MAJOR ECONOMIC DISEASES OF CASSAVA, PLANTAIN AND COOKING/STARCHY BANANAS IN AFRICA

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ABSTRACT

Cassava, plantain and cooking/starchy bananas are major staple food for more than 300 million people in sub-saharan Africa. Africa produces 44.3 and 68.5 of the world's total output of cassava and plantain/cooking bananas, respectively. Major diseases of cassava are the African cassava mosaic virus, the cassava bacterial blight and the cassava anthracnose disease. Others include the Cercospora leaf spots and root and tuber rots caused by various fungi and bacteria. Research over the years at IITA has focussed on the improvement of cassava through breeding and has produced many varieties that are adaptable to various ecological zones, disease resistant and high-yielding.

The major disease of plantain and cooking/starchy bananas so far reported in Africa is the black Sigatoka which was first reported in Zambia in 1973 and has since spread to nearly all the countries in Africa. Since chemical control of the disease is very expensive, IITA has started to breed for black Sigatoka resistant plantain and cooking/starchy bananas. The breeding program is supported by a worldwide collection of *Musa* germplasm and their screening for black Sigatoka resistance at the IITA's Onne sub-station situated in southeastern Nigeria.

Introduction

1 Cassava

Cassava (*Manihot esculenta* Crantz) originated from South America and was introduced to Africa by Portuguese traders at the end of the 16th century (Jones, 1959). The crop has since become a staple food for the population of the cassava-growing areas because it adapted well to diverse environmental conditions and fitted well to the traditional farming and food systems in Africa (Kahn *et al.*, 1979). It is usually available to farmers throughout the year as a major carbohydrate source and the crop has the potential of famine relief when other crops have failed due to drought and disease and pest attacks. It thus produces more than 50% of the caloric requirement for more than 300 million inhabitants in the cassava-growing areas (Kahn *et al.*, 1979).

Out of a world total production of 137 million MT, Africa produces 60 million tons (44.3%). Zaire is Africa's leading producer (16.0 million tons) followed by Nigeria (14.7 million tons) (FAO, 1986). Cassava output in Africa rose by 5% in 1986. The increase in cassava production in Africa is due to the increase in the land put to cassava cultivation and partly in production by the use of high-yielding, disease resistant improved varieties.

Cassava has for a long time been regarded as a hardy crop, resistant to both diseases and insect pests (Lozano, 1977) and in Africa, the crop had been low-yielding. However, since extensive research began on cassava in the early 1970s, it was found that the crop was susceptible to at least thirty different diseases of fungal, bacterial and viral origin. Amongst the major economic diseases of cassava in Africa are the African cassava mosaic virus (ACMV), the cassava bacterial blight (CBB), the cassava anthracnose disease (CAD), the Cercospora leaf spots (CLS) and the root and tuber rots.

1) The African cassava mosaic virus disease

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The African cassava mosaic virus disease is prevalent in all parts of Africa as well as the adjacent islands and in southern India. The disease was first described in 1894 in East Africa under the name "Krauselkrankheit" by Warbug. The disease is the most serious and widespread in cassava-growing areas of Africa and southern India but has not been reported in Latin American countries where the genus *Manihot* is indigenous.

The African cassava mosaic virus disease is characterized by malformation and irregular distribution of chlorophyll in the leaves which show chlorotic patches interspersed with deep green areas. The affected leaves fail to expand fully resulting in asymmetrical enlargement of adjacent areas and distortion of the leaflets. Leaves may be reduced in size, misshapen and twisted. The internodes may become shortened, resulting in stunting of the whole plant. Symptom expression varies between cultivars and depending on environmental conditions. Virtually all local varieties and genetic sources from other continents are susceptible to the disease.

The causal organism of the disease belongs to the geminivirus group, each paired or bonded particles averaging 20 × 30 nm (Bock and Woods, 1983). The virus is transmitted from plant to plant by the whitefly *Bemisis tabaci* (Genn.) (Aleyrodidae) while the spread and persistence of the disease is through the use of infected cuttings as planting materials.

Yield loss due to this disease depends on the susceptibility of the cultivar but has been variously put between 5 and 69% (Jennings, 1970), however, yield reduction varies from one ecological zone to another.

The East African cassava brown streak virus disease is of no economic importance and is restricted only to that region.

2) Cassava bacterial blight

This disease caused by *Xanthomonas campestris* (Pammel) Dowson pathovar *manihotis* (Arthaud-Berthet) Starr, is widespread over the areas where cassava is grown. It was first reported in Brazil in 1912 by Bondar, but its first report in Africa was made by Bouriquet (1946) in Madagascar. Later, the disease was reported in Mauritius, Zaire, Congo, Nigeria, Cameroon, Tanzania, Uganda, Rwanda, Central African Republic, Togo, Republic of Benin, Ghana and Kenya (Anon., 1978).

The bacterium induces characteristic angular water-soaked leaf spots, leaf blight, gum exudation, die-back, stem and root necrosis. Under severe attack, rapid defoliation occurs, leaving bare stems commonly referred to as "candlesticks". Cassava varieties show varying degrees of susceptibility and resistance to the disease.

Yield loss attributed to this disease has been put at 20 to 100% depending on the variety, the weather conditions and the geographical location.

The cassava bacterial blight disease is different from a less widespread bacterial disease caused by *Xanthomonas campestris* pv. *cassavae* (Wiehe and Dowson) which causes angular leaf spots and which is restricted to Central, East and parts of southern Africa. The disease caused by this organism is less severe and results in less yield loss than the bacterial blight.

3) Other diseases

The cassava anthracnose disease (CAD) caused by *Colletotrichun, gloeosporioides* f. sp. *manihotis* Henn (Penz) Sacc., has been reported in the Republic of Congo, Zaire, Cameroon, Nigeria, Ghana and Cote d'Ivoire (Theberge, 1985). No attempt has yet been made to correlate disease incidence and severity with yield loss since the disease does not occur in isolation in the field. However, stems with cankers used as planting materials do not establish well in the field. A sap-sucking insect, *Pseudotheraptus devastans* is believed to be responsible in part for the spread of cassava anthracnose disease.

Cercospora leaf spots are caused by *Cercosporidium henningsi*, Allesch., (brown leaf spot), *Cercospora vicosae* Muler and Chupp (leaf blight), and *Cercospora caribaae* CIF (white leafspot). These are diseases of mature crops in the field, hence yield reductions are minor (Theberge, 1985).

An improvement of cassava for resistance to these diseases was started in 1971 by the Root and Tuber Improvement program of the International Institute of Tropical Agriculture (IITA). The Program has come up with many varieties of cassava that are highly adaptable to the different agro-ecological zones of Africa, are high-yielding and combine resistance to both African mosaic virus disease and cassava bacterial blight (Kahn *et al.*, 1979; 1980). Improved work is still going on with the anthracnose disease.

Root and tuber rots caused by different fungi and bacteria occur on soils that are not well drained. An improvement of agronomic practices through proper crop and soil management may be able to reduce tuber loss due to rots.

2 Plantain and cooking/starchy bananas

Although plantain and cooking/starchy bananas originated in South India (Simmonds, 1966), they are now a major staple food source in the lowlands of the humid tropics stretching from the Caribbean Islands, Central and South America to the Pacific Islands. South and South-East Asia, India and Africa. The highest variability of plantain and cooking/starchy bananas is encountered in Africa (De Langhe, 1964).

Out of a world's total production of 27.19 million tons, Africa alone produces 18.57 million tons which represents 68.5%. Uganda (8.0 million tons), Rwanda (2.1 million tons), Nigeria (1.7 million tons), Zaire (1.5 million tons) and Cote d'Ivoire (1.4 million tons) are the largest producers of plantains and cooking/starchy bananas. Others are Tanzania (1.1 million tons), Cameroon (0.99 million tons) and Ghana (0.68 million ton) (FAO, 1986).

Plantain and cooking/starchy bananas can be eaten in various forms. The use of plantain and cooking/starchy bananas as food is second only to cassava. When ripe, they can be eaten raw or boiled or fried, roasted or boiled and pounded after cooking. Plantain chips are a delicacy for adults and children. Doctors even prescribe plantain in its unripe form for diabetics as a source of energy (D. Famuyiwa, personal communication). The green fingers are reported to contain 29% starch on a fresh fruit basis (Sanchez *et al.*, 1970) or about 80% starch on a dry weight basis (Marriot *et al.*, 1983).

Yearly per capita consumption in some African countries is presented in Table 1. However, national consumption figures do not always show the importance of the crop to people living in or near the wetter regions. This is because plantain and cooking/starchy bananas are cultivated only in the humid areas and do not transport and store well. As such, regional per capita consumption often exceeds in some cases the national per capita consumption several times.

Most of the plantain and cooking/starchy bananas are grown in the homestead where high yields are obtained due to the rich soil which receives ample supplies of household refuse (Wilson *et al.*, 1987). Plantain and cooking/starchy bananas are also an important component of shifting

Table 1 Estimated yearly per capita consumption of plantain and cooking/starchy bananas in some African countries (kg/capita/yr)

Country	Consumption kg/capita/yr
Uganda	237.2
Rwanda	206.2
Cote d'lvoire	99.5
Ghana	80.7
Cameroon	76.5
Zaire	62.7
Congo	24.6
Nigeria	19.9

Source: FAO Yearbook (1986).

cultivation where they are associated with crops as maize, beans, cocoyam, yam, and vegetables (Okigbo and Greenland, 1976).

They are also used as a shade crop in coffee and cocoa plantations and play a major role in the agro-forestry development (taungya) system. Attracted by the high prices, the number of plantain and cooking/starchy banana monocrop fields are on the increase. However, productivity in these fields declines very quickly unless high amounts of mulch are applied (Wilson *et al.*, 1987). The exact reasons for the rapid yield decline are not yet identified but several factors have been quoted such as soil fertility, poor suckering and root ramification, high mat, stemborers and nematodes.

Diseases of plantain and cooking/starchy bananas

Diseases of plantain and cooking/starchy bananas in Africa include the leaf spots caused by *Deightoniella torulosa, Cordana musae, Chloridiun musae, Cladosparium musae, Phyllachora musicola, Phyllostictina musarun,* and the black Sigatoka disease caused by *Mycosphaerella fijiensis* Morelet. Plantain and cooking/starchy bananas are also susceptible to the bunchy top virus disease, the cucumber mosaic virus disease, the rhizome or head rot caused by *Erwinia chrysanthemi* (= *Erwinia musae*). The fruits of plantain and cooking/starchy bananas are susceptible to the cigar end rot caused by *Trachysphaera fructigena* and the pitting disease caused by *Pyricularia grisea*. While it is being speculated that Panama wilt caused by *Fusarium oxysporum* f. sp. *cubense* affects plantain and cooking/starchy bananas, their resistance or susceptibility to the different races of the pathogen has not been verified.

By far the most important economic disease of plantain and cooking/starchy bananas in Africa today is the black Sigatoka disease. In Africa, it was first reported in Zambia in 1973 (Raemaekers, 1975) and in Gabon in 1976, through an introduction of vegetative materials from South-East Asia (Frossard, 1980). Since then, the disease has spread northwestwards to Cameroon, Nigeria, Cote d'Ivoire and Ghana (Wilson and Buddenhagen, 1986) and northeastwards to Malawi, Tanzania, Burundi, eastern Zaire, Rwanda and Uganda (Sebasigari and Stover, 1988).

Infection occurs on the furled heart leaf (Stover, 1987) but the first symptoms of the disease are first visible on the lower surface of the third or fourth youngest leaf as reddish-brown streaks which appear later on the upper surface. The streaks gradually change into elongated spots with grey centres surrounded by a dark brown or black border. Often, there is a yellow transitional zone between the leaf spot border and the normal green tissue. When the infection is more intense, especially in excessively wet months, typical leaf spots do not form. Instead, large areas of the leaf turn black, then dry out and wither. The leaf spots and streaks are usually parallel to the leaf veins. Rapid development of the disease is favored by a warm temperature of 23–28°C and very humid or rainy weather. The disease does not kill the plant.

Losses due to the disease have been put at between 30 and 50%. So far, no plantain cultivar has been found to be resistant to the black Sigatoka disease in Africa.

Black Sigatoka disease can be controlled by fungicides (Foure, 1983) but their use is either hazardous since most plantains are grown in backyards or too expensive for resource-poor farmers and thus are beyond their reach. The only long term solution is therefore the production and use of black Sigatoka resistant cultivars.

IITA has screened 116 *Musa* cultivars in the past one year for black Sigatoka disease resistance. All 79 plantain cultivars included in this study were susceptible (Table 2). This shows the seriousness of the black Sigatoka threat to the small African holder. However, sources of black Sigatoka resistance were found in some ABB cooking bananas, dessert wild bananas (Table 2). These black Sigatoka disease resistant ABB cooking bananas are now being rapidly multiplied in *in vitro* and distributed through the national programs in an attempt to alleviate the situation in the short term.

To obtain black Sigatoka disease resistant plantain and cooking/starchy bananas, IITA embarked on a breeding program in which ten female fertile plantain varieties were identified and up

Table 2 Levels of black Sigatoka disease resistance (BSR)

Wild and edible diploids		Dessert bananas		Cooking/starchy bananas		Plantain	
Name	BSR	Name	BSR	Name	BSR	Name	BSR
AA genome	(1)	*AA genome*		*AAA starchy banana*		*AAB genome (plantains)*	-
Calcutta 4	+++	Km 5	++	Pisang nangka	-	79 cvs	-
M. acum. type 3	++	Dwarf Cavendish	-	*ABB genome (cooking banana)*			
M. acum. ssp.		Giant Davendish	-	Pelipita 2	-		
malaccensis	++	Poyo	-	Foulah	-		
M. tavoy	++	Valery	-	Bom	++		
M. pahang	++	Gros Michel	-	Fougamou	++		
Pisang tongat	-	Green Red	-	Gia Hui	-		
Pisang lilin	++	Red	-	Matavia	-		
Muga	-			Maduranga	-		
Wh-o-gu	-	*AAAA genome*		Bluggoe	-		
		IC2	++	Sabra	-		
BB genome				Montnan	-		
M. balbisiana		AAB genome		Nzizi	-		
(1-63)	++	Pisang kelat	-	Simili Radjah	-		
		Silk	-	Cacambou	-		
		Rome	-				
		ABB genome					
		Ice cream	-				

(1) +++ = Very resistant
++ = resistant
\+ = moderately resistant
\- = susceptible

to 145 seeds per bunch were obtained from crosses with black Sigatoka disease resistant wild bananas (Swennen and Vuylsteke, unpublished). This is in spite of the general belief that it is extremely difficult to produce hybrid seeds with plantain.

More germplasm is now being collected and introduced with the assistance of the International Network for Improvement of Banana and Plantain (INIBAP). The germplasm will be screened for black Sigatoka disease resistance at IITA's Onne sub-station in Nigeria and included in an expanded breeding program.

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Discussion

Tresh, J.M. (UK): What are the characteristics of the improved cassava varieties? Are they tolerant of infection or resistant to infection? In other words, is this material being released free of virus or is this material tolerant and therefore already infected with the virus? Does the range of varieties show similar characteristics or do some of the varieties differ in their resistance? How widely have they been adopted in different African countries and what are the limitations to be overcome?

Answer: The improved cassava varieties are not free of virus. They seem to be tolerant of infection as they become much less infected by cassava mosaic virus. There is a wide range of varieties with different levels of resistance to the virus. The improved cassava varieties or material have been tested and released by national programs in many countries in Africa with different environmental conditions. Quality characters need to be further improved to meet the requirements of consumers in certain countries.

de Guzman, Enriquito D. (The Philippines): What causes the disease of yam and what is the growth impact on the yam industry in Africa?

Answer: I have no data on yam diseases.

Uritani, I. (Japan): 1. As cassava roots easily deteriorate after harvest, how do the people in Nigeria handle the roots after harvest to prevent them from deteriorating? 2. You mentioned that cassava leaves are used as vegetables by some farmers. How do they cook them to decrease the content of linamarin?

Answer: I. The storage roots of cassava deteriorate within 2-3 days after harvest. Therefore they need to be processed into such forms as "gari" and "cosset" that can be stored longer or they need to be consumed soon after cooking. In the dry areas of Africa, in particular fresh cassava tubers are consumed as cooked vegetables directly after harvest and are not stored as water is required for the processing of the tubers. 2. Cassava leaves as well as storage roots contain cyanide, the former containing more in general than the latter. Cassava leaves are pounded in mortars to destroy the tissues and hydrolyze the glycoside and cooked for 30-60 minutes to reduce the cyanide content from the leaves. It has also been stated that in Africa the cyanide contained in cassava causes goiter and mental retardation. However I believe that goiter is mainly caused by the lack of iodine in the water.