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On-farm Evaluation of *Musa* Hybrids in Southern Nigeria

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ABSTRACT

Performance and adoption potentials of new *Musa* hybrids were tested in southern Nigeria. To this end, ten *Musa* hybrids and a local check were deployed to the plantain and banana growing belt of southern Nigeria through a farmer participatory approach. Participating farmers were identified in each of the 10 selected plantain-producing states in collaboration with the agricultural extension network, using criteria related to technical know-how, social status, and resource capacity. On-farm trials were established and maintained by the farmers with provision of planting materials and facilitation of access to required inputs by IITA. Data were collected on two consecutive growth cycles on phenological and yield traits as well as resistance to black Sigatoka. Farmers' preference ranking of the test varieties was also recorded. Genotype by environment interaction effects were significant ($P < 0.001$) for all the traits evaluated. Agronomic performance across locations was best for FHIA-25 and FHIA-23 with respect to bunch weight and for PITA26 and PITA14 for crop cycling and resistance to black Sigatoka disease, with farmer's preference going to PITA14 and PITA17. Thus, field performance did not always correspond with farmers' preference, which appeared to be influenced by ethnic-based perception of the culinary uses and processing potential of the varieties.

Keywords: adoption, on-farm trial, preference ranking

INTRODUCTION

Plantain and banana (*Musa* sp. L.) are major staple food crops in the humid ecologies of West and Central Africa where per capita consumption can reach 150 kg in some traditional production areas (Vuylsteke *et al*. 1997). Continuous supply throughout the year makes plantain and banana basic components of the farming system in many areas of the region. Thus, the crops have assumed a prestigious status as staple foods that are critical to the nutritional and economic well-being of the people, thereby playing an important role in food security and poverty alleviation (Frison and Sharrock 1999).

Traditional banana and plantain varieties are susceptible to a number of biotic factors, including black Sigatoka (caused by *Mycosphaerella fijiensis* Morelet), banana weevil (*Cosmopolites sordidus* Germar), and a complex of plant parasitic nematodes (Vuylsteke *et al*. 1997). Black Sigatoka reduces photosynthetic area, resulting in yield losses ranging from 30% to complete crop failure (Mobambo *et al*. 1996). Genetic resistance to black Sigatoka was discovered in some diploid accessions in south-east Asia, and successfully bred into plantain-derived tetraploid hybrids (Swennen and Vuylsteke 1993). Thus, many improved varieties combining genetic resistance to black Sigatoka with appropriate agronomic characteristics have been developed (Swennen and Vuylsteke 1993; Ortiz and Vuylsteke 1998). The improved varieties are more than two to five times more productive than the traditional plantain landraces, and provide economically and environmentally sound options for control of black Sigatoka. Introducing the new varieties into farmers' fields in several countries constitutes the next logical step since resistant cultivars are generally considered as the most appropriate components of integrated disease management that are within grasp of African farmers (Vuylsteke *et al*. 1994). The deployment of improved cultivars is a most powerful and cost-efficient means of enhancing crop productivity and farmers' incomes (Kueneman 2002).

Plant breeding programs aim to develop and deploy improved varieties that consistently display distinct phenotypic superiority in cultivation or utilization when compared to existing varieties across their cropping range in farmers' fields. Typically, superior genotypes are identified and selected in experimental fields that only marginally represent the range of target environments, but the breeders' reward depends on the suitability of such superior varieties to the biophysical and socio-economical circumstances of the farmers. Genotype × environment interactions may cause discrepancies between expected and observed performance of bananas and plantains both spatially and temporally as has been observed in Nigeria (Baiyeri 1998). Causes of spatial variation include differences in climate (rainfall pattern and temperature), soil quality (biophysical characteristics), and cultural practices. The same factors can change over time and explain temporal variations. Both types of variations were observed in Nigeria, warranting that, before introducing new varieties to the farmers, their performance at the small-holder-managed environment be established.

One means of achieving this is through on-farm farmer-participatory variety selection (PVS) trials, whereby breeders and farmers jointly conduct and evaluate trials in order to identify those varieties most suited the needs and circumstances of the farmers, which are often location-specific. Thus, PVS allows farmers to cast their varietal choices without exposing the household to any risk (Sperling *et al*. 2001). Thereafter, deploying the improved cultivars on a large scale in matching regions constitutes one powerful and cost-efficient means of enhancing crop productivity and farmers' incomes (Kueneman 2002).

Farmer participatory on-farm trials constitute a crucial mechanism for the transfer of newly bred varieties from researchers to farmers, and have become a key component of agricultural research and development In this study, we examine the interrelationships between genotypes and environments, both physical and human, in determining the agronomic performance and grower's choice of 10 improved

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Table 1 Geographical coordinates and soil characteristics of on-farm sites used for evaluation of improved varieties of banana and plantain in southern Nigeria.

Location (State)	Alt (masl)	Lat (N)	Long (E)	*RC	Sand (%)	Silt (%)	Clay (%)	pH (H_2O)	OC (%)	N (%)	P (ppm)	Ca (cmol/kg)	Mg (cmol/kg)	K (cmol/kg)
Etiti Ulo (Abia)	135	5.32	7.38	SE	86	4	10	4.6	1.10	0.08	16.20	3.08	0.45	0.10
Ubakala (Abia)	152	5.29	7.26	SE	.	.	.	4.5	.	0.12	10.76	.	.	0.23
Ikot Ide (Akwa Ibom)	46	5.06	7.41	SE	82	6	12	4.7	0.95	0.06	86.20	0.91	0.21	0.33
Ikwa (Akwa Ibom)	25	4.36	7.4	SE	78	6	16	4.9	1.40	0.10	74.90	1.25	0.43	0.25
Elebele (Balyelsa)	20	5.24	2.2	SS	.	.	.	4.1	.	0.12	10.76	0.23	.	.
Imiringi (Bayelsa)	27	4.52	6.22	SS	26	54	20	5.0	1.66	0.17	3.10	2.67	0.81	0.23
Akpabuyo (C/River)	63	4.56	8.24	SE	72	6	22	4.9	2.06	0.16	164.10	1.26	0.32	0.27
Ehom (C/River)	75	5.27	8.08	SE	62	12	26	4.7	2.18	0.25	18.00	1.61	0.67	0.29
Agbarha (Delta)	19	5.33	5.04	SS	82	6	12	4.6	1.00	0.11	76.70	1.86	0.23	0.17
Patani (Delta)	19	5.12	6.11	SS	50	36	14	4.9	1.05	0.09	80.70	4.07	1.06	0.64
Irrua (Edo)	113	6.44	6.14	SS	74	3	23	5.3	1.92	0.17	25.50	2.71	0.45	0.13
Ivue (Edo)	407	6.44	6.15	SS	80	7	13	5.6	1.87	0.16	57.80	3.62	1.48	0.14
Iworo (Ogun)	101	6.51	3.57	SW	78	9	13	5.2	0.98	0.12	5.40	3.15	1.32	0.24
Simawa (Ogun)	78	6.47	3.3	SW	80	7	13	5.2	1.27	0.16	17.40	4.23	1.22	0.17
Ondo (Ondo)	256	7.07	4.48	SW	76	11	13	5.4	0.77	0.08	3.90	1.31	0.27	0.21
Akure (Ondo)	355	7.17	5.17	SW	70	15	15	5.2	1.32	0.15	31.00	5.57	0.85	0.18
Fiditi (Oyo)	299	7.42	3.53	SW	68	15	17	4.8	2.05	0.24	30.20	9.46	1.39	0.17
Ilora (Oyo)	307	7.46	3.53	SW	64	20	16	5.1	0.96	0.10	4.50	2.11	0.42	0.15
Okwale (Rivers)	35	5.31	2.57	SS	72	4	24	5.2	1.27	0.11	198.80	1.19	0.43	0.25
Omoku (Rivers)	21	5.17	6.38	SS	48	24	28	4.1	1.17	0.12	8.10	1.59	0.19	0.14

*RC: Regional classification of experimental sites: SS: south-south; SE: southeast; SW: southwest

banana and plantain varieties targeted for release to growers across the Nigerian Plantain Belt.

MATERIALS AND METHODS

The choice of varieties for this on-farm validation study was dictated by their past performance, based on extensive testing in researcher-managed multilocational evaluation trials in Nigeria (BITA-3, PITA-14, PITA-17, FHIA-21, and FHIA-23) or substantial field evaluation elsewhere (FHIA-17, FHIA-18, FHIA-20, FHIA-25 and CRBP-39) as documented, among others, by Baiyeri *et al*. (2000) and Orjeda (2000). Genotypes with BITA or PITA prefixes are hybrids derived from banana or plantain landraces, respectively, from the International Institute of Tropical Agriculture (IITA, Nigeria). The CRBP and FHIA prefixes designate hybrids from the Centre Africain de Recherches sur Bananiers et Plantains (CARBAP, Cameroon) and the Fundación Hondureña de Investigación Agricólà (FHIA, Honduras), respectively.

Virus-tested cultures or explants of the FHIA and CRBP hybrids were introduced, via the Nigerian Plant Quarantine Service, and subjected to mass-propagation in vitro (Vuylsteke 1998), along with the BITA and PITA hybrids as well as a local check (Agbagba), in order to generate adequate quantities of planting materials for subsequent establishment of on-farm trials.

This study was carried out between 2001 and 2003 in the framework of a project for large-scale delivery for evaluation of improved varieties of banana and plantain to the smallholder farmers across the Nigerian Plantain Belt (NPB), a region lying between 3°E and 9°E of longitude and south of 8°N latitude, with a northern boundary running approximately parallel to the coast of the Gulf of Guinea. This region encompasses the territories of 11 states, namely, Abia, Akwa-Ibom, Bayelsa, Cross River, Delta, Edo, Imo, Ogun, Ondo, Oyo, and Rivers.

Each state has an agricultural extension network coordinated by erstwhile World Bank-sponsored Agricultural Development Programmes (ADP). Other field operatives of banana and plantain extension include the National Horticulture Research Institute (NiHort) and the Plantain and Banana Development Programme (PBDP), both of which are agencies of the Federal Government of Nigeria. A joint exploratory survey involving these agencies and IITA was carried out to identify candidate farmers for the study. Thus, shortlists of five farmers for each of five farming communities per state were provided by the extension agencies and site-screened by IITA on the basis of the suitability of their farms (size and accessibility, biophysical condition) and their personal credentials (experience with plantain cultivation, leadership status in the community). One farmer per community was retained, giving a sample of 55 contact farmers for the study. Geo-referencing and soil analyses were done for each site (**Table 1**).

Land preparation for planting and subsequent field maintenance operations were carried out by the farmers. Planting was also done by the farmers with supervision from IITA and ADPs, using a spacing of 3 m between rows and 2 m within rows, with 10 plants per row. To provide adequate control of intra-field heterogeneity, multiple rows of the landrace (L) check were planted in alternation with paired rows of the hybrids (H) giving a L-H-H-L sandwich layout. Hybrid randomization was done separately for each farmer, and each farmer was considered as a replication of a randomized block design. Planting schedule was dictated by the rainfall pattern across the target zone, but efforts were made to complete this operation within one month, starting in July 2001.

While farmers were encouraged to keep records on the performance of the different varieties, systematic data collection was only carried out in two randomly selected fields per state, except for Imo state where fields had not been maintained. Data were collected on plant height (PHT) at flowering and height of the tallest sucker (HTS) at the time of harvest of the mother-plant, allowing for calculation of the crop cycling index (CCI=HTS/PHT). This index is a good indicator of time interval between consecutive harvests, a value close to unity being indicative of rapid sucker growth equating to short intervals. Yield data included bunch weight, number of fruits per bunch and fruit weight. Field response to black Sigatoka was also measured by recording the youngest leaf spotted (YLS) and the number of standing leaves (NSL) in order to derive the index of non-spotted leaves (INSL) calculated as INSL = 100(YLS-1)/NSL. The INSL represents the proportion of standing leaves without serious symptoms of black Sigatoka (Craenen 1998).

Plot means were subjected to analysis of variance using the GLM procedure of SAS version 9.1 (SAS 2003) to separate effects due to locations (L), varieties (V), and their interactions, according to the following statistical model:

$$Y_{ijk} = \mu + \alpha_i + \beta_{j(i)} + \gamma_k + (\alpha\gamma)_{ik} + \varepsilon_{ijk}$$

where Y_{ijk} is the observed performance of the k^{th} variety in the j^{th} replication (=farmer) at the i^{th} location (=state) ; μ is overall mean of the trait; α_i is the effect of the i^{th} location (i=1,2, …,11); $\beta_{j(i)}$ is the effect associated with the j^{th} replication (j=1,2) within the i^{th} location; γ_k is the effect of the k^{th} variety (k=1,2,..,11); $\alpha\gamma_{ik}$ is the location × variety interaction effect; and ε_{ijk} is the residual associated with each observation.

Genotypes were ranked for bunch weight, CCI and INSL in each state and mean rank was calculated for each genotype, providing an indication of overall agronomic performance and adaptation pattern across the region. Variety preference rankings were obtained from each participating farmer, with input from other farmers in his community, and analyzed to corroborate agronomic performance and discern patterns possibly related to cultural heritage. Ranking was performed in a stepwise manner, in which case, genotypes were ranked by farmers in each State; mean of ranking in States belonging to the same geopolitical zone was calculated. Finally, genotypes overall preference ranking was estimated as average of the specific genotypes ranking across the geopolitical zones. This region encompasses the territories of eleven States, namely, Abia, Akwa-Ibom, Bayelsa, Cross River, Delta, Edo, Imo, Ogun, Ondo, Oyo, and Rivers. These States are grouped into three of the six geopolitical zones of Nigeria, namely Southwest (Ogun, Ondo, Oyo), Southeast (Abia, Imo) and the South-south (Akwa-Ibom, Bayelsa, Cross River, Delta, Edo, Rivers), the latter being also referred to as the Niger Delta Area. The geopolitical zones are based on linguistic affinity, contiguity and cultural affiliation (Bassey *et al*. 2007). Thus the dominant ethnic groups are Yorubas in the Southwest, Igbos in Southeast, and Ijaws in the South-south.

RESULTS

Agronomic performance

Significant ($P < 0.05$) effects of locations (States), varieties, and the interaction thereof were found for plant growth, crop cycling index, index of non-spotted leaves and bunch weight (**Tables 2–5**). Thus, the plants grown at locations in eastern Nigeria tended to display shorter stature associated with faster cycling and lower susceptibility to black Sigatoka compared to plants grown in western Nigeria. With the exception of Rivers State that displayed the best bunch weight, yields recorded in eastern Nigeria were less than in western Nigeria (**Table 5**).

Differences between varieties across locations did not follow the same pattern for the various traits. For example, 'BITA 3' and 'PITA 17' were taller than all other varieties (**Table 2**) but 'PITA 26' had the fastest crop cycling index and the highest index of resistance to black leaf streak (**Tables 3, 4**). Likewise, 'FHIA 25' produced the biggest bunch but it had a relatively low cycling index. The local check "Agbagba' had the lowest index of disease resistance and the smallest bunch size (**Tables 4, 5**)

Bunch weight, crop cycling index and resistance to black leaf streak were considered most important traits for genotype performance evaluation and adaptation; thus, genotypes were ranked for each of these traits in each States. The rank-sum mean across the ten States (**Table 6**) is indicative of general performance in the *Musa* growing belt of Nigeria. Bunch weight of 'FHIA 25' ranked first in all the States, it is a cooking banana hybrid, and current knowledge level on utilization is limited. Two dessert banana hybrids 'FHIA 23' and 'FHIA 17' ranked second and third, respectively. 'PITA 14' a plantain hybrid generally ranked fourth in bunch weight, but had the best yield among the plantains. This genotype combined good bunch weight with an excellent ranking for crop cycling index and resistance to black leaf streak. 'PITA 26', a plantain hybrid, combined the fastest crop cycling with the highest disease resistance index in all the sites. Expectedly, the local check, 'Agbagba' had the poorest ranking for yield and disease resistance.

Farmers' assessment

Genotype preference ranking across sub-regional groups revealed that two plantain hybrids from IITA, 'PITA 14' and 'PITA 17' were ranked as the best genotypes by farmers in

Table 2 Plant height (cm) of banana and plantain as influenced by genotypes and location in southern Nigeria (2001-2003).

Variety	States										
	Abia	**Akwa-Ibom**	**Bayelsa**	**Cross River**	**Delta**	**Edo**	**Ogun**	**Ondo**	**Oyo**	**Rivers**	**Mean**
Agbagba	265.5	283.0	285.5	295.0	296.5	286.5	288.0	293.0	290.5	285.5	286.9
BITA3	283.5	283.5	293.5	296.5	296.0	286.0	298.5	303.5	298.5	293.5	293.3
CRBP39	268.0	268.0	274.0	283.5	284.0	274.0	279.0	284.0	283.0	274.0	277.2
FHIA17	255.0	255.0	279.0	280.5	286.5	276.5	280.0	285.0	278.0	279.0	275.5
FHIA18	237.0	236.0	268.0	279.0	283.5	273.5	285.5	290.5	277.0	273.5	272.4
FHIA20	248.3	-	271.0	278.8	295.5	285.5	295.0	-	287.0	271.0	278.6
FHIA23	273.0	284.0	297.5	302.0	295.5	285.5	284.0	289.0	288.0	297.5	289.6
FHIA25	268.0	268.0	290.0	292.0	297.0	287.0	298.5	303.5	283.0	290.0	287.7
PITA14	271.0	273.5	282.0	289.0	282.5	272.5	281.0	286.0	286.0	282.0	280.6
PITA17	287.0	297.5	282.5	290.0	291.0	281.0	297.0	302.0	302.0	282.5	291.3
PITA26	264.0	264.0	293.0	292.0	307.5	297.5	291.5	296.5	290.0	293.0	288.9
Mean	265.6	273.1	284.0	289.4	292.3	282.3	288.6	293.3	287.5	283.8	

$LSD_{(0.05)}$ comparing:
Main effect of State: 1.16
Main effect of genotypes: 1.22
State-by-genotype interaction: 2.86

Table 3 Crop cycling index (%) of banana and plantain as influenced by genotypes and location in southern Nigeria (2001-2003).

Variety	Abia	Akwa-Ibom	Bayelsa	Cross River	Delta	Edo	Ogun	Ondo	Oyo	Rivers	Mean
Agbagba	0.50	0.45	0.30	0.30	0.30	0.30	0.35	0.35	0.35	0.30	0.35
BITA3	0.30	0.30	0.30	0.25	0.20	0.20	0.20	0.25	0.20	0.20	0.24
CRBP39	0.30	0.30	0.30	0.30	0.30	0.25	0.25	0.30	0.30	0.25	0.29
FHIA17	0.30	0.30	0.30	0.30	0.30	0.25	0.20	0.30	0.30	0.25	0.28
FHIA18	0.50	0.50	0.40	0.40	0.30	0.30	0.30	0.40	0.40	0.35	0.38
FHIA20	0.40	-	0.40	0.30	0.20	0.30	0.30	-	0.30	0.35	0.33
FHIA23	0.35	0.30	0.30	0.30	0.30	0.30	0.25	0.30	0.40	0.30	0.31
FHIA25	0.35	0.35	0.40	0.35	0.30	0.45	0.25	0.30	0.30	0.30	0.32
PITA14	0.50	0.50	0.50	0.45	0.45	0.45	0.55	0.55	0.50	0.40	0.49
PITA17	0.45	0.50	0.55	0.50	0.45	0.45	0.35	0.35	0.50	0.45	0.46
PITA26	0.70	0.70	0.60	0.55	0.45	0.35	0.60	0.60	0.60	0.60	0.59
Mean	0.42	0.42	0.40	0.37	0.33	0.32	0.33	0.37	0.38	0.34	

$LSD_{(0.05)}$ comparing:
Main effect of State: 0.009
Main effect of genotypes: 0.010
State-by-genotype interaction: 0.030

Table 4 Index of non-spotted leaves (%) of banana and plantain as influenced by genotypes and location in southern Nigeria (2001-2003).

Variety	Abia	Akwa-Ibom	Bayelsa	Cross River	Delta	Edo	Ogun	Ondo	Oyo	Rivers	Mean
Agbagba	40.2	40.2	36.0	35.9	29.6	18.6	36.9	24.9	46.4	43.2	35.2
BITA3	69.0	69.0	70.3	64.0	64.4	60.4	74.3	60.4	71.4	73.1	67.6
CRBP39	65.7	65.7	65.4	58.4	57.0	51.5	69.9	60.4	67.8	68.6	63.0
FHIA17	65.2	65.2	63.3	63.1	61.4	56.8	69.0	56.4	68.2	66.5	63.5
FHIA18	84.4	89.0	80.1	70.3	56.8	51.8	82.5	63.8	70.9	81.7	71.9
FHIA20	86.2	-	75.9	56.4	53.1	47.5	85.8	-	58.7	78.1	67.4
FHIA23	71.2	71.2	69.5	57.1	59.3	53.9	77.5	58.8	71.6	72.4	66.3
FHIA25	88.8	88.8	79.6	83.3	80.4	78.3	93.2	81.5	69.5	81.3	82.5
PITA14	78.9	78.9	83.5	75.5	80.5	77.9	85.9	85.9	83.9	84.9	81.6
PITA17	70.2	70.0	70.8	70.9	70.8	67.6	74.4	60.8	76.8	73.4	70.5
PITA26	96.6	96.6	90.5	94.2	94.3	93.7	93.7	74.5	95.4	91.3	92.1
Mean	74.1	72.5	70.9	66.8	64.3	59.8	76.3	62.7	70.9	74.0	

$LSD_{(0.05)}$ comparing:
Main effect of State: 0.74
Main effect of genotypes: 0.77
State-by-genotype interaction: 2.44

Table 5 Bunch weight (kg/plant) of banana and plantain as influenced by genotypes and location in southern Nigeria (2001-2003).

Variety	Abia	Akwa-Ibom	Bayelsa	Cross River	Delta	Edo	Ogun	Ondo	Oyo	Rivers	Mean
Agbagba	3.9	3.9	4.3	4.8	5.8	4.8	5.9	5.5	5.8	6.3	5.1
BITA3	10.0	10.0	13.8	12.7	13.8	13.2	12.0	11.5	11.9	15.8	12.4
CRBP39	7.7	7.7	8.9	10.9	9.1	8.9	8.9	8.4	8.9	10.9	9.0
FHIA17	18.3	18.3	19.0	15.5	14.7	13.7	20.3	19.8	20.3	21.0	18.1
FHIA18	10.5	9.4	11.0	10.2	10.2	9.2	12.5	12.0	12.5	13.6	11.2
FHIA20	9.3	-	10.6	14.5	17.0	14.5	11.0	-	10.9	12.6	12.2
FHIA23	18.8	18.8	19.2	21.3	22.3	21.3	20.8	20.3	20.0	21.2	20.4
FHIA25	32.9	32.9	33.1	31.2	32.2	31.2	34.9	34.1	34.9	35.1	33.2
PITA14	12.0	12.0	13.1	11.9	10.9	9.9	14.0	13.5	13.2	15.1	12.5
PITA17	10.5	10.9	10.9	12.2	13.1	12.1	12.5	12.0	12.0	12.9	11.9
PITA26	11.4	11.4	11.4	10.4	10.4	9.4	13.4	12.9	12.0	13.4	11.6
Mean	13.2	13.7	14.3	14.1	14.4	13.5	15.3	15.0	14.8	16.2	

$LSD_{(0.05)}$ comparing:
Main effect of State: 0.67
Main effect of genotypes: 0.71
State-by-genotype interaction: 2.11

Table 6 Performance ranking of eleven banana and plantain varieties evaluated at 22 locations across Nigeria based on agronomic data and growers' preference.

Varieties	Agronomic performance ranking			Growers preference ranking across sub-regional groups					
	Bunch weight	Crop Cycling Index	Index of Non-Spotted Leaves	SE	Eastern NDA	Southern NDA	Northern NDA	SW	Mean
AGBAGBA	10.8 ± 0.1	5.9 ± 0.6	10.8 ± 0.1	4.3 ± 1.8	3.8 ± 0.3	8.3 ± 1.8	9.5 ± 0.0	6.8 ± 2.7	6.5 ± 0.9
BITA 3	6.1 ± 0.6	10.8 ± 0.1	6.3 ± 0.4	4.3 ± 0.3	7.0 ± 1.0	5.0 ± 0.0	4.8 ± 0.3	5.2 ± 0.8	5.2 ± 0.4
CRBP 39	9.6 ± 0.2	8.4 ± 0.4	8.5 ± 0.2	7.0 ± 0.0	3.5 ± 2.5	2.8 ± 1.8	8.5 ± 1.5	7.8 ± 0.9	6.0 ± 0.9
FHIA 17	3.2 ± 0.3	9.1 ± 0.2	8.5 ± 0.5	5.3 ± 1.8	6.3 ± 1.8	6.0 ± 3.0	4.0 ± 0.0	5.7 ± 0.9	5.5 ± 0.6
FHIA 18	7.2 ± 0.5	4.6 ± 0.2	4.9 ± 0.7	10.0 ± 0.0	6.3 ± 0.8	5.5 ± 3.5	4.3 ± 0.3	5.7 ± 0.5	5.9 ± 0.7
FHIA 20	6.9 ± 0.9	7.5 ± 0.8	7.1 ± 1.0	9.0 ± 0.0	7.5 ± 2.5	6.5 ± 2.0	7.0 ± 2.5	7.0 ± 1.2	7.2 ± 0.7
FHIA 23	2.1 ± 0.1	6.2 ± 0.6	6.8 ± 0.5	4.8 ± 1.3	4.0 ± 1.0	4.5 ± 1.5	5.0 ± 2.0	4.3 ± 2.3	4.5 ± 0.6
FHIA 25	1.0 ± 0.0	6.6 ± 0.4	3.1 ± 0.5	3.5 ± 1.0	4.0 ± 2.5	6.0 ± 1.0	5.8 ± 0.3	2.3 ± 0.7	4.1 ± 0.6
PITA 14	5.1 ± 0.4	2.6 ± 0.2	2.7 ± 0.4	2.8 ± 0.3	4.0 ± 0.0	2.8 ± 0.3	4.0 ± 1.5	4.7 ± 2.2	3.7 ± 0.5
PITA 17	6.8 ± 0.3	2.6 ± 0.3	5.3 ± 0.5	2.8 ± 0.8	3.0 ± 1.0	3.7 ± 0.5	3.0 ± 1.0	5.0 ± 1.8	3.5 ± 0.5
PITA 26	6.4 ± 0.5	1.0 ± 0.0	1.2 ± 0.2	8.0 ± 0.0	7.5 ± 1.5	10.3 ± 0.3	10.0 ± 0.5	7.5 ± 3.4	8.5 ± 0.8

Agronomic performance ranking order: 1 = Best performance; 11 = Poorest performance; Growers preference ranking order: 1 – 3 = Excellent; 4 – 6 = Very good; 7 – 9 = Good/fair; 10 – 11 = Poor. NDA: Niger Delta Area of Nigeria; SE: Southeastern Nigeria; SW: Southwestern Nigeria.

four out of the five sub-regions, that is, the contact farmers in those sub-regions rated these genotypes as excellent (**Table 6**). The preferential ranking of the genotypes was further evaluated on the basis of peoples' group (data not shown). Ranking of 'PITA 14' and 'PITA 17' was either excellent or very good by the entire peoples group. 'FHIA 25', a cooking banana was rated excellent only in Southwestern Nigeria. Grand mean ranking pattern revealed that 'PITA 14' and 'PITA 17' were the best in the evaluation areas. 'FHIA 23' and 'FHIA 25' had a grand mean ranking value less than 6; this indicates that farmers classified them as being very good. 'BITA 3' was not rated excellent anywhere. The genotype, however, had an overall ranking less than six, meaning that it was generally considered as very good. 'PITA 26' and 'FHIA 20' had the lowest acceptability rating. The local check, 'Agbagba' was on average rated good, although, it was considered excellent by only about 9.0% of the contact farmers.

Spearman rank correlation between the mean agronomic performance ranking and mean growers' preference ranking was low (r = 0.36) and non-significant, suggesting independence or non-association between the two ranking criteria.

DISCUSSION

The significant interaction between State and genotype suggests that each genotype performed differently in each State. According to Stover and Simmonds (1987) temperature and rainfall are the major determinants of the growth and development of *Musa* species; therefore, changes in these variables across sites will affect the phenotypic performance of the genotypes. This is because gene expression is environmentally induced and regulated (Kang 1998). Performance ranking, thus, suggested variable adaptation pattern of the genotypes to the evaluation sites. Generally, good adaptive capacity means somewhat superior productivity (relative to all strains being tested) of a genotype or population over several environments (Cooper and Byth 1996). Based on consistent topmost bunch yield ranking in all the sites, 'FHIA 25' and 'FHIA 23' were considered most adapted, however, agronomic performance ranking differed from farmers' preference ranking. A non-significant relationship between agronomic performance ranking and growers' preference ranking suggests that the latter might be influenced by socio-cultural and culinary values, which ultimately dictates the choice of genotypes for adoption.

Thus, 'PITA 14' and 'PITA 17' were the most acceptable genotypes in the plantain growing belt of Nigeria. This might probably be because of their relatively high yield, fast cycling and good post harvest qualities. Besides, the bunch features of 'PITA 14' have some similarities with those of 'Obino L'Ewai' (a landrace French plantain, traditional grown in the Niger Delta region where 'PITA 14' was rated excellent). In an earlier study by Lemchi *et al*. (2005), it was found that relative to the landrace genotype 'Agbagba', 'PITA 14' demonstrated good performance in terms of resistance to black sigatoka disease, compatibility with the local plantain cropping system, high yield and cash income.

Besides agronomic performance, it is suspected that the attitude of the farmers towards the new varieties would depend on their cultural heritage, including the prevalence of banana and plantain in their agricultural practice and diets. Thus, attempts were made to determine whether observed differences in preference rankings could be traced to cultural heritage. For example, it seems that in Southwestern Nigeria, people are fun of foods with low sugar content, which may explain their preference rating for 'FHIA 25', a high-yielding, low-sugar cooking banana hybrid. Elsewhere, it seems that farmers' preference for 'PITA 14', which only ranked fourth in terms of bunch yield (after a cooking banana and two dessert bananas hybrids), could be attributed to its utilization potential as a plantain-derived hybrid, besides disease resistance and, more importantly, fast cycling rate. Unpublished data of the authors showed that under Nigerian growing conditions two harvests of 'PITA 14' are made before one harvest of 'FHIA 25' (the highest yielding genotype). Our results are in agreement with those of Sharma and Duveiller (2006) who also showed that 'farmers' preference criteria were overriding determinants of adoption of wheat genotypes, above grain yield.

In conclusion, participatory variety evaluation provided a means for identification of those banana and plantain hybrids that are most likely to undergo adoption by farming communities in Nigeria. Thus, the most preferred varieties were 'PITA 14', 'PITA 17', 'BITA 3', 'FHIA 17' and 'FHIA 23', which are expected to be formally released for cultivation in Nigeria. This study also allowed us to obtain information on the preference criteria of farmers in Nigeria, which will prove useful for targeting new varieties meeting particular criteria to those areas were such criteria are most valued.

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