BANANA DISEASES AND PESTS IN EAST AFRICA

Report of a survey in November 1987

K. SEBASIGARI - R.H. STOVER

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inibap

International Network for the Improvement of Banana and Plantain

The International Network for the Improvement of Banana and Plantain (INIBAP) was established in 1985. Its headquarters are in Montpellier, France. Regional networks are being established in Western and Eastern Africa, Latin America and the Caribbean, and the Asia and Pacific region.

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- to initiate, encourage, support, conduct and coordinate research aimed at improving the production of bananas and plantains.
- to encourage the collection and exchange of documentation and information relating to bananas and plantains.
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SUMMARY

A survey of diseases and pests was made in Burundi, Rwanda, Eastern Zaire, Pemba, Zanzibar, mainland Tanzania and Uganda. The main varieties grown are the East African beer and cooking bananas (AAAs) present in the area for centuries and the more recently planted Pisang awak, Ney poovan and Gros Michel. Bluggoe and Cavendish varieties are also widely planted. All of the more recently planted varieties except Cavendish were being attacked by Panama disease in all countries. These varieties were planted for their tolerance to drought, poorer soils, borers and nematodes and good beer-making qualities.

Black Sigatoka (Mycosphaerella Fijiensis) has recently entered all countries except Uganda. It is only 35 kilometers from the Uganda border in Eastern Zaire. The disease is still in a spreading and consolidation phase and will take two to three years to reach maximum defoliation capacity through out the area. Rainfall in most areas is highly favorable for disease development most of the year. Temperatures above 1,500 m may be limiting unless a strain tolerant to low temperatures evolves. Some East African AAAs are susceptible and will have to be replaced by more tolerant varieties in this group. New resistant varieties such as Mysore, Yangambi, Saba, Cardaba and Pelipita should be introduced, multiplied and given to farmers to evaluate. Exploratory genetic studies should begin with the East African varieties.

Pratylenchus goodeyi, the root lesion nematode is widespread in all areas and Radopholus similis, the burrowing nematode, is present in Uganda and the Kagera District of Tanzania. It was recently introduced into Zanzibar on planting material from the mainland. Root rot is common, especially in areas with poor plant nutrition, but no uprooting was observed that can be attributed to nematodes. The effect of these nematodes on yields needs to be determined. Pisang awak, Gros Michel and certain beer varieties appear to have some tolerance.

Banana streak virus was found in one district of Rwanda, in Zanzibar and in the Bukoba area of Tanzania. These are the first reports outside of West Africa, Morocco and the Canary Islands. Eradication should be undertaken.

Bunchy top is confined to the Bujumbura Valley in Burundi and the adjacent Bugarama plain in Rwanda. This is a relatively small area and it should be eradicated. At present the disease spreads slowly - a situation that could change.

Serious nutritional and mineral deficiency problems are found in all countries. These are much more severe where beans and other crops are intercropped with bananas. As far as yield reduction is concerned, these problems are the major cause and not diseases. There are no data from cropping systems and fertilizer research in the entire area surveyed.

Other diseases and pests encountered that are mostly of minor importance are : Mycosphaerella musicola (yellow Sigatoka), Cladosporium leaf speckle, Armillaria rhizome dry rot, eye spot of young leaves (Dreschlera (Helminthosporium) gigantea), rhizome rot and pseudostem wet rot (Erwinia chrysanthemi), cigar end (Verticillium theobromae), cucumber mosaic, corky scab of fruit caused by thrips (Hercinothrips bicinctys (?)) in the dry season.

Banana research has been greatly neglected in the entire area but much increased interest is being shown and some research has recently been initiated. Suggestions are made for research needs to be undertaken and varieties to introduce for testing. Assistance is required and suggestions are made for additional staff for some major problems. The most urgent need is for a description and listing with synonyms of the East African beer and cooking bananas.

INTRODUCTION AND TERMS OF REFERENCE

Scattered reports from East Africa of "new" banana diseases involving nematodes, fusarial wilt, leaf spots and viruses indicated a survey by specialists was needed to verify the identity and the extent of the problems. In addition, production problems in general would be observed because of declining yields. Major production areas in Burundi, Rwanda, Eastern Zaire, Uganda and Tanzania were to be visited. Diseases and pests were to be noted and an estimation made of the effect on local and overall production. Other production problems affecting yield and long term needs for increased production to meet rapidly expanding populations were also to be assessed. Populations in all areas are expected to more than double in the next 30 years. Following the evaluations, suggestions and recommendations for disease and pest control will be made. Productivity problems in general will be discussed. Some research and staff requirements will be outlined to provide the knowledge to make other necessary decisions to alleviate the problems observed.

CHAPTER I : BURUNDI, RWANDA AND EASTERN ZAIRE

1. Diseases and pests observed

The most serious and widespread diseases over the entire area were leaf spot caused by Mycosphaerella fijiensis (black Sigatoka) and Pratylenchus coffeae (root lesion nematode). The former is still in the spreading stage and will take another two years to seriously affect all of the area.

Black Sigatoka (Mycosphaerella fijiensis).

The locations where this foliage destructive disease were found are listed in Table 1. The disease is still in the initial stages of introduction and will eventually spread over the entire area. There were two to three leaves of beer and cooking varieties heavily spotted below 1,500 m. It is estimated the earliest infections occurred only 12-18 months ago. It is still too early to determine if some of the East African acuminatas will be resistant and the level of susceptibility among different cultivars. Pisang awak, widely planted in drier areas at lower altitudes, has some spotting but with an ABB genome should not be heavily defoliated. Spotting on other varieties will be heavy below 1,500m. It is too early to tell how cultivars will respond at 1,600 m where cooler temperatures should retard the rate of disease development.

Temperature and rainfall data (Table 2) indicate rainfall could be a limiting factor only three months of the year. However, at 1,600 m average temperatures are considerably below the optimus of 26°C for disease development for tropical strains of M. fijiensis. Nevertheless, in Colombia, a strain of M. musicola is present that severely defoliates plantains in the coffee zones at 1,200-1,800 m and not at low altitudes. This indicates a strain could evolve and be selected for optimum development at lower temperatures. (tables 1 and 2).

Root Lesion Nematode (Pratylenchus goodeyi).

Marc Goethals, nematologist from the University of Leuven, identified this nematode in the IRAZ Gitega variety collection and he also confirmed its presence in two samples we gave him including one from the abandoned Mosso Station variety collection in Burundi. The lesions are somewhat distinct from those of the burrowing nematode (Radopholus similis) in having a reddish colour often including a reddish pigment in the stele. Root rot is not as extensive as with R. similis on Cavendish varieties in West Africa. There appeared to be differing levels of resistance or tolerance in the East Africans AAAs with the beer banana IGITSIRI having the most lesions. Cavendish varieties also had numerous lesions. There was no uprooting and it appears this nematode is not as destructive as R. similis. However, a simple trial should be carried out to determine if it does affect yield and how much.

Seven collections of nematodes were made from lesioned roots using the Baermann funnel technique and were sent to Montpellier for identification.

Cladosporium Leaf Spot (C. musae).

This leaf spot was widespread on beer and cooking bananas but was usually confined to the two or three oldest leaves. The intensity of spotting varied greatly, probably related to more humid micro-environments. It does not appear to be the cause of yield loss except in small localized areas where high humidities persist for long periods.

Rhizome Borer or Weevil (Cosmopolites sordidus).

This widespread banana insect was found mostly below 1,500 m in three locations in abundance two of which were abandoned areas with no maintenance. It is also present in Kibungo prefecture (Rwanda) at 1,500 to 1,700 m. In all areas infected rhizomes would be next to plants with little or no infestation. One plantain (AAB) was found heavily infested next to robust beer bananas. Plantains are known to be highly susceptible in some areas of West Africa.

There was no uprooting or toppling of other varieties anywhere attributed to borers. Borers are reported to be present in the IRAZ variety collection at Gitega, but we did not detect any in several varieties including Cavendish examined for nematodes. Borers could be locally important in poorly managed bananas at the lower altitudes. There are scattered infestations in the Mosso area (1,100 m) and the Bujumbura plain (850 m).

Fusarial Wilt (Panama Disease). Fusarium oxysporum f. cubense.

Fusarial wilt was found only on Pisang awak in two locations in Burundi. The epicenter is near the Mosso Station and involves an area of no more than 50 ha with scattered cases. From there it appears to have been taken more than 150 km to the Bujumbura Valley in the flood plain of Kaburantwa River near the town of Kaburantwa. There we found one case noted from the main highway by the bright yellow upright leaves. This disease will spread with flooding and can be transported in the petioles of leaves and pseudostem leaf sheaths from infected plants used for packing horticultural goods.

Bunchy Top (Virus Transmitted by Pentalonia nigronervosa).

This disease is confined to the Bujumbura Valley(850-1,200 m) and the adjacent Bugarama Valley in Rwanda (800-850 m). It is not present in Eastern Zaire, but is widespread for hundreds of kilometers from Kinshasa to the Atlantic coast. The incidence varies from field to field from less than 5% up to 20% in localized areas. Pisang awak and the East African AAAs are affected. Farmers cut down affected plants but seldom dig up the rhizomes. Plant growth is vigorous in the rich alluvial soils of the Bugarama Valley and farmers did not complain about bunchy top being a limiting factor in production. The disease has been present for

more than 20 years and why it does not spread is a mystery. A search should be made for the aphid vector Pentalonia nigronervosa to see if the vector does not prosper or is absent. It should be possible to eradicate the disease as it poses a threat to other adjacent areas if there was a mutation to a more easily vectored virus or if vector relationships changed.

Banana Streak Virus (A Bacilliform Virus Related to Cocoa Swollen Shoot and Rice Tungro Bacilliform Virus).

This virus has been reported from Morocco, the Ivory Coast and the Canary Islands. Symptoms consist of broken or continuous chlorotic streaks and spindle shaped lesions on the leaves. These chlorotic spots become necrotic and blackened. Necrotic spots are present in the leaf sheaths and petioles in advanced cases. Fruit is stunted and of poor quality. We observed this disease at only one location at Ntara 22 km East of Kibungo in Rwanda. It did not appear to extend beyond an epicenter of about 200 meters with the highest incidence about 30%. Dr. Lassoudiere told us the virus was present at four other locations in Kibungo Prefecture. This "new disease" in East Africa appears to be confined to Kibungo Prefecture in Rwanda and efforts should be made to eradicate it as infected plants do not produce marketable fruit. It is not soil or mechanically transmitted and the vector is unknown.

Rhizome Rot Caused by Armillaria sp.

This disease was found at six locations in Burundi and Rwanda and caused minor losses in localized areas. In some areas it also attacked cassava in the same field. It is characterized by a dry rot with the presence of white rhizomorphs in the rhizome and on the lower leaf sheaths that destroys the entire mat.

Eye Spot Caused by Dreschlera gigantea (Helminthosporium).

This fungus causes characteristic small spots on the unfurling heart leaf and is widely distributed on beer and cooking bananas, but does not cause serious defoliation. It is common on grass hosts and was observed on Setaria sp. near infected bananas at the ISAR Station in Rubona, Rwanda.

Pseudostem Wet Rot Caused by Erwinia chrysanthemi.

This ubiquitous soft rot bacterium can sometimes invade the pseudostem from the outer leaf sheaths inward weakening the structure and resulting in its collapse. On two occasions farmers described the disease but we did not see it until we arrived at the ISAR Station in Rubona, Rwanda, where several cases occurred on Pisang awak. It is not common. The same bacterium sometimes causes rhizome rot and may be associated with rotting around borer tunnels.

Cigar End Disease.

The disease causes serious losses of fruit in the dry season (June to August) in Gisenyi and Ruhengeri prefectures (Rwanda) and along the road from Goma to Rutshuru (Zaire). It can be controlled by tying the bracts

of the emerging flower. For this, the farmers have developed an ingenious device using a noose of dry pseudostem fibre on a long pole.

2. Cultivation systems related to production problems and yield

Production of bananas will have to double in the next 30 years if the needs of the rapidly expanding population are to be met. From observations made in this survey, it appears production per ha has actually declined in recent years because of the necessity of dedicating an increasing area of bananas to single and double inter-cropping with beans and other food crops. This results from population pressures on land and food needs. These crops are planted among the bananas resulting in : removal of and competition for scarce nutrients ; cutting of the banana roots ; removal of the banana trash reducing soil organic matter; creating an open canopy structure favoring water stress in dry periods, increasing leaf shredding by wind and creating a more favorable environment for black Sigatoka. In coffee areas banana leaves and leaf trash were removed for mulching coffee.

Outside of the rich alluvial soils near Lake.Kivu in Eastern Zaire where there is also less inter-cropping, nutritional deficiency signs were visible almost everywhere. Exceptions were the small percentage of plantings that received mulch and compost from farm and household wastes.

Foliage symptoms of nitrogen, magnesium and potassium deficiencies were common. Where magnesium deficiency was pronounced, root systems were poor and often rotten. Bunch size was probably one-half or even less of the potential for the variety grown and plant size was small.

In general, other than some use of mulch and compost in limited areas, no nutrients are added to banana fields. Thus yield has undoubtedly declined in most areas over recent years aggravated by intercropping with beans and in many cases two crops a year.

Unfortunately, there is no research data on cropping systems and the economics and sociology of the various cropping systems involving bananas in monoculture versus intercropping and methods of inter-cropping with bananas.

3. Recommendations

. Initiate a program to eradicate banana streak virus in Kibungo Prefecture.

. Initiate a program to eradicate bunchy top in the Bujumbura (Burundi) and adjacent Bugarama (Rwanda) valleys.

(Note : Legislation may have to be introduced to authorize eradication teams to enter infected fields).

. Evaluate varieties for tolerance to black Sigatoka and nematodes. Along with the evaluation of varieties to Sigatoka and nematodes, set up a tissue-culture-nursery project to produce disease-free plants for distribution. Variety plots at the Experiment Stations in Burundi and Rwanda are infested with Pratylenchus goodeyi.

. Issue a botanical bulletin **within the next 18 months** on the East African bananas (AAA(EA)) bases on studies at the IRAZ Experimental Farm by K. Sebasigari.

. Carry out agronomic studies in different areas of the three countries on cropping systems (banana monoculture versus various types of intercropping).

. Carry out fertility and nutrition studies in different ecological zones where fertility problems are the most acute and deficiency symptoms are pronounced.

. Introduce new varieties for testing through the INIBAP network and IRAZ. Exploratory studies should begin at IRAZ on the fertility and genetics of the East African bananas.

4. Assistance

What is most urgently needed is increased agronomy staff at IRAZ in Burundi for cropping system and nutritional studies in different ecological zones. Black Sigatoka resistant varieties should be used based on observations in Eastern Zaire where black Sigatoka is beginning to cause some defoliation.

High school level staff are needed to be trained to multiply varieties in tissue culture and in a plastic bag nursery for distribution to farmers free of Pratylenchus goodeyi. Present variety plots are infested with this nematode.

A staff of Junior level agronomists with transportation would be needed for a virus eradication program. Eradication cannot be left to farmers.

CHAPTER II : PEMBA AND ZANZIBAR ISLANDS

1. Diseases and pests observed

Black Sigatoka has been present on Pemba for at least one year and for somewhat less time in Zanzibar. It is still in the spread and consolidation phase. Highly susceptible varieties such as the widely grown Cavendish and Mlali Maua will eventually disappear. Other varieties will have to be evaluated for the ability to produce a marketable bunch of fruit even with considerable defoliation. For example, in Central America plantains (AAB) produce marketable bunches although severely defoliated.

Banana streak virus was found on Zanzibar. This is the first report of the disease outside of Rwanda in East Africa.

Nematode injury (Pratylenchus goodeyi) is widespread on roots and rhizomes. What affect they have on yield is unknown. Varieties need to be classified with respect to susceptibility and tolerance. Radopholus similis was recently introduced.

Panama disease in present on Silk (Pukusa) in both islands - how extensive is not known.

Race 2 of Fusarium oxysporum f. cubense is widespread on Bluggoe on Zanzibar Island.

Borers appear to be causing some injury on plantains and perhaps other varieties on Pemba Island but are not common on Zanzibar Island. Borer injury can be confused with the deep blackish lesions produced on rhizomes by nematodes. The latter are far more prevalent and root destructive than borers.

Fertility problems and mineral deficiencies are widespread on Zanzibar. In some areas only one to three hands are produced per bunch. Many fields are not taken care of : no disuckering, old leaves not removed, no weeding except where bananas are intercropped with cassava. However, intercropping is not general. The small banana patches are often planted too far apart producing an unfavorable microclimate for best growth. Open plantings will also favor defoliation by black Sigatoka.

2. Recommendations

. Conduct surveys to indicate prevalence of both races of Panama disease and banana streak virus.

. Initiate a program to eradicate all plants with banana streak virus.

. Evaluate varieties for tolerance to nematodes and black Sigatoka.

. Begin an extension program to :

a) familiarize farmers with banana diseases and where to eradicate diseased plants (banana streak virus, Panama disease);

b) how to prepare "clean" rhizomes by peeling free of all lesions and dipping in hot water or a nematicide solution so as not to carry borers and nematodes into "clean" fields;

c) improve cultural practices such as planting no more than 2 to 2.5 meters apart and no more than 25 cm deep;

d) carry out fertilizer and mulching trials in farmers fields. (Fertilizer prices are subsidized).

Introduce new varieties through INIBAP (Pelipita ABB, Cardaba ABB, Saba ABB) Tetraploid 3426 (AAAA), Mysore (AAB), Yangambi (AAA).

3. Assistance

There is at present a Dutch plant pathology student from Wageningen with a counterpart who is on a 9-month assignment to study banana plant protection problem. There is also a senior Dutch entomologist working on food crops in general. The most urgent need is for a full-time banana research agronomist with post-graduate overseas training to at least the MS level. He should visit banana research stations in the Windward Islands and Jamaica and perhaps West Africa. He should carry out trials in the experiment stations on varietal response to diseases and in the farmers fields on spacing, fertilization and mulching with the most disease tolerant varieties. He should also determine what effect nematodes have on yield. He would need 2-3 foreman or junior assistants, depending on the number of trials. The most essential equipment would be a pick-up truck and motorcycles for the assistants.

CHAPTER III : MAINLAND TANZANIA

1. Diseases and pests observed

Arusha - Kilimanjaro

Black sigatoka was not observed. There was very light spotting on Cavendish varieties of Mycosphaerella musicola.

Nematode lesions on roots are common but severe root rot was observed only in the Kilimanjaro area. According to the pathologist at Tengera Experiment Station the most important nematode is Pratylenchus species.

A few borer tunnels were observed in the Arusha area but were not a cause of serious losses. Statements such as borers "eliminated" or "devastated" certain plantings were later changed to "we don't know how much injury borers cause". Certainly, in the coffee-banana intercroppings where manure and fertilizer were applied, huge plants with 25-30 kg bunches indicated borers were not a major problem. Borers may be more prevalent and destructive in the Kilimanjaro area where growth is much poorer and fertility is much less. However, nematode root rot seemed far more serious.

Panama disease is extensive on Ney poovan and Pisang awak. In one area we were told the disease had destroyed 75% of Ney poovan. We did not see Race 2 on Bluggoe but local extension people said it had eliminated Bluggoe in some areas around Kilimanjaro. The presence of Race 2 on Zanzibar and in the Kilimanjaro area are the first reports of the disease outside of the American tropics and Uganda (about 1960). The presence of a strain attacking Pisang awak is the first report of the disease outside of Burundi. The observation that Ney poovan and Pisang awak were diseased in nearby fields suggests the same strain may be attacking both varieties.

Bluggoe and Pisang awak are important varieties in localized areas in East Africa where rainfall is deficient and conditions are marginal for other varieties. Other ABB clones need to be tested as replacements.

Zinc deficiency and other fertility problems were observed in the Kilimanjaro area. Plants in all areas were showing signs of drought stress from a long dry period in September, October and early November. Root rot in the Kilimanjaro area could be related to magnesium deficiency.

Bukova Area - Kagera District

Black Sigatoka was found on one plant at the Maruka Experiment Station. This must be a very recent introduction of air-borne inoculum. Rainfall data from this Station (Table 3) indicate a highly favorable environment for black Sigatoka most of the year.

Severe borer damage was present in some fields. According to the survey made by a British nematologist and entomologist in 1985 of 58 farms 41% had a serious nematode infestation and 31% a serious borer infestation.

Radopholus similis was present on 21% of the farms and Pratylenchus goodeyi on 94%. The former was believed to have been introduced from Uganda.

Panama disease is widespread and is gradually taking out the widely planted Pisang awak and Gros Michel varieties.

Banana streak virus is present and may be widespread and a survey is needed.

Nutritional and mineral deficiency problems were **the worst seen anywhere** in East Africa. In addition to the major elements, magnesium deficiency was widespread as indicated by severe foliar symptoms. Magnesium deficiency results in root rot and poor roots and can contribute and be confused with nematode root rot.

2. Recommendations

. Black Sigatoka is present in Tanzania and will spread and become consolidated over the next 2-3 years. The varietal response of the most widely grown varieties needs to be evaluated. Also resistant varieties such as Mysore, Yangambi, Saba, Cardaba and Pelipita should be introduced and evaluated for agronomic, organoliptic (cooking and beer) and disease resistance status. These varieties are also resistant to Panama disease which is widespread on the widely grown Pisang awak (ABB).

. The effect of Pratylenchus goodeyi and Radopholus similis individually on production needs to be determined.

. The borer problem in Kagera is related to the same problem in adjacent Uganda and research work in borers recommended for Uganda would be applicable. Increased extension work is needed on producing **clean seed** and cultural practices for borer control.

. The agronomist of the EEC program has shown that peeling rhizomes free of all lesions and dipping in a solution of Furadan for 20 minutes results in new plantings being free of borers and parasitic nematodes. (5 kg of 5% Furadan in 20 liters of water).

. Nutrition and fertility problems in the Kilimanjaro and Kagera areas are the most serious factors limiting production and fertilizer and organic matter research are vital to improving and preventing a continual decline in production.

3. Assistance

The EEC has one banana agronomist stationed in Bukoba. Since the most serious problem in this area is related to plant nutrition and soil fertility, short term consultancies are needed in these fields. Also, along with plant and soil nutrition experts, a cooperating overseas laboratory is needed for soil and foliar analyses. However, there are no base data on critical levels for the varieties grown except the Cavendish group. These levels would need to be established from "good" and "poor" areas and from fertilizer plots.

CHAPTER IV : UGANDA

1. Diseases and pests observed

As in the other East African countries, Pisang awak, Ney poovan and to a lesser extent Gros Michel have been extensively planted in the last twenty years. All are susceptible to Panama disease which is widespread in Ankole District on Pisang awak and to a lesser degree on Ney poovan.

Black Sigatoka was not found but is present in Eastern Zaire 35 km from the Kigezi District border. It should enter this area in 1988 and eventually spread to other areas over the next 2-3 years.

Cladosporium leaf spot was ubiquitous and in some areas caused severe injury to the 2-3 oldest leaves.

Nematode lesions are common and both Pratylenchus goodeyi and Radopholus similis are present. However, nowhere did we see uprooting that could be attributed to severe root rot caused by these nematodes.

The banana borer or weevil has caused severe losses in localized areas where often more than 50% of the plants have fallen (toppling). It affects some fields in districts along Lake Victoria extending into Kagera District in Tanzania. Of the 750,000 ha of bananas in Uganda, it was not possible to find out what percentage was seriously infested. The vast majority of the fields we saw from the road while driving did not have a toppling problem. Often one field would have a toppling problem and a near-by field would not. There was a general consensus of opinion everywhere that those fields receiving a 1984-85 consignment of dieldrin were most affected by toppling. It was stated borers were now resistant to dieldrin after more than 20 years of use. Farmers that have used dieldrin are now clamoring for Furadan and some 400 tons were distributed. It costs the farmer 6-7 US dollars per kg at the official exchange rate.

We observed borers under banana trash in fields that had no toppling and in general most areas did not have a toppling problem. It appears that some "biological balance" has been disrupted in fields with a borer problem and the use of dieldrin has contributed to a severe borer infestation in some fields.

A frequent complaint heard was that of declining yield ("banana decline") and small bunches - the "small bunch syndrome". This is undoubtedly related to declining soil fertility and mineral deficiencies in the poorer soils. Apart from mulch, and manure where cattle are present, nothing is applied to the bananas to maintain soil fertility.

2. Recommendations

. Introduce Panama disease and black Sigatoka resistant varieties via the tissue culture laboratory of IRAZ : Mysore, Yangambi, Saba, Cardaba, Pelipita. Multiply in nurseries free of the nematodes Pratylenchus and Radopholus and distribute to farmers for evaluation.

. Evaluate the traditional beer and cooking types (AAA(EA)) for resistance to borers, nematodes and black Sigatoka (once this leaf spot is widely distributed) and for agronomic characteristics, especially yield. These agronomic evaluations should be carried out with and without fertilizer.

. Set up demonstration plots in those areas showing the small bunch syndrome and foliage symptoms of nutrient deficiency using NPK and Mg. Determine if it pays to apply fertilizer.

. Study borer populations and damage under various cultural conditions in fields with a high level of toppling (mulch, manure, leaving pseudostem intact after harvest versus removing, use of fertilizer). In Central America borers are attracted to the harvested plant and do not cause damage. The pseudostem is not removed after harvest. It gradually rots and falls down.

. Intensify the extension program to produce clean seed by peeling and dipping in a nematicide (Furadan 1.0 kg in 20 L of water).

. The widespread use of chemicals for borer control should be discouraged. Apart from the cost and drain on scarce foreign exchange, problems of insect resistance, rapid microbiological breakdown and upsetting the "biological balance" can arise.

3. Assistance

An expatriate entomologist with a doctorate is needed to study the perplexing borer problem in Uganda - why do some fields topple and others do not? This would involve a detailed study of the entire insect population and a search for possible predators and parasites. A ugandan counterpart entomologist should also be assigned to the project. A relationship should be established with ICIPE in Nairobi for identification and library services and for more sophisticated laboratory equipment if needed. This would need to be a minimum two year project and preferably three. The biology is complex.

In conjunction with this project, biological control in Cuba with ants and in Brazil with fungi would need to be evaluated.

APPENDICES

APPENDIX A

ABBREVIATED LIST OF PLACES VISITED AND FIELD NOTES

1. BURUNDI, RWANDA AND EASTERN ZAIRE

November 5, 1987.

Burundi, Mosso Experiment Station (800 m)

In the mid-1950s Pisang awak (ABB) began to replace East African AAAs (mostly beer types) because of vigor and drought resistance. Observed epicenter of Panama disease first noted in 1982 on Pisang awak. Has spread about 1.0 km. No Panama disease on Bluggoe or Prata. Variety collection (abandoned): yellow Sigatoka on Dwarf Cavendish and Prata. Deep nematode lesions on Inshakara (AAA(EA)) and some borers. Dwarf Cavendish: deep nematode lesions and borers on some plants. Nematode extraction made. Pisang awak near station : drought stress mimics yellow leaves of Panama disease, no nematode lesions or borers. Heavy borer injury on one plant of Ikimaga (AAA(EA)) but adjacent plants not affected.

Burundi, Gaterama, Rutana Province (1,400 m)

Basidiomycete rhizome rot probably caused by Armillaria sporadically attacks most varieties. Ikimaga (AAA(EA)): no deep nematode lesions, no borers. Farmers report Erwinia chrysanthemi pseudostem wet rot sometimes present.

Burundi, Gasongati, Gitega Province

Igitsiri (AAA(EA)) : nematodes lesions on roots and root swelling. Nematode extraction made.

November 6, 1987.

Burundi IRAZ Variety Collection

Guindi (AB?), Makara (AAA(EA)), Kisubi (AB), Grand Nain (AAA): all had deep reddish nematode lesions identified by Marc Goethals, nematologist, Louvain University as Pratylenchus goodeyi. Borers reported present but could not find on varieties examined. Some Erwinia rhizome rot on Ingote (AAA(EA)). Magnesium deficiency symptoms on foliage widespread. Yellow Sigatoka (light spotting) on Dwarf Cavendish.

Burundi, Nyarunazi, Muramvya Province (1,470 m)

Igitsiri (AAA(EA)) and Pisang awak: some nematode lesions on Igitsiri. No borers

Burundi, Mageyo, Bujumbura Province (1,300 m)

Igitsiri: deep nematode lesions on roots, sample taken to nematologist. Two Cavendish variety group plants had symptoms that appeared to be black Sigatoka (Mycosphaerella fijiensis) which was confirmed in laboratory. No spotting on adjacent beer bananas (AAA(EA)).

Burundi, Programme d'Appui pour le Développement Communal (Center) Mubimbi, Bujumbura Province (1,500 m)

Black Sigatoka on Dwarf Cavendish. Some tip-overs from root rot caused by water-logging; no borers.

November 7, 1987.

Burundi, (Bujumbura plain) Bujumbura to Bukavu, Zaire. Nyamitanga area, commune Buganda, Cibitoke Province.

Inshakara, Igitsiri (AAA(EA)), Pisang awak, Prata: black Sigatoka on lower leaves, Some borer injury noted.

Burundi, Kaburantwa River Plain, Kaburantwa Commune, Cibitoke

Panama disease on Pisang awak. A few cases of bunchy top on Pisang awak. Black Sigatoka on Pisang awak and Silver Bluggoe on lowest leaves and a beer banana.

Burundi, Mparambo near border with Rwanda

Igihanda (AAA(EA)): borers common but not on Pisang awak. Scattered cases of bunchy top on Pisang awak and Prata. Black Sigatoka present, Yangambi has no spotting.

Rwanda, Bugarama Valley (850 m)

Muzibo (AAA(EA)): some scattered bunchy top and grade 4 (more than 33% of leaf spotted) of black Sigatoka. No black Sigatoka on Gros Michel (disease in early stages of consolidation). Inyamunyu (Rwanda), Igasahira (Burundi): black Sigatoka. No deep nematode lesions found, no borers observed.

Rwanda, Batura, Rwanda, Machaca Village (1,600 m)

Black Sigatoka on beer banana, Prata, but not on Lacatan. No nematode lesions or borers.

Zaire, Lake Kivu, 8 km West from Bukavu (1,460 m)

Black Sigatoka on Lacatan, Red Banana (AAA) and beer banana.

Zaire, Mulungu Station, 32 km from Bukavu. Institut National pour l'Etude et la Recherche Agronomique (INERA)

Prata : heavy spotting yellow Sigatoka. Cladosporium spotting on older leaves some beer varieties. No nematode lesions, no borers found.

November 8, 1987.

(Bukayu to Kigali via Butare), Rwanda, 10 km East of Lake Kivu, Mulindi Village (1,650 m), Cymbogo commune

Magnesium deficiency. Armillaria rhizome rot common ; nematode lesions, roots collected for extraction; no borers, no Sigatoka.

Rwanda, Gashirabwoba, Gisuma Commune (1,900 m)

Armillaria rhizome rot and magnesium deficiency symptoms on beer bananas. No leaf spots or borers. Root rot probably associated with Mg deficiency.

Rwanda, Murambi, Mbazi commune

Magnesium deficiency on Pisang awak , Dwarf Cavendish, no nematode lesions but light yellow Sigatoka.

November 9, 1987.

(Kigali to Kibungo, Rwanda) 1,400 m - Rwanda, Gikoro, Bisenga Commune

Igitsiri, Pisang awak, Dwarf Cavendish : deep nematode lesions but less on Pisang awak. Root sample for nematode extraction. Much leaf yellowing and necrosis from potassium and magnesium deficiencies.

Rwanda, Bijange, Bicumbi Commune

Foliar symptoms of potassium and magnesium deficiencies. Igitsiri and Gros Michel roots, heavy nematode lesions. Light yellow sigatoka on Gros Michel.

Rwanda, Kabarondo, Kabarondo Province

Potassium deficiency except on heavily mulched area next to house. No nematode lesions on beer bananas mulched area.

Rwanda, Ntara, Rukira Commune, 22 km East of Kibungo

Banana streak virus on beer bananas and to less extent on Pisang awak and Ney poovan. About 30-50% incidence in epicenter of about 100 m with occasional case out to 500 m. Probably present 6-8 years according to owner. No rhizomes introduced last 20 years. No nematode lesions, trace of borer tunnels on harvested plants. Yellow Sigatoka on Red banana.

November 10, 1987.

Kigali to Gisenyi, Rwanda - Rwanda, Shyorongi, 15 km West of Kigali (1,950 m)

Igitsiri (AAA(EA)): good roots, no borers, no Sigatoka.

Rwanda, Buhande, Tare Commune, 33 km West of Kigali

Armillaria rhizome rot on Pisang awak, common. According to farmer, Pisang awak more susceptible than beer bananas (AAA(EA)). Igitsiri: heavy nematode lesions, root sample for extraction. Banana and beans foliage show magnesium deficiency symptoms.

Rwanda, Kiryi, Kigombe Commune (1,700 m), 4 km East of Ruhengeri

Igitsiri : nematode lesions, no borers, no Sigatoka.

Rwanda, Gisa, Rubavu Commune (1,700 m)

Intokatoke (AAA(EA) : some nematode lesions but appears more resistant than Igitsiri. Cigar end reported common in dry season and method of delaying bract opening for control demonstrated. No borers, no Sigatoka.

November 11, 1987.

Goma to Rutshuru, Zaire - Zaire, Monigi, 6 km North of Goma (1,500 m)

Mugumira beer variety : excellent roots, no nematod lesions or borers Cladosporium leaf spot abundant on oldest leaves.

Zaire, Kiliate, 10 km North of Goma (1, 850 m)

Mugumira beer variety, nematode lesions but roots appear resistant as many healthy. No borers.

Zaire, Rugari, 45 km North of Goma (1,600 m)

Mugumira beer variety : one root in 10 has nematode lesions. Some cigar end.

Zaire, Kinyandonyi, 9 km East of Buturande (1,150 m)

Mugumira beer variety : abandoned plants had two out of fivewith borers. Nematode lesions on roots. Last 2-3 leaves with heavy black Sigatoka with near mature fruit - all leaves heavily spotted.

Zaire, Nyabirehe 15 km South of Rutshuru (1,300 m)

One plant of French plantain (AAB) affected by borers and rhizome rot that cuts roots causing leaf yellowing. No Sigatoka.

November 12, 1987.

Goma (Zaire) to Gitega (Burundi) via Kigali (Rwanda) - Rwanda, Rubona, ISAR Experiment Station (1,700 m)

Nematode lesions on Dwarf Cavendish, Igitsiri and Umugumira. Light yellow Sigatoka on Dwarf Cavendish. Cladosporium leaf spot abundant on old leaves. Eye spot on furled heart of cooking variety. Pseudostem wet rot on Pisang awak.

2. PEMBA AND ZANZIBAR ISLANDS

November 16, 1987.

Pemba Island - Matangatuani, Kilimo Experiment Station

Heavy black Sigatoka spotting on most varieties, Mlali Maua (AAA(EA)) completely defoliated. Disease first observed in May, 1986. Northern half of the Island infected but as yet not in Southern portion. Severe Deightoniella (?) speckle on young plantain fruit with sunken black spots up to 5 mm on one side of fingers.

Konde

Reddish lesions on otherwise good root system. Sample of lesioned roots taken for nematode identification.

Gando, Minyenyeni

Panama disease on Pukusa variety (Silk, AAB) detected during past years and believed to be localized. This variety, most prized on the Island and fetches highest price. Disease erroneously identified as Moko. Light borer tunneling on a Zanzibar variety. Prata has heavy black Sigatoka spotting. Deep reddish-black nematode lesions on young suckers and peepers. A sample processed for nematode species identification.

Weni

A horn plantain (AAB) fallen over and with borer tunnels. In general, plantains have to be replanted every three years. Dwarf Cavendish rhizome with nematode lesions and borer tunnels in outer cortex.

Chake - Chake

Yellowing of plantain leaves from drought stress and compact soil. One rhizome no nematode lesions and adjacent plant had deep, abundant lesions on sucker. These lesions processed for nematode species identification. Black Sigatoka present in district.

November 17, 1987.

Zanzibar Island - Kizimbani Experiment Station

Yellow Sigatoka on Mlali Maua (AAA(EA)) and Cavendish varieties. Panama disease on Pukusa (Silk). Banana streak virus on Giant Cavendish. Abundant nematode lesions on roots and rhizomes. Low fertility and magnesium deficiency symptoms on variety brought from Bukoba on the mainland. Roots and Rhizome sampled for nematode extraction.

Machui state Farm

Black Sigatoka and Yellow Sigatoka present on Cavendish varieties. Pukusa (Silk) had grade 3 and 4 infection on one or two oldest leaves. This is the first report for Zanzivar Island. Banana streak virus on Pukusa. Extra Dwarf Cavendish showing severe rosetting and bunches sometimes emerge (choke throat) from side of pseudostem. This variety very sensitive to stress of drought. This was diagnosed as possible bunchy top. Cladosporium leaf spot common on old leaves.

Mdogaa Village

Panama disease (Race 2) on Bluggoe (locally called Koroboi) and diagnosed erroneously as Moko. Disease seems widespread as indicated by bright yellow upright leaves observed along roadsides.

Kitope

President's field had been destroyed and planted with peanuts because root sample was sent to the Institute of Parasitology in England where Radopholus similis was found to be abundant. Roots in adjacent field of Pukusa and Cavendish free of lesions. One sucker with heavy lesions in rhizome sampled for nematode extraction in adjacent field. Banana streak virus on one plant.

3. TANZANIA MAINLAND

Arusha - Kilimanjaro

November 19, 1987.

Tengeru Experimental Station, Arusha

Severe thrip injur on fruit of Williams, Uganda and other varieties said to be a dry season problem from July to October; species not identified; bunches with severe injury do not ripen satisfactorily. Paz a Grand Nain like Cavendish variety from Israel said to be resistant to borers. Light Mycosphaerella musicola spotting on Paz. An experiment comparing Furadan and no Furadan for nematode and borer control underway but only 21 plants per treatment. Cavendish varieties had 10-15% of roots with nematode lesions - appear resistant. Root sample for nematode extraction.

Arusha District, Baraa Ward N° 1

Panama disease on Ney poovan - 75% of plants said to be killed.

Barra Ward N°2

Cigar end present; traces of borer tunnels on old harvested plants. Saw system of feeding good dairy cows in stalls for manure production for coffee and bananas.

Road Arusha to Moshi, Arumeru District

Panama disease on Pisang awak. This variety widely planted from 1960s onward in marginal rainfall areas for beer production (drought tolerant). Rhizome sample for vegetative compativility grouping.

Kilimanjaro Area - Kilema Masaera N°1

Panama disease on Pisang awak and Ney poovan. Deficiency symptoms and fertility problems.

Kilimanjaro Area - Kilema Masaera N° 2

Severe root rot and borers on beer type (Mrarao). Cavendish variety severe root rot and deep nematode lesions in rhizome - no borers

Kilimanjaro Area - Kilema Masaera N° 3

Severe zinc deficiency symptoms on Mchare and nematode root rot. Root rot may also be associated with magnesium deficiency.

Bukoba District - Kagera Region

November 21, 1987.

Kabale Village (1,250 m) South of Bukoba

Note : Pisang awak and Gros Michel have been widely planted in the last 20 years because of tolerance to soils with reduced fertility and to drought. Pisang awak is an excellent beer banana and Gros Michel can be used for beer, cooking or dessert.

Kimbungu Village (1,350 m)

Banana streak virus common on cooking variety (Nchoncho) and heavy borer infestation. Panama disease on Ney poovan and borer damage severe on Nshakara. Poor soil fertility and nutrition. Banana streak virus on cooking banana and Gros Michel.

November 22, 1987.

Yanga Village -North of Bukoba

Heavy borer infestation with snap-off (breakage of rhizome) and uprootings. Cladosporium leaf spot causing damage to two oldest leaves. Deficient and nutrition and deficiency symptoms.

Kiilema Village, Bukoba Rural

Panama disease epidemic on Gros Michel. Light yellow Sigatoka on Gros Michel. Gros Michel planted because of resistance to borers.

Kiilema Village, Bukoba Rural : Taro/maruku demonstration field

Demonstration of clean rhizomes of Nyoya and Nshakara (East African cooking bananas) planted and Furadan applied first two years. No nematicide last two years. Excellent growth although borers present and no toppling.

Maruku Experiment Station, Bukoba District, Kagera Region

Variety plots - Panama disease on Pisang awak and Ney poovan. Black Sigatoka on one plant of a cooking variety (confirmed microscopically in La Lima).

4. UGANDA

November 23, 1987.

Field Next to Kawanda Experiment Farm

New planting 18 months old; Furadan applied in planting hole, 3 m spacing, 1,100 per ha and leave 3 suckers per plant. Good growth and good root system. Cladosporium leaf spot lower leaves.

Kawanda Village

Coffee and scattered bananas. Heavy Cladosporium infection lowest two leaves. Light yellow Sigatoka. Eye spot common on unfurled heart leaf. Light nematode lesions; nematodes identified as Pratylenchus and Radopholus by experiment station nematologist.

Kiteezi Village, Kyaddondo county, Mpigi District

Severe toppling from borer damage; plants fall exposing rotten roots. A 1984-85 consignment of Dieldrin applied. Toppling began about one year ago.

November 24, 1987.

Kagando Village (1,500 m), Kinoni county, Mbarara District

High mat, Cladosporium leaf spot, very little toppling. Heavy mulching.

November 25, 1987.

Rutooma Village (1,500 m), Kashari county, Mbarara District

Vigorous plant growth, no toppling. Cladosporium and eye spot present.

Rubinda Village, Kashari County, Mbarara District

Panama disease on Pisang awak (called Musa in Uganda); 50% plants diseased. Heavy Cladosporium spotting, eye spot; cucumber mosaic - light mosaic pattern on young leaves.

Kabagoma Village

Pisang awak leaves yellow and drying up but no Panama disease. Heavy Cladosporium infection on 2-3 oldest leaves.

Rwebingo Village, Ibanda county, Mbarara District

Panama disease on Pisang awak.

November 26, 1987.

Kabasumba Village (1,300 m), Kalisio county, Rakai District, South of Mosaba

Severe borer injury and toppling (50%). Dieldrin applied two years ago. Adjacent plot has very little toppling (2%) where no Dieldrin applied. Gros Michel and Ney poovan tolerant to borers. Many fields showed nutritional problems - small fruit, yellow foliage.

Kitenga Village, Mukungwe county, Masaka District

Heavy losses from toppling. Dieldrin had been applied several years ago. Adding mulch and dried grass and replanting with Furadan application.s In contrast to most toppling where roots emerge, here the rhizome broke in two.

APPENDIX B

Preliminary Nematode Disease analysis.

Nematodes from roots (and rhizome sample) were collected by the Baermann funnel technique. Specimens were identified by Marc Goethals (text) and J.L. Sarah (Table 4.).

All samples from mainland East Africa were infected with Pratylenchus goodeyi. On Pemba Island both Radopholus similis and Pratylenchus goodeyi were present. On Zanzibar Island only Radopholus similis was detected in the two samples collected. Thus P. goodeyi is the prevalent species on East African bananas with Radopholus similis reported previously from Uganda and Kagera Province in Uganda and now from Pemba and Zanzibar. Varietal response to both species should be determined. Nurseries free of both species are needed for dissemination of "clean" planting material.

APPENDIX C

Preliminary results of analysis of samples for Fusarium oxysporum f. sp. cubense (FOC) by Dr R.C. PLOETZ*.

To date, eight isolates of Fusarium oxysporum f. sp. cubense (FOC) from East Africa have been characterized for vegetative compatibility (see list below). Three isolates recovered from Ney Poovan in Tanzania (STNP1, STNP2, and STNP3) are compatible, but are incompatible with other African isolates tested and with previously described VCGs in FOC (Ploetz and Correll, 1988**). Likewise, an isolate recovered from Bluggoe in Tanzania (STBLZ1) is incompatible with other African isolates and with previously described VCGs. A third group of isolates recovered from Pisang Awak and Ney Poovan (STPA1, STPA2, STPA3, and STNP5) are compatible. This third group is also generally compatible with isolates in VCG 0124 and VCG 0125; interestingly, these isolates appear to "bridge" these two VCGs. VCG 0124 and VCG 0125 contain race 2 and race 1 isolates, respectively. We have recently detected bridging between VCG 0124 and VCG 0125 for a few other non-African isolates, but at the present time can only guess the reasons for and significance of this phenomenon. Presumably, isolates in VCG 0124 and VCG 0125 are closely related. How closely related they are, and whether the African-bridging isolates have race 1- and race 2-type virulence is not known.

Isolate	Cultivar	Origin
STNP1	Ney Poovan	Pemba Island, Tanzania
STNP2	Ney Poovan	Tenguero Station, Tanzania
STNP3	Ney Poovan	Pemba Island, Tanzania
STBLZ1	Bluggoe	Zanzibar Island, Tanzania
STPA1	Pisang Awak	Bujumbura Valley, Burundi
STPA2	Pisang Awak	Kagera, Tanzania
STPA3	Pisang Awak	Kazo, Uganda
STNP5	Ney Poovan	Eastern Zaire

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** PLOETZ, R.C. and CORRELL, J.C. 1988. Vegetative compatibility among races of Fusarium oxysporum f. sp. cubense. Plant Disease 72 (4), 325-328.

APPENDIX D

SURVEY ITINERARY 1987

Oct.	30 Friday	San Pedro Sula, Miami, London
	31 Saturday	Arrived London
Nov.	01 Sunday	London, Nairobi
	02 Monday	Arrived Nairobi 6:30 am
	03 Tuesday	Nairobi (tickets, visa, money)
	04 Wednesday	Nairobi, Bujumbura, Gitega
	05 Thursday	Gitega to Mosso Expt. Station, Burundi
	06 Friday	Gitega to Bujumbura
	07 Saturday	Bujumbura to Bugarama (Rwanda) to Bukoba, (Zaire)
	08 Sunday	Bukavu (Zaire) to Kigali (Rwanda)
	09 Monday	Kigali to Kibungo (Rwanda)
	10 Tuesday	Kigali to Gisenyi and Goma (Zaire)
	11 Wednesday	Goma to Rutshuru (Zaire)
	12 Thursday	Goma (Zaire) to Gitega via Kigali
	13 Friday	Gitega, Bujumbura, Nairobi
	14 Saturday	Nairobi
	15 Sunday	Nairobi, Dar es Salaam, Zanzibar
	16 Monday	Zanzibar, Pemba Island
	17 Tuesday	Zanzibar
	18 Wednesday	Zanzibar, Dar es Salaam, Kilimanjaro
	19 Thursday	Arusha, Kilimanjaro
	20 Friday	Kilimanjaro, Nairobi
	21 Saturday	Nairobi, Bukoba (Tanzania)
	22 Sunday	bukoba to Entebbe (Uganda)
	23 Monday	Kampala area, Uganda
	24 Tuesday	Kampala to Mbarara , Uganda
	25 Wednesday	Mbara to Ibanda to Masaka
	26 Thursday	Masaka area and to Kampala
	27 Friday	Kampala, Entebbe, Nairobi
	28 Saturday	Nairobi, London
	29 Sunday	London (flight to Miami cancelled)
	30 Monday	London to Miami
Dec.	01 Tuesday	Miami
	02 Wednesday	Miami, San Pedro Sula

TABLES

TABLE 1.

Distribution of black Sigatoka, November, 1987 in Burundi, Rwanda and Zaire.

Burundi, Mayego, Bujumbura Province, 1,300 m :
Black Sigatoka on Cavendish variety but not adjacent beer varieties

Burundi, P.A.D.C. Center at Mubimbi, 1,500 m:
Black Sigatoka on dwarf Cavendish but not on adjacent East African AAA.

Burundi, Bujumbura plain, 800 m :
Black Sigatoka general in area on Pisang awak, Silver Bluggoe, Prata, Igitsiri (AAA (EA)) on lower leaves

Rwanda, Cyangugu, Bugarama Valley, 850 m (Cyangugu Prefecture)
Black Sigatoka general in area. Muzibo variety (AAA(EA)) has some leaves grade 4 (more than 33% spotted) while Gros Michel had no spotting indicating disease is still in consolidation phase. Some black Sigatoka on Inyamunyu variety (AAA(EA))

Rwanda, Batura in Cyangugu prefecture, Machaca village, 1,600 m :
Black Sigatoka on beer banana (Intembe) and Prata. Lacatan had none.

Zaire, Lake Kivu at Murhundu 8 km from Bukavu, 1,460 m :
black Sigatoka, grade 3 on Lacatan and Red banana (AAA); also on beer banana.

Zaire, Kinyandonyi, 9 km East of Buturande (Rutshuru region), 1,150 m :
Black Sigatoka grade 3 on 2-3 leaves of Mugurmira (Intokatoke) var AAA(EA) and all Dwarf Cavendish.

TABLE 2.

Average Monthly Rainfall and Minimum and Maximum Temperatures at 1,600 and 800 meters in Burundi.

	Rainfall		Temperature			
			Maximum		Minimum	
	BA	K	BA	G	BA	G
J	100.5	140.7	29.0	24.9	19.0	13.2
F	104.9	130.4	29.4	25.0	18.1	13.2
M	120.8	157.3	29.3	25.0	19.0	13.6
A	122.1	177.3	28.8	24.5	19.4	14.0
M	69.6	94.2	29.0	24.0	19.0	13.4
J	9.5	6.0	29.2	24.5	17.3	11.3
J	2.4	4.1	29.0	25.0	16.3	10.8
A	11.4	13.0	29.8	26.4	17.4	11.9
S	35.6	45.6	30.5	26.8	18.4	12.6
O	67.3	85.9	30.2	26.3	18.8	12.9
N	105.9	143.6	28.7	24.5	18.8	12.9
D	111.2	143.0	28.6	24.0	19.0	12.7

Notes : **BA** = Bujumbura Airport at 800 m
G = Gitega at 1,600 m
K = Karuzi at 1,610 m

Source Institut Géographique du Burundi
Climatologie Publication 17 and 18.

TABLE 3.

Monthly Rainfall at the Maruku Experimental Farm, Bukoba, Tanzania (25 year average, elevation 1,250 m)

	mm of rain
January	154.5
February	151.8
March	239.6
April	371.8
May	314.2
June	87.0
July	45.3
August	67.3
September	103.7
October	152.5
November	233.3
December	201.4

TABLE 4.

Species of nematodes found in roots of East African bananas (mostly AAA beer and cooking varieties) in November, 1987

Sample n°	Locality	Country	Radopholus similis	Pratylenchus goodeyi	Pratylenchus spp	Helicoty-lenchus	Meloidogyne	Tylenchidae	Longido-ridae	Tricho-doridae
1	Mosso	Burundi	-	+++	-	-	-	+	-	P
2	Gaterama	Rwanda	-	+	-	-	P	+	P	-
3	Bisinga	Rwanda	-	++++	-	P	P	+++	-	-
4	Kiliate	Zaire	-	++	-	-	-	P	P	-
5	Gitega	Burundi	-	++++	-	-	P	++	P	-
6	Mulundi	Rwanda	-	+++	-	-	-	++	-	-
7	Buhante	Rwanda	-	++++	-	-	-	P	-	-
8	?	Pemba (roots)	+	-	-	++	P	-	P	-
9	Chake Chake	Pemba (Rhizome)	-	++	+++	P	-	-	-	-
10	Tengeru	Tanzania	-	++++	-	-	-	+	-	-
11	Kitope	Zanzibar	++++	-	-	+	-	P	-	P
12	Kizimbani	Zanzibar	+++	-	-	P	-	++	-	-

Notes : P = Presence noted, to be confirmed
+ = Rare
++ = Fairly abundant
+++ = Abundant
++++ = Very abundant

TABLE 4