Agronomic Performance of Two Tetraploid Hybrid Plantains in Ghana

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Summary

Field performance of two IITA plantain hybrids ('PITA-1', 'PITA-4') were assessed at two locations in Ghana alongside two local landraces (False Horn 'Brodeyuo', Intermediate French 'Oniaba') and a hybrid cultivar 'Apem Hemaa' ('FHIA-21'). The objective of the study was to identify high yielding and disease resistant hybrids for growers in Ghana. The hybrids were evaluated for their agronomic performance and yield, tolerance to Black Sigatoka disease, number of functional leaves at flowering and at harvest, crop cycle, plant height and pseudostem girth. The results showed that the hybrids were tolerant/resistant to the Black Sigatoka *(Mycosphaerella fijiensis*) disease with high number of functional leaves at flowering and at harvest. This characteristic of the hybrids was an important feature that could fit well into the smallholder cropping system. The crop cycles were comparable to that of 'False Horn' plantains. The yield performance of the hybrids was better compared to the landraces. The number of hands per bunch produced by the hybrids was also higher than those of the landraces except the intermediate French plantain ('Oniaba'). The finger lengths of the IITA hybrids were however shorter compared to the landraces and this could hinder their acceptance by consumers.

Key words

Musa hybrids, landraces, agronomy, yield, Black Sigatoka

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Introduction

Plantain and banana *(Musa spp.)* are important staple food crops in West Africa, providing an important source of carbohydrates, minerals, vitamins and revenue to both rural and urban communities. Plantains and bananas belong to the traditional sectors of the rural economy, where they fit well into the cropping system. They are used mainly to shade cocoa and as an essential component of the diet. They are among the major food crops in sub-Saharan African (SSA) where they serve as one of the major staples to about 70 million people in the region (Tshiunza et al., 2001).

Plantain cultivation is of great socioeconomic importance in Ghana from the point of view of food security and job creation. Plantain and banana are also very important sources of rural income (Ortiz and Vuylsteke, 1996). More than 90 % of the cultivated area in Ghana belongs to smallholder farming system. In the agricultural sector, plantain is ranked fourth in Ghana (FAO, 2005) and contributes about 13.1 % to the Agricultural Gross Domestic Product (AGDP). Its per capita consumption of 101.8 kg (FAO, 2005) is higher than all other starchy staples. A total annual production is about 3.7 million tons, of which more than 95 % is sold on the domestic market (SRID-MOFA, 2006).

Plantain production is concentrated in the three agro-ecological zones namely Rain forest, Moist semi-deciduous forest and Forest-savanna transition. The rainfall pattern is bi-modal from March to July as the major rainy season and August to November as the minor season. The rainfall amounts ranging from 1300 mm to 2200 mm per year.

Despite the high value of plantain and banana, growing pest and disease pressures have affected production, the most notable being the fungal disease Black Sigatoka *(Mycosphaerella fijiensis*) (Stover and Simmonds, 1987; Ortiz and Vuylsteke, 1996; Swennen, 1990). Yield losses due to the disease are highly significant ranging from 20 to 50 %. Under very severe conditions yield losses may be as high as 80 %. Also banana streak viral disease cause by banana Badna virus has been observed to attack plantain and banana. Unfortunately all the landraces in Ghana are susceptible to the Black Sigatoka disease except a cooking banana. As a result of the increasing pest and disease pressures genetic improvement of the species was initiated at various international research centers. High-yielding, pest and disease resistant tetraploid hybrids were obtained from inter-specific crosses between triploid and diploid accessions (Rowe and Rosales 1993; Robinson, 1996; Vuylsteke et al., 1997). In view of this, new hybrids were introduced to supplement the landraces.

The Black Sigatoka disease can be controlled with appropriate fungicides but the cost is prohibitive. Furthermore, the fungicides are not environmentally friendly and thus threaten the fragile ecosystem. To address these problems, as a long term solution, two new hybrids ('PITA-1' and 'PITA-4'), resistant/tolerant to these pests and diseases have been introduced from International Institute for Tropical Agriculture (IITA) and Honduran Agricultural Foundation (FHIA) for evaluation of their agronomic performance. The reason for introduction was the fact that all the local landraces are susceptible to the Black sigatoka disease. Furthermore, plantain and banana are very important to the national economy and there is the need to sustain the contribution of the industry towards achieving national food security. This study was conducted to evaluate two of the hybrid plantains from IITA for their yield potential and adaptability under different growing conditions.

Materials and methods

All the planting materials used for the trial were raised from tissue culture. *In-vitro* plantlets were raised from the tissue culture laboratory of the Crops Research Institute, Kumasi, Ghana. The hybrids used for the trial were 'PITA-4' and 'PITA-1'. The PITA series are hybrids from the International Institute of Tropical Agriculture, Nigeria. The parental source of 'PITA-1' is a cross between 'Obinol Ewai' and 'Calcutta 4' whereas 'PITA-4' is a cross between 'Bobby Tannap' and 'Calcutta 4'. The local cultivars used were False Horn 'Brodeyuo' and Intermediate French 'Oniaba'. The local cultivars are triploids (AAB) and one released hybrid cultivar 'Apem Hemaa' (AAAB), whose parental source is a cross between 'AVP-67' and 'SH-3142'.

The trials were established in 2001 at two locations: Fumesua (1º 37'W, 5º 43'N,) in the Ashanti region and Assin-Fosu (1º25'W, 5º 40' N) in the Central region, all in the semi-deciduous forest region of Ghana. The locations were selected on the basis of the variation in the soil types and the severity of Black Sigatoka incidence. Fumesua is characterized by sandy-loam (Arenosols) soils. The Assin-Fosu soils are red-brown and clay-rich (Nitrosols).

The design was randomized complete block (RCBD) with three replications. Planting was done in holes measuring 60 cm X 60 cm and spaced at 3 m X 2 m between and within the rows, respectively giving a plant population of 1667 plants/ha. Each plot however had 42 plants. No soil amendment was applied during the trial. Weeding was done when necessary and was alternated with glyphosate application.

Data was collected on the inner rows of 20 plants. Data was collected on: plant height at flowering and at harvest, pseudostem girth at one meter above ground, number of leaves at flowering and at harvest, number of months to flowering and to harvest, bunch weight, number of hands per bunch, number of fingers and finger length. The Black Sigatoka disease evaluation was done using the Stover scale of 1 (less severe) to 10 (very severe) (Stover and Simmonds, 1986) as observed on the 3rd leaf. Data was analyzed using analysis of variance (ANOVA).

Results and discussion

There was a significant Genotype – Environment (G x E) interactions for most of the agronomic parameters (Table 3). There was a significant difference (5 %) in the yield between the hybrids and the landraces. The yields of the IITA hy-

Table 1. Means of the number of functional leaves at flowering and harvest of *Musa* species at two locations

	Fumesua		A. Fosu	
	At flowering	At harvest	At flowering	At harvest
PITA-4	12	7	11	7
PITA-1	12	7	11	7
Brodeyuo	12	4	12	4
Oniaba	9	4	10	4
Apem hemaa	11	6	10	6
LSD (5%)	1.2	1.3	0.9	1.1

brids were higher at the Fumesua location than at Assin Foso (Tables 2 and 3). There was however a significant difference in yield across locations for 'PITA-1', 'PITA-4' and 'Brodeyuo'). The yield values for the hybrids ranged from 24.5 tons/ha to 35.0 tons/ha; whereas the landraces ranged from18.8 tons/ha to 23.7 tons/ha. Similar results were observed by Vuylsteke et al. (1996) for the False Horns and the French plantains. All yield components (bunch weight, number of hands and number of fruits) were significantly lower in the landraces compared to the hybrids. This might have contributed to the lower bunch weights of the landraces. Similar results were observed by Dzomeku et al. (2004) and de Silva (1997). Vuylsteke et al. (1996) reported that less fruits per plant may require less time to fill with dry matter, resulting in earlier fruit maturity. This could be corroborated by the results obtained for 'Oniaba' (an intermediate French plantain) (Table 3). There was a significant difference in the crop cycle across locations for 'Apem Hemaa' (Table 3). The number of hands/bunch was also not significant among the hybrids (Table 3). The hybrids also compared favourably in terms of numbers of fingers across locations.

All the evaluated hybrids showed tolerance to the Black Sigatoka fungus *(Mycosphaerella fijiensis*) (Table 2). Severe infection measuring 6 on the Stover scale were observed on the third leaf of the local landraces at periods of fruit development with 'Oniaba' showing the severest incidence. There was no significant difference between the numbers of leaves of the hybrids at flowering. However there was a significant difference between the hybrids and the landraces. All the hybrids reached flowering with more than eleven functional lesion-free leaves (Table 1). This situation allowed the more tolerant clones ('PITA-1', 'PITA-4' and 'Apem Hemaa') to complete their vegetative cycle with more than eight functional leaves (Table 1). The total number of functional leaves that a plant has at flowering is a good indicator of its tolerance or susceptibility to the disease, with correlation existing between number of leaves and bunch weight (Alvarez, 1997). The hybrids presented very vigorous plants with stronger and more erect pseudostems which allowed them to support heavier bunches and to resist the effect of the wind. There was significant difference in the plant height across location for all the accessions (Table 3).

The landraces were all susceptible to the Sigatoka disease. Apem Hemaa ('FHIA-21') was superior to the other hybrids as well as to the landraces both in agronomic character and yield. It was also Sigatoka-free compared to the False Horns. PITA-1 produced very short plants at Assin Foso (175 cm) (Table 2). PITA-4 and PITA-1 produced the smallest pseudostems (43 cm) at the two locations (Tables 2). All the hybrids retained sufficient functional leaves (7) at harvest at the two locations (Tables 1) compared to the local cultivars. There was no difference in the crop cycle between the hybrids and the locals at the two locations (Table 3). There was

Table 2. Means for yield and selected agronomic parameters of *Musa* hybrids and landraces

Genotype	Bunch weight (kg)	Number of hands/bunch	Number of fruits/bunch	Plant height (cm)	Leaves at harvest	Plant girth (cm)	Months to flowering	Months to harvest
PITA-1	14.7c	7a	55c	210.4c	7b	46.9	11.9bc	13.6c
PITA-4	14.7c	7a	54c	236.2d	7b	42.0	12.1ab	15.3b
Apem Hemaa	18.2b	7a	70a	248.7e	6c	53.1	11.8c	13.2d
Brodeyuo	14.2c	5c	43d	277.1f	4d	48.3	12.0abc	13.5c
Oniaba	11.3e	6b	55c	251.5h	4d	46.9	9.4e	10.8e
Cv (%)	15.9	4.4	9.0	2.5	2.7	5.8	7.5	5.7
LSD(5%)	0.9	0.1	0.9	1.2	0.1	0.0	0.3	0.3

Figures with the same letters in the same column are not significantly different across locations

Table 3. F-tests of the analysis of variance for yield and selected agronomic parameters of 'PITA-4', 'PITA-1' (hybrids) and 'Brodeyuo' landrace

Source of variation	Bunch weight (kg)	Number of hands/bunch	Number of fruits/bunch	Plant height (cm)	Leaves at harvest	Plant girth (cm)	Months to flowering	Months to harvest
Location (L)	*	*	*	*	*	*	*	*
Varieties (V)	*	*	ns	*	*	*	*	*
L x V	*	*	ns	*	ns	*	*	*
Cv (%)	15.9	0.0	9.0	2.5	2.7	5.8	7.5	5.7

* – significantly different; ns – non-significantly different

a significant difference in the bunch weight among varieties tested and the landraces (15 kg). The fingers of 'PITA-1' and 'PITA-4' were however very short compared to the landraces and Apem Hemaa. The shape of the fingers of the hybrid plantains (the PITAs) may disqualify them as good materials for release; especially when the consuming public is used to finger lengths ranging from 21-34 cm.

Conclusion

The hybrids were resistant to the leaf spot disease *(Mycosphaerella fijiensis)*. The bunch weights were comparable to the local landraces. However, the fruit of 'PITA-1' and 'PITA-4' were very short unlike normal French and False Horn plantains. The finger sizes of the IITA hybrid plantains may not distinguish them as good consumers material; especially when the consuming public is used to plantain finger lengths ranging from 21- 34 cm. The breeding work should improve the finger length of the hybrids. A consumer acceptability study on the hybrids is recommended.

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