African Crop Science Journal, Vol. 16, No. 1, pp. 17 - 25 ISSN 1021-9730/2008 $4.00

PRELIMINARY EVALUATION OF IMPROVED BANANA VARIETIES IN MOZAMBIQUE

A. T. UAZIRE, C. M. RIBEIRO, C. RUTH BILA MUSSANE[1], M. PILLAY[2], G. BLOMME[3], C. FRASER[4], C. STAVER[3] and E. KARAMURA[3]

Eduardo Mondlane University (UEM), Av. Julius Nherere, Campus Universitário
[1]Agrarian Research Institute of Mozambique (IIAM), Av. FPLM 2698, Maputu, Mozambique
[2]International Institute of Tropical Agriculture (IITA-Uganda), P.O. Box 7878, Kampala, Uganda
[3]Bioversity Internatonal Uganda, P. O. Box 24384, Kampala, Uganda
[4]Institute for Tropical and Subtropical Crops (ITSC), Nelspruit, South Africa

ABSTRACT

Banana (*Musa* spp.) production in Mozambique is largely confined to the Cavendish variety that is eaten as a dessert. On the other hand, banana is a staple food crop in many countries in sub-Saharan Africa. The introduction of a range of high yielding and disease resistant cooking and dessert varieties in Mozambique could play a potential role in ensuring food security and raising incomes of millions of small scale farmers. In the framework of a USAID-funded project on dissemination and evaluation of improved banana varieties, plantlets of new *Musa* hybrids were distributed to small-scale farmers. In addition, several demonstration plots and an on-station trial at the Agrarian Research Institute of Mozambique (IIAM), Umbeluzi research farm were established. The objectives of this study were (i) to evaluate the general performance of the hybrids in the different locations and analyse data collected from one of the sites, and (ii) to assess farmer acceptability of the hybrids in one of the agro-ecologies in Mozambique. The FHIA (Fundacion Hondurena de Investigacion Agricola) hybrids performed relatively well in the more moist agro-ecologies and where irrigation was available, but not in the drier areas in the south of Maputo. Although 'FHIA 17' was the most vigorous, this variety took the longest time to produce a bunch. The hybrid, 'SH 3640' produced the largest bunch but this was not significantly different from that of 'Grand Naine' the local check used in the trials. The hybrid 'SH3460' and 'Grand Naine' emerged as the best cultivars in terms of post-harvest quality and acceptability. Less than 50% of the participants indicated their preference for 'FHIA17', 'FHIA21' or 'FHIA23'. Feedback from farmers involved in the on-farm activities indicated that those from the central and southern parts of the country preferred dessert types, while those from the north preferred both dessert and cooking types.

Key Words: Demonstration plots, introduction, performance, yield

RÉSUMÉ

La banane (*Musa* spp). La production au Mozambique est principalement limitée à la variété de Cavendish qui est mangé comme un dessert. D'autre part, la banane est une récolte de nourriture d'agrafe dans beaucoup de pays en Afrique de Sud du Saharan. L'introduction élévé d'une gamme de produit et les variétés la maladie résistantes de preparation et de dessert au Mozambique pourraient jouer un rôle potentiel dans la garantie de sécurité de nourriture et élevé les revenus de millions d'agriculteurs à petite échelle. Dans le cadre d'un projet d'USAID-SUBVENTIONNE sur la diffusion et d'évaluation de variétés de banane améliorées, plantlets de nouveau *Musa* hybride a été distribué aux agriculteurs à petite échelle. Par ailleurs, plusieurs terrains de démonstrations et un procès de sur-station à l'Institut de Recherche Agraire de Mozambique (IIAM), la ferme de recherche d'Umbeluzi a été établie. Les objectifs de cette étude étaient d' (i) évaluer l'exécution générale de l'hybride dans les emplacements différents et analyse des données recueillies d'un des sites, et (ii) évaluer l'admissibilité d'agriculteur de l'hybride dans une des agro-écologies dans Mozambique. Le FHIA (Fundacion Hondurena d'Investigacion Agricola) hybride réussisaient relativement bien dans les agro-écologies plus humides et où l'irrigation était disponible, mais pas dans les secteurs plus secs dans le sud de Maputo. Bien que ‹ FHIA

17 › était le plus vigoureux, cette variété a pris le temps plus long pour produire un regime. L'hybride, ‹ SH 3640 › a produit le plus grand regime mais ceci n'était pas significativement différent de cela de ‹ Grandiose Naine › selon le rapport de contrôle local utilisé. Hybride « SH3460 » et ‹ Grandiose Naine › a émergé les meilleurs cultivars dans les termes de qualité de poste-moisson et d'accessibilité. Moins que 50% des participants a indiqué leur préférence pour 'FHIA17', « FHIA21 » ou « FHIA23 ». Les réactions des agriculteurs impliqués dans les activités de ferme a indiqué que ceux-là du central et des parties du Sud du pays a préféré les types de dessert, pendant que ceux-là du nord a préféré les types de dessert et préparation.

Mots Clés: Parcelle de démonstration, introducation, performance, rendement

INTRODUCTION

Bananas (*Musa* spp.) are produced mainly on small-scale farms in Mozambique, however, a few large-scale plantations are found around the capital Maputo and in central Chimoio Province. These large-scale plantations cultivate mainly Cavendish varieties and supply the large cities such as Maputo, Beira and the South African markets. Currently, banana plantations occupy 14,000 ha in Mozambique, with an estimated production of 90,000 t per *annum* (FAO, 2004). Production on the small-scale farms averages 6.4 t ha^{-1} and is hampered by various pests (nematodes and weevils) and diseases (Sigatoka, Fusarium wilt, viruses), lack of production knowledge, lack of high performing varieties, low soil fertility, long dry spells (particularly in the south of the country) and a lack of support from government extension agents (Fancelli, 1997; Lamb, 1997).

Cooking varieties of banana are rare in Mozambique. On the contrary, cooking varieties play a major role in ensuring food security and raising incomes of millions of small-scale farmers in sub-Saharan Africa. The introduction of high yielding, pest and disease tolerant/resistant *Musa* cooking and dessert varieties could contribute to food security and increase farm income in Mozambique. The introduction of new banana varieties would also increase banana diversity in Mozambique and increase post-harvest options.

In the framework of a 2 year USAID-funded TARGET project, several high performing *Musa* varieties were introduced into Mozambique in 2003. The introduced germplasm included four multi-use FHIA varieties developed by the Fundacion Hondurena de Investigacion Agricola (FHIA) Breeding Programme and a check variety 'Grand Naine'. The selected FHIA hybrids had proven to be high yielding and resistant to different pests and diseases in a number of countries such as Cuba (Gonzalez *et al*., 1997), Colombia (Alvarez, 2003), Uganda (Pillay *et al*., 2003), Philippines (Faylon *et al.*, 2004), Sri Lanka (Kudagamage, 2004), Indonesia (Djatnika and Sutanto, 2004), and China (Linbing *et al*., 2004) across a wide range of agro-ecologies. Plantlets were distributed to small-scale farmers, while others were established in several demonstration plots and in an on-station evaluation trial at the Agrarian Research Institute of Mozambique (IIAM), Umbeluzi research farm.

The objectives of this study were (i) to evaluate the general performance of the hybrids in the different locations, and (ii) to assess farmer acceptance of the hybrids in one of the agro-ecologies in Mozambique.

MATERIALS AND METHODS

Planting material. A total of 16,000 plants of five varieties, viz 'Grand Naine', 'FHIA17', 'FHIA21', 'FHIA23' and 'SH3640', were selected for distribution in Mozambique. Out of the five genotypes, four were improved varieties from FHIA, while 'Grande Naine' (*Musa* AAA Cavendish sub-group) is a locally grown landrace which served as a local check for yield and post harvest qualities. The planting material was obtained as tissue culture plantlets about 5 cm in height, from the Du Roi laboratory (www.duroi.co.za) in South Africa. The plantlets were transplanted into plastic bags and weaned, and hardened in several nurseries in the country; namely, one in Nampula, one in Manica, two in

Maputo, one at Casa Gaiato and one in the district of the Manhica. The nurseries were constructed with local wooden poles and covered with a shade net to protect the young plants from direct sunlight. The plants were distributed to farmers when they had reached a height of about 30 cm and were ready for field establishment.

Establishment of trials. In January 2004, an on-station germplasm trial was established at the IIAM, Umbelúzi research farm located in Boane District about 25 km from the capital Maputo. The station is located at 26.03° N, 32.23° E and an altitude of 12 masl. The minimum temperature ranged from 11.5°C to 22.7°C, while the maximum temperature ranged from 24.7°C to 33.0°C. The average annual rainfall is 200 mm at this location. Rainfall is unevenly distributed with a pronounced dry season from April till August. The soils at the Umbelúzi research station have the following characteristics: a pH of 6 to 6,5, a normal salinity, an organic matter content of 2,6%, a low total nitrogen content (0,095%), a high calcium content (13,49 cmoles kg^{-1}), a high magnesium content (4.61 cmoles kg^{-1}), a high potassium content (0,65 cmoles kg^{-1}), a high sodium content (3,53 cmoles kg^{-1}) and poor drainage (Ripado, 1986).

The experimental layout of the on-station germplasm trial at the IIAM, Umbelúzi research farm was a randomized complete block design with 5 treatments per block ('FHIA17', 'FHIA21', 'FHIA23', 'SH3640' and 'Grande Naine') and 4 replications. Each treatment consisted of 6 plants per genotype and a total of 120 plants were established. The field was prepared using a tractor and planting holes measured 40 cm x 40 cm x 40 cm, spaced at 3 m between rows and 2 m between plants.

Planting was done manually and 10 kg of composted manure, mixed with topsoil, was applied in each planting hole. No fertilisers or chemicals were applied subsequently to simulate small-scale farmers' cultivation methods. During the dry season, plants were irrigated with 40 mm of water at weekly intervals. Plants were mulched and weeded manually. Excess suckers were removed, while de-budding was done when all the hands had emerged. Where necessary, forked wooden sticks were used to support plants and prevent toppling.

Data collection and analysis. The following data were collected in the on-station germplasm trial at the IIAM, Umbelúzi research farm from January 2004 till April 2005: the number of days to flower emergence and harvest; girth at soil level at planting, flower emergence and harvest (cm); girth at 1 meter height at flowering and harvest (cm); height of pseudostem at planting and flower emergence (m); number of functional leaves at planting, flowering and harvest (functional leaves are those with more than 50% green leaf lamina area). At harvest the following data was recorded: bunch and hand weight, number of hands per bunch, number of fingers per bunch, diameter of the fingers at the centre of the bunch (bunch and hand weight was measured using a weighing scale).

At the end of the project an ex-post impact assessment survey was carried out. In addition, palatability and acceptability tests were carried out with 200 persons including 50 people from Boane district where the project was implemented (*i.e.*, 20 farmers belonging to two farmer associations, 20 individual farmers and 10 staff including field technicians of the Agrarian Research Station of IIAM) and 150 people from Maputo city. There was a gender balance in the people who participated in the different tests. The acceptability tests focussed on fruit size and colour, fruit pulp colour, fruit pulp smell and flavor as well as the content of juice and starch. The palatability tests focussed on taste, smell, similarity with other traditional varieties and preference related to other traditional varieties.

The data were analysed using the MSTAT-C statistical software (MSTAT-C, 1989). The F test was used to determine significant differences (at 5% level); while a mean separation was carried out for multiple comparisons.

RESULTS

Agronomic performance. 'FHIA17' was the most vigorous clone with the biggest pseudostems and biggest height (Table 1). Pseudostem girth decreased for all genotypes

during the reproductive stage (Table 1). This may be linked to drying out of oldest leaves and leaf sheaths. All the FHIA hybrids were taller than 'Grande Naine' (Table 1). Grande Naine produced the most leaves at flower emergence (Table 2). 'FHIA17' and 'FHIA21' had the longest flowering cycle (Table 3). 'SH3640' was the earliest to produce a bunch, while 'FHIA17' took longest (Table 3). 'Grand Naine' and 'SH3640' produced significantly larger bunches than the other genotypes (Table 4). 'FHIA17' and 'Grande Naine' produced the largest number of hands per bunch (Table 4). 'FHIA21' and 'FHIA23' had the longest fingers, while 'SH3460' had the thickest fingers. Growth and yield of plants in the on-farm trials was higher in Nampula and Manica compared to Maputu. This is, perhaps, linked to the dry season which was more pronounced in the south.

Consumer acceptability. The palatability tests indicate that 89 and 96% of the participants, respectively, scored 'Grand Naine' and 'SH3640' as sweet in taste (Table 6). 'FHIA17' was ranked last. The aroma of 'SH3460' and 'Grand Naine' was considered superior. The other three FHIA genotypes scored low on aroma. 'SH3460' and 'Grand Naine' were considered as very similar to the traditional varieties (Table 6) and stood out as the best varieties in terms of post-harvest

TABLE 1. Pseudostem girth at soil level and at 1 meter height, and plant height assessed at different growth stages from the IIAM Umbeluzi research farm

Genotypes	Girth at soil level (cm)			Girth at 1 m height (cm)		Plant height (m)	
	Planting	Flower emergence	Harvest	Flower emergence	Harvest	Planting	Flower emergence
Grand Naine	7.52a	26.2b	24.8b	18.7b	17.0b	0.36b	2.24d
FHIA17	7.50a	28.7a	26.6a	20.5a	20.2a	0.57a	2.99a
FHIA21	6.88a	25.7b	23.6b	16.2c	15.7bc	0.38b	2.80b
FHIA23	7.21a	25.5b	24.2b	16.1c	14.7c	0.39ab	2.65bc
SH3640	5.25a	27.9a	25.1ab	18.6b	17.2b	0.23b	2.53c
CV (%)	15.12	3.10	4.22	5.03	6.23	3.09	4.53

Averages followed by the same letter in a column are not significantly different at $p < 0.05$ according to Tukey's studentised range test

TABLE 2. Number of leaves at planting, flower emergence and harvest from the IIAM Umbeluzi research farm

Genotypes	Number of leaves		
	Planting	Flower emergence	Harvest
Grand Naine	6.4a	15.2a	10.2ab
FHIA17	5.5a	12.7b	9.2bc
FHIA21	4.3a	10.8b	7.8cd
FHIA23	5.8a	11.1b	7.4d
SH3640	5.3a	12.8b	10.9a
CV (%)	23.6	10.1	11.2

Averages followed by the same letter in a column are not significantly different at $p < 0.05$ according to Tukey's studentised range test

TABLE 3. Crop cycle duration traits for the different genotypes from the IIAM Umbeluzi research farm

Genotypes	Weeks		
	From planting to flower emergence	From planting to harvest	From flower emergence to harvest
Grand Naine	50.1bc	63.4ab	14.0a
FHIA17	57.3a	66.3a	11.3a
FHIA21	56.6a	65.8a	13.4a
FHIA23	52.8b	62.8ab	9.5a
SH3640	48.3c	61.3b	12.4a
CV (%)	3.6	3.2	17.1

Averages followed by the same letter in a column are not significantly different at $p < 0.05$ according to Tukey's studentised range test

TABLE 4. Yield traits for the different genotypes from the IIAM Umbeluzi research farm

Genotypes	Yield components						
	Weight of the bunch (kg)	Weight of the hands (kg)	Number of hands	Number of fingers per hand	Finger length (cm)	Finger diameter (cm)	Finger girth (cm)
Grand Naine	34.1a	3.4a	10.6ab	21.3a	16.4bc	3.63b	12.35b
FHIA17	21.5b	2.2a	11.8a	17.0b	15.5c	3.10c	10.93c
FHIA21	17.0b	2.4a	8.3c	14.0c	20.3a	3.03c	11.07c
FHIA23	18.4b	2.8a	8.3c	14.9bc	21.3a	2.96c	11.55c
SH3640	31.8a	3.5a	10.5b	16.8b	17.9b	4.90a	13.88a
CV (%)	19.8	18.1	7.6	8.9	6.3	6.98	5.63

Averages followed by the same letter in a column are not significantly different at $p < 0.05$ according to Tukey's studentised range test.

TABLE 5. Acceptability test results (expressed as % of respondents) for the 5 assessed varieties according to peel and pulp colour, and fruit size. 200 persons participated, including 50 people from Boane district where the project was carried out and 150 persons from Maputo city

		Genotypes				
	Visual aspect	Grand Naine	FHIA17	FHIA21	FHIA23	SH3640
Peel	Attractive	97	41	75	73	94
	Not attractive	3	59	25	27	6
Pulp	Attractive	91	48	87	85	92
	Not attractive	9	52	13	15	8
Size	Small	0	52	0	2	0
	Medium	10	48	14	14	10
	Big	90	0	86	84	90
	Ideal	96	36	82	81	95
	Not ideal	4	64	18	19	5

TABLE 6. Palatability test results (expressed as % of respondents) for the five assessed genotypes. 200 persons participated, including 50 people from Boane district where the project was carried out and 150 persons from Maputo city

Evaluated parameters		Genotypes				
		Grand Naine	FHIA17	FHIA21	FHIA23	SH3640
Taste	Sweet	89.0	56.3	63.5	65.2	96.0
	Neutral	9.0	35.3	30.0	29.0	4.0
Smell	Good	98.9	54.5	52.1	50.3	96.1
	Not good	1.1	45.5	47.9	49.7	3.9
Similarity with other traditional varieties	Similar	97.5	62.1	7.4	5.3	98.7
	Not similar	2.3	37.9	92.6	94.7	1.3
Continue to consume	Yes	99.2	46.8	38.2	46.7	99
	No	0.8	53.2	61.2	53.3	1
Preference related to other traditional varieties	Highly preferred	96.0	21.0	18.3	15.0	98.2
	Slight preference	4.0	38.8	40.7	42.5	1.8
	Other	0	40.2	41.0	42.5	0

qualities and acceptability. Less than 50% of the participants had a preference for 'FHIA17', 'FHIA21' or 'FHIA23'.

In terms of peel and pulp colour, 'Grand Naine' and 'SH3640' scored best (Table 5) with an acceptability index of over 90%. In contrast, 'FHIA17' had an acceptability index of only 41%. The 'FHIA17' fruits were considered too short and rated as poor with regards to acceptability (Tables 4 and 5).

DISCUSSION

Agronomy. This is the first report on the agronomic performance of FHIA varieties in Mozambique. In general, the FHIA hybrids performed relatively well, especially in the more moist agro-ecologies and where irrigation was available. The plants did not grow well in the drier areas, especially in the south of Maputo, but grew better where irrigation was provided. Although 'FHIA 17' was the most vigorous variety, it took the longest time to produce its bunch. This appears to be anomalous since the plant was regarded as vigorous. In Colombia, at an altitude of 1050 masl, 'FHIA 17' was harvested in 66 weeks while 'FHIA 23' took 74.7 weeks to harvest. In this study, 'FHIA 23' took 62.8 weeks from planting to harvest. It appears that 'FHIA 17' used most of its energy in its vegetative growth since it was the tallest hybrid at shooting. A significantly shorter cycle time of 48.2 weeks was also recorded for SH 3640 in Cote d'Ivoire (Coulibaly and Djedji, 2004) compared to 61.3 weeks in Mozambique. Among the FHIA hybrids, 'SH 3640' produced the largest bunch but this was not significantly different from that of 'Grand Naine'. Moreira (1987) indicated that there is a positive correlation between diameter of the pseudostem and bunch size. However, this study showed that 'Grande Naine' which had the second largest pseudostem girth, produced the largest bunch. This may be due to the larger leaf photosynthetic area of 'Grand Naine' since it had significantly more leaves than the other genotypes at flower emergence. The larger bunch size in 'SH3640' compared to the other FHIA varieties is probably due to the number of standing leaves it had at harvest.

Some of the FHIA hybrids used in this study have been evaluated in other countries such as Colombia (Gonzalez *et al.*, 2003; Herrera and Aristozibal 2003), Cuba (Alvarez, 1997; Perez *et al.*, 2002), Ghana (Dzomeku *et al.*, 2000),

Nicaragua (Dens *et al.*, 2002), and Uganda (Pillay *et al.*, 2003; Nuwakunda *et al.*, 2000). Some of the equivalent data gathered from these studies for the relevant hybrids are listed in Table 7. The agronomic data of the hybrids from Mozambique compared favorably with the performance of the hybrids in other countries, irrespective of the different agro-ecologies.

Bearing in mind that bananas are sensitive to genotype x environment interactions (De Cauwer *et al.*, 1995; Pillay *et al.*, 2003) there were some notable differences. For example, pseudostem girths of 'FHIA 23' and 'FHIA 21' were much larger in Uganda and Ghana, respectively, than in Mozambique (Djatnika and Sutanto, 2004; Nowakunda *et al*., 2000). Generally, the FHIA hybrids were much shorter in Mozambique than in other countries. It is generally accepted that short plants are less prone to wind damage than taller plants. All the hybrids showed more leaves at harvest in Mozambique than those in other countries. It was interesting to find that 'Grande Naine', a variety susceptible to black Sigatoka (Romero and Sutton, 1997) had 10.2 leaves at harvest in Mozambique while in Cuba the variety had 0.0 leaves. The effect of black Sigatoka on bananas is highly variable and depends on climatic factors and inoculum pressure. All the hybrids in Mozambique had more standing leaves at harvest than those grown in other countries (Tabe 7). This probably indicates that disease pressure for black Sigatoka was low in Mozambique. With the exception of 'Grande naine', all the other hybrids were found to be resistant to black Sigatoka. This accounts for the large number of standing leaves recorded at harvest. There was a good correlation between number of standing leaves at harvest and bunch weights in this and other studies. The large bunch weights of the FHIA hybrids, coupled with disease resistance, are some of their outstanding characteristics; which were also visible in Mozambique.

Acceptability of hybrids. The varieties 'SH3460' and 'Grand Naine' emerged as the best varieties in terms of post-harvest quality

TABLE 7. Agronomic characteristics of some FHIA hybrids and Grand Naine in five countries

Country	Colombia			Ghana	Nicaragua		Cuba		Uganda
Varieties	FHIA 17	FHIA 21	FHIA 23	FHIA 21	FHIA 17	FHIA 23	Grande Naine	FHIA 21	FHIA 23
Pseudostem girth (cm)	19.1	19	25.7	55.4					67
Plant height (cm)	280	330	350	269.1	334	339			310
Number of leaves at flowering	11	9	9	13.7			7.6	4.8	10
Number of leaves at harvest	6	4	4	6.3			0.0	4.5	6
Months to flowering	22.3-31.6	11.8	28.5-38.08	11.4					
Months to harvest	36.3-43.3	15.4	36.9-48.5	15.1					
Number of hands/bunch				7.7	12.5	10.3		8.7	9.1
Number of fingers	104-156	53-114	182-266	107	213	159			147
Bunch weight (kg)	18.0-29.4	10.2-33.1	37.4-58.4	23.8	37.5	20.1	14.6	21.3	29.3

Sources : Colombia: Gonzalez *et al*., 2003; Herrera and Aristizabel, 2003; Ghana: Djatnika and Sutanto, 2004; Dzomeku *et al*., 1999; Nicaragua: Dens *et al*., 2002; Cuba: Perez *et al*., 2002; Uganda: Nowakunda *et al*., 2000

and acceptability. 'SH 3640' was also preferred over the dessert banana 'Poyo' as regards taste, colour, consistency and texture in Cote d'Ivoire (Coulibaly and Djedji, 2004). Less than 50% of the participants indicated a preference for 'FHIA17', 'FHIA21' or 'FHIA23'. The low acceptability rate of these three FHIA hybrids in Mozambique is similar to that observed generally for the FHIA hybrids in Uganda (Nowakunda *et al.*, 2003). In Uganda, banana is the staple food for majority of the people and their preference for new varieties that do not exactly match the taste of the local varieties is, perhaps, understandable. In Mozambique, eating bananas as food is not common practice. Therefore, the three cooking varieties were least preferred by the farmers in southern Mozambique. Perhaps a survey from the central and northern part of the country may provide interesting results. Feedback obtained from farmers involved in the on-farm activities indicated that farmers from the south (Maputo) and centre (Manica) preferred dessert types, while farmers from Nampula (north) preferred both dessert and cooking types equally. In Uganda, the 'FHIA' hybrids had ratings that could make them acceptable for cooking in parts of the country where cooking banana landraces are disappearing due to diseases and pests. It is possible that this could also happen in Mozambique.

In conclusion, this study showed that two of the five introduced banana varieties are preferred in southern Mozambique. Further work is necessary to gauge the impact of the entire project in Mozambique.

ACKNOWLEDGEMENTS

The authors thank the following: USAID for funding this project, IITA and Bioversity for providing the necessary networking and coordination, the Agrarian Research Institute of Mozambique (IIAM) and the University Eduardo Mondlane (UEM) for providing the in-country coordination, and project partners Care, Africare, Casa Gaiato and the Ministry of Works for their active input into the success of this project.

REFERENCES

Alvarez, J. M. 1997. Introduction, evaluation, multiplication and dissemination of FHIA hybrids in Cuba. *Infomusa* 6:10-14.

Coulibaly, S. and Djedji, C. 2004. Organoleptic qualities of the fruit of hybrids SH-3640 and CRBP-39. *Infomusa* 13: 27-30.

De Cauwer, I., Ortiz, R. and Vuylsteke, D. 1995. Genotype-by-environment interaction and phenotypic stability of *Musa* germplasm in West and Central Africa. *African Crop Science Journal* 3:355-362.

Dens, K., Vargas, M., Matton G., Coessens, S., Van den Houwe, I. and Swennen, R. 2002. Introduction and multiplication of improved bananas and plantains in Nicaragua and distribution to farmers. *Infomusa* 11:44-47.

Djatnika, S.I. and Sutanto, A. 2004. Banana R&D in Indonesia: Updates and highlights. In: *Advancing banana and plantain R&D in Asia and the Pacific*. Molina, A.B., Xu, L.B. Roa, V.N., Van den Bergh, I. and Borromeo, K.H. (Eds.). Vol. 13. Proceedings of the 3rd BAPNET Steering Committee meeting held in Guangzhou, China 23-26 November 2004.

Dzomeku, B.M., Banful, B., Ankoma, A.A., Yeboah, D. and Darkey, S.K. 1999. Multilocational evaluation of FHIA hybrids in Ghana. *Infomusa* 9: 20-22.

FAO, 2004. FAO Production year book, Rome, Italy.

Faylon, P.S., Eusebio, J.E. and Anit, E.A. 2004. Philippine banana R & D highlights 2004. In: Molina, A.B., Xu, L.B., Roa, V.N., Van den Bergh, I., Borromeo, K.H. (Eds.), pp. 109-124. Advancing banana and plantain R & D in Asia and the Pacific Vol 13. *Proceedings of the 3rd BAPNET Steering Committee meeting held in Guangzhou, China* 23-26 November 2004. INIBAP- Asia Pacific, Los Banos, Laguna, Philippines.

Francelli, M. 1997. Pragas da bananeira. Banana para exportação. Aspectos técnicos da produção. FRUPEX. Embrapa – SPI. Brasil. 106 pp.

Gonzalez, A.M.L., Gomez, C.,and Aristizabal, M.L. 2003. Characteristics of growth and production of FHIA hybrids in a region of Colombia. *Infomusa* 12:46-49.

Herrera, J.W.M. and Aristizabel, M.L. 2003. Characterisation of the growth and production of some plantain hybrids and cultivars in Colombia. *Infomusa* 12:22-24.

Kudagamage, C. 2004. Banana in Sri Lanka: Status and prospects. In: Molina, A.B., Xu, L.B., Roa, V.N., Van den Bergh, I., Borromeo, K.H. (Eds.). Advancing banana and plantain R & D in Asia and the Pacific Vol 13. *Proceedings of the 3rd BAPNET Steering Committee meeting held in Guangzhou, China* 23-26 November 2004. INIBAP- Asia Pacific, Los Banos, Laguna, Philippines. 13: 125-130.

Lamb, Z. 1997. Banana for export. Technical aspects. Embrapa-CTT. Brasília. pp. 30-38.

Linbing, X., Hu, Y., Bingzhi, H. and Yuerong, W. 2004. Banana research and production in China. In: Molina, A.B., Xu,L.B., Roa, V.N., Van den Bergh, I., Borromeo, K.H. (Eds.). Advancing banana and plantain R & D in Asia and the Pacific. *Proceedings of the 3rd BAPNET Steering Committee meeting held in Guangzhou, China* 23-26 November 2004. INIBAP- Asia Pacific, Los Banos, Laguna, Philippines.13: 51-64.

Molina, A.B., Xu, L.B., Roa, V.N., Van den Bergh, I. and Borromeo, K.H. (Eds.). 2004. Advancing banana and plantain R & D in Asia and the Pacific Vol 13. Proceedings of the 3rd BAPNET Steering Committee meeting held in Guangzhou, China 23-26 November 2004. INIBAP- Asia Pacific. Los Banos, Laguna, Philippines. 13: 81-87.

Moreira, R.S., Hiroce, R. and Saes, L.A. 1987. Analysis of 12 nutritive elements at the edges and centers of the leaves of 50 banana cultivars Revista Brasileira de Fruticultura (BRA), 9(1):21-26

MSTAT-C. 1989. MSTAT-C, a microcomputer program for the design, management, and analysis of agronomic research experiments. Michigan State Univ., East Lansing, MI.

Nowakunda, K., Rubaihayo, P.R., Ameny, M.A. and Tushemerierwe, W. 2000. Consumer acceptabilty of introduced bananas in Uganda. *Infomusa* 9: 22-25.

Perez, P.O., Caraballoso, I.B., Rodriguez, L.G. and Rodriguez, N.V. 2002. Evaluation of he agronomic characteristics of plantain hybrids (*Musa* spp). *Infomusa* 11: 34-35.

Pillay, M., Tenkouano, A., Makumbi, D. and Ragama, P. 2003. Genotype x environment interactions in multilocational testing of *Musa* hybrids in three sites in Uganda. 6th African Crop Science Society Proceedings 12-17 October 2003.

Ripado, M. 1986. Os solos da Estação Agrária do Umbelúzi. IIAM. Comunicação.5 pp.

Romero, R.A., Sutton, T.B. 1997. Reaction of four *Musa* genotypes at three temperatures to isolates of *Mycosphaerella fijiensis* from different geographical regions. *Plant Disease* 81:1139-1141.