diseases of relatively minor importance that will not be discussed in this article.

Viral and bacterial diseases

Cassava mosaic disease. Cassava mosaic disease (CMD) is caused by a virus or a virus-like agent and occurs in all parts of east, west and central Africa and the adjacent islands (18,1,9). Accurate assessment of the yield loss it causes is difficult, but estimates range from 20% to 90% (1,9,3); however, recent studies by Edwards and Kang (personal communication) indicate that no apparent relationship exists between tuber yields, leaf dry weight and the apparent severity of the disease in the two Nigerian local varieties studied.

Cassava mosaic is characterised primarily by chlorosis of discrete areas of the leaf lamina which fail to expand fully, resulting in unequal enlargement of adjacent areas and distortion of the leaflets. Leaves are reduced in size and are mis-shapen and twisted, with bright yellow areas separated by normally green areas to produce a nearly uniform mosaic pattern. The causal agent of the disease has not been identified, but it is known to be transmitted to disease-free seedlings by whiteflies (*Bemisia* spp) (18). The disease is spread primarily by planting stem cuttings obtained from diseased plants, while secondary spread to disease-free seedlings in the field is by whitefly transmission, with up to 80% infection of a highly susceptible variety occurring over a six-month period (7).

The most promising method of controlling CMD is to utilise disease-resistant varieties. Screening for resistance is being carried out at IITA and several high-yielding, mosaic-resistant clones have been identified.

Cassava brown streak disease. The incidence of cassava brown streak disease has only been reported along the east coast of Africa and at altitudes below 1200m (16). Because this disease and CMD invariably occur together in the coastal regions, it has not been possible to determine the yield loss caused by cassava brown streak alone; however, it causes extensive root necrosis which renders tubers unfit for human consumption and so its potential to cause loss is considerable (11).

The main leaf symptom of CBS is chlorosis, which is distinguishable from senescence in that diseased leaf segments always show some green areas, whereas with senescence the leaves become uniformly yellow. Stem symptoms consist of brown streaks which elongate and coalesce

with adjacent streaks to produce blotchy patches that may be masked once bark is formed. Necrotic lesions can also be observed in the leaf scars after leaves have been shed. Root infection manifests itself by the formation of necrotic lesions in the tuberous starch tissues (16).

The causal agent of CBS is a rod-shaped virus, about 60 nm long (12), which is transmitted mechanically and by grafting (17,16). Temperature has a marked effect on the severity of the disease (17), with the low temperatures experienced at high altitudes causing the most severe disease reaction: with the onset of warmer weather, infected plants produce new growth and almost completely recover. Effective control of this disease can be achieved by using disease-free planting material. Varietal resistance has been identified and utilised to control the disease (10).

Cassava bacterial blight disease. Cassava bacterial blight disease is considered the most devastating of several bacterial diseases because when conditions are favourable for its development, it often causes severe loss of both yield and planting material (13). Within the last five years, serious outbreaks of CBB have been reported in Zaire (6), Nigeria (21), Cameroon (19), Togo and Ghana (Persley, personal communication).

Yield reduction from this disease ranges from 36·6% on a moderately susceptible variety to 58·2% on a highly susceptible variety (8). The characteristic symptoms include the development of angular, water-soaked leaf spots which are initially small but later enlarge, coalesce and eventually turn brown; varying degrees of leaf wilt; the exudation of a yellow-orange gum on the leaves, petioles and young shoots; severe defoliation; and finally tip dieback resulting from vascular necrosis and death of growing points.

The CBB agent, *Xanthomonas manihotis,* is a gram negative, motile, slender rod bacterium with a single polar flagellum (14) which enters the plant via the stomata or through wounds in epidermal tissues of leaves and young shoots; it invades the vascular tissues and causes extensive breakdown of parenchymatous tissues. The incidence of the disease is highest during the rainy season; at Ibadan, for example, a susceptible variety planted during the dry season remained free of the disease for seven months until the first of the heavy rains in May. At the end of the long rainy season in September every plant was severely affected (8).

Rain splash is the most important means of spread of CBB over short distances while dissemination from one area to another occurs largely through infected planting material (14). It is possible that the practice of removing young cassava leaves by hand for cooking may also play a role in disease spread. Preliminary results on the effects of soil fertility on the severity of the disease indicate a trend towards a higher death rate of susceptible plants in soils of low fertility (8).

CBB can be successfully controlled by utilising disease-resistant varieties. Screening for such varieties at IITA has revealed a large number of clones with resistance, even in high-rainfall areas which favour disease development. Another control measure is by careful selection of disease-free planting material and a method of producing bacteria-free plants in this way has been developed (15). Crop rotation has been suggested as a means of control, but the pathogen has the ability to survive in dry gum-exudate for up to 22 months without losing infectivity (8).

Fungal diseases

Cassava anthracnose. Cassava anthracnose has recently assumed major importance in Nigeria, Zaire, Ivory Coast, Liberia (8) and Ghana. Accurate assessment of yield loss due to this disease has not been made, but in Zaire in 1975 it was estimated that 90% of the local varieties were severely affected (8). Infection of young cassava plants is characterised by a dramatic wilt, accompanied by withering of the young tender shoots, and this may be followed by the death of plants. On older plants, the disease is characterised by the presence of oval, shallow depressions of a light brown colour on green stems. On the woody tissues, raised stringy lesions occur which develop into deep cankers. Leaves and petioles attached to infected stems become blighted and drop. The causal agent has been identified as *Colletotrichum manihotis* which is probably the conidial stage of *Glomerella cingulata* (2): earlier reports of this disease (4) indicated that young plants were the most susceptible at the beginning of the rainy season, and that the disease tended to disappear with the approach of the dry season. In contrast, old plants in a high-density planting have been shown to favour the development of the disease (2), while recent observations in Zaire and Nigeria have indicated that severe defoliation during the dry season may be due to anthracnose.

High humidity favours rapid production of conidia of the anthracnose fungus, while the perfect stage appears to increase during the dry season, thus permitting the survival of the pathogen. At present local Nigerian varieties and IITA hybrids are being screened for host resistance at IITA.

Leaf spot diseases. Several *Cercospora* species induce leaf spot diseases; the three most important are brown leaf spot, white leaf spot and grey leaf blotch. Brown leaf spot is probably the most widespread of the three and occurs in almost all the cassava-growing areas. Recently, severe incidences of this disease were observed in Nigeria, Zaire, Sierra Leone, Liberia, Ivory Coast and Togo (8). Field surveys have shown that the coastal areas of Sierra Leone and Liberia, and the Bas Zaire area of Zaire have high incidences of white leaf spot while severe attacks of grey leaf blotch have been observed in Nigeria and Uganda. Data on the yield loss of cassava due to these diseases are not available at present.

Symptoms of the brown leaf spot disease are characterised by tan-coloured circular lesions with a distinct dark border on the upper surface of leaves, while on the lower surface the lesions have less distinct margins and in the centre they may have a greyish tint. Sometimes a yellowish halo is present round the lesions. As the disease progresses, infected leaves turn yellow, then brown and eventually die.

The white leaf spot disease is characterised by circular and angular white or cream lesions which have an irregular violet brown border surrounded by a yellow or brownish halo. The centres of the lesions have a velvet appearance due to the presence of the fruiting bodies of the fungus. Grey leaf blotch symptoms are that large diffuse lesions without definite borders appear, with the upper surface normally greyish-brown, and the under surface of the lesion assuming a distinctly grey colour. The symptoms of this disease can quickly be distinguished from those of the brown leaf spot in that one diffuse lesion of the former can cover a large part of the leaflet.

The fungi that are the causal agents of these leaf spot diseases belong to the following species: brown leaf spot, *Cercospora henningsii;* white leaf spot, *C. caribaea;* and grey leaf blotch, *C. vicosae.* The most favourable conditions for development of the brown leaf spot and grey leaf blotch occur during warm, humid periods (2). Primary infections are initiated in new plantings when wind or rain carry conidia from lesions on old fallen infected cassava debris to the surfaces of both young and old leaves (13). Secondary disease cycles are reported throughout the rainy season whenever conidia are carried to new infection sites by wind or rain. The pathogens survive the dry season on debris from infected cassava plants.

The successful development of white leaf spot disease depends upon cool, humid conditions; the development of the disease, however, is similar to that of brown leaf spot and grey leaf blotch diseases. Cultural practices that can reduce excess humidity within a cassava stand may reduce infection by these three *Cercospora* spp. (13), but the best control method is to plant resistant varieties. Varietal resistance has been observed among the cassava hybrids produced at IITA.

Root rot diseases. The root rot diseases of cassava appear to be important mainly in areas with badly drained soils and excessive rainfall (13). The two most important are *Phytophthora* root rot, reported in Rwanda and Burundi (20) and in the Congo (5), and white thread disease, reported in Nigeria, Ghana (4) and Central and East Africa (11). Data for the yield losses caused by the two diseases in Africa are not available, but *Phytophthora* root rot has resulted in up to 80% loss of yield in Latin America (13).

Phytophthora root rot is characterised by sudden wilting and a severe soft rot of swollen roots; infected young roots become water-soaked and later turn brown. Infected swollen roots may eventually decompose in the soil, producing a distinctive foul odour. The disease is caused by *Phytophthora erythropeptica* and *P. cryptogea* (5). ▶

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The causal organism of white thread disease is *Fomes lignosus* (20), and the condition is characterised by the presence of a white mycelial mat under the bark of swollen roots, and of a white, thread-like coating on infected roots: infected roots become dry and produce a distinctive odour.

The two most important conditions that favour the incidence of the root rots are waterlogging and excessive rainfall, and control is therefore achieved through cultural practices such as good drainage, planting on light soils, the avoidance of waterlogged areas, sensible crop rotation and early harvest (13).

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One main object of IITA's cassava improvement programme is breeding for host plant resistance. In Nigeria, Shell-BP, collaborating with the Bendel State Ministry of Agriculture and Natural Resources, have screened 3330 IITA CBB-resistant clones in 1974. A total of 284 of the most promising clones were multiplied and distributed to farmers in the state through the National Accelerated Food Production Project. In Zaire, the Programme National Manioc is also screening and multiplying for farmers' use out of IITA's foundation stock, and to date the yields of IITA's improved disease-resistant varieties are from five to 20 times higher than those of local varieties in Nigeria and Zaire.

Recognising that the identification of major economic diseases of cassava and the means of controlling them is of tremendous importance to all cassava-growing countries, IITA held the first All-African Cassava Improvement Workshop in 1975; it was attended by delegates from 15 countries. Three formal training sessions have also been arranged at IITA for young African cassava research and production workers. These activities coupled with research, development and testing work, all contribute to the dissemination of the accumulated knowledge of the identification and control of yield-reducing cassava diseases. It is hoped that the outcome will be improved yields followed by increased availability of cassava at a reduced cost.

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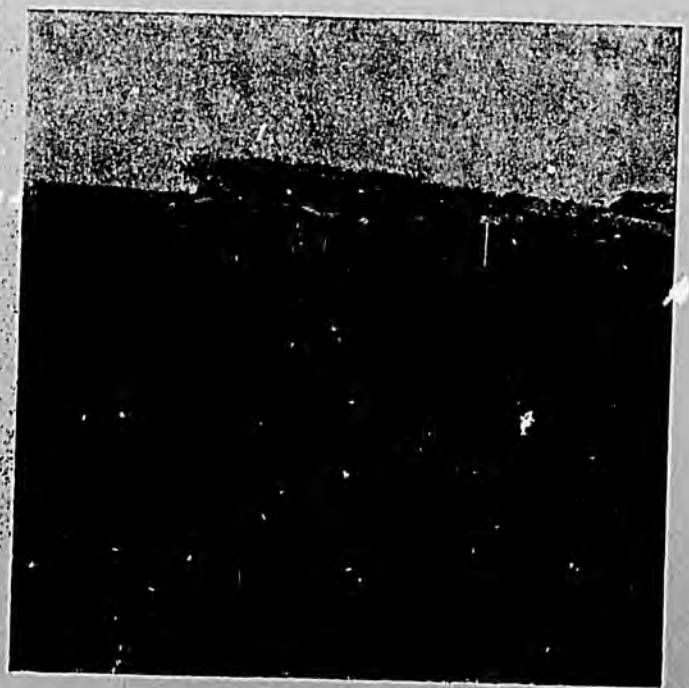
Left: *Cassava mosaic disease causes the leaves to be reduced in size, mis-shapen and twisted, and they assume a yellow-and-green mosaic pattern.*

Right: *Some of the disease-resistant varieties of cassava bred at IITA.*



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