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Full Length Research Paper

Agroeconomic evaluation of black Sigatoka resistant hybrid plantains under smallholder management systems

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Plantain production in Sub-Saharan Africa has been seriously threatened by black Sigatoka disease since the early 1980s. The International Institute of Tropical Agriculture has succeeded in developing hybrids that are resistant to the disease, and out-yields the best landrace by about 100%. Before introducing these hybrids to the farmers, their performance at the smallholder environment has to be established. This study was carried out to assess the performance of the hybrids under farmer-managed systems, using PITA14 (a hybrid) and Agbagba (best landrace) . Thirty-six farmers from nine villages were involved. Five suckers each of the varieties were planted in farmers' fields. Data were collected over a period of 22 months on the agronomy, economics, post harvest and marketing. Results show that PITA14 had reduced cropping cycle compared to the landrace. Average black Sigatoka resistant index was 96% for PITA14 against Agbagba's 48%. The mean bunch weight was 13.3kg for PITA14 and 7.0Kg for Agbagba. Eighty-three percent of the farmers harvested 124 bunches from 81 mats of PITA14, while 55% harvested 62 bunches from 52 mats of Agbagba. Each farmer obtained an equivalent of $8.62 from PITA14 and $4.33 from Agbagba. The post harvest technology attributes were ranked higher for the hybrid. The combination of disease resistance and increased yield by the hybrid is suggestive of its high adoption potential.

Key words: Black Sigatoka, PITA14, on-farm trial.

INTRODUCTION

Plantain is an important component of the African farming system, particularly in the region of Sub-Saharan Africa where more than 70 million people depend on it for their livelihood (Ortiz and Vuylsteke, 1994; Vuylsteke, 2001). With increasing urbanisation, bananas and plantains are fast becoming more and more important as cash crop, in some cases providing the sole source of income to rural population, thereby playing an important role in poverty alleviation (Frison and Sharrock, 1999). In the Cameroons, it is described as a positive-elasticity income asset (Temple et al., 1996) while in Nigeria alone, about 49% of farming households produce plantain as a main crop (Nweke, 1996) . Unfortunately, the crop has been under serious threat since the early 1980s resulting from Black Sigatoka (BS) attack (Vuylsteke, 2001; Dumpe and Ortiz, 1996) . BS is a fungal leaf spot disease that has the potential of reducing yield by more than 50%, and in more severe cases, can wipe out an entire field. In 1987, African governments encouraged the International Institute of Tropical Agriculture (IITA) to launch an urgent research program to help combat the disease. The institute quickly responded, and confronted the menace from two angles. One was an interim measure that aimed at ameliorating the effect of the disease on the welfare of the people through the introduction of resistant cooking banana cultivars into Southeastern Nigeria (one of the zones where plantain/banana production in the country is

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Table 1. Distribution of trial villages and farmers across the blocks in the benchmark area.

Village	Number of farmers	Block	State
Abaomege	4	Abakiliki	Ebonyi
Amauzam	4	Abakiliki	Enugu
Isuawa	4	Abakiliki	Enugu
Ikpe	4	Umuahia	Akwa-Ibom
Okwe	4	Umuahia	Imo
Umuasua	4	Umuahia	Abia
Obeama	4	Port Harcourt	Rivers
Okposi	4	Port Harcourt	Rivers
Rumuekpe	4	Port Harcourt	Rivers

Number of blocks = 3, number of states = 6, number of villages = 9, and number of farmer = 36.
Source: On-farm study, 1998 – 2000.

concentrated) in the late 1980s. The other approach was a long-term strategy that involved breeding for BS resistant host plantain and banana.

Through the breeding research program, IITA has successfully developed several plantain and banana hybrids, which are resistant to BS (Ortiz and Vuylsteke, 1998; Ortiz et al., 1998) and out-yield the best landraces by about 100% at the breeding stations. These new hybrids have successfully undergone several tests including early evaluation trial, preliminary yield trial, multilocational trial, and advanced yield trial, preparatory for introduction to the farmers. However, before introducing these hybrids to the farmers, their performance at the smallholder-managed environment has to be established. This is because technologies are only successful when they are accepted and used by the clients for whom they are designed (Attah-Krah, 1995). And, no matter how well a technology may work on research stations and/or under research control, if farmers do not use them, their development will be in vain (Attah-Krah, 1995). Thus, farmer-participatory on-farm trial constitutes a crucial link between technology generation and transfer, and has become a key component of agricultural research and development. Apart from being a vital process in the dissemination of innovation from research stations to farmers, it results in gaining farmers' confidence and trust in the research and the researcher (Manu-Adeuning and Boa-Amponsen, 1999).

This study therefore carried out the last test - on-farm trial - through which new agricultural innovations have to pass before any decision is taken concerning their release to farmers. The trial assessed the performance of PITA14 (7152- 2), one of the most promising new hybrids against that of Agbagba, the most preferred and the most common plantain landrace in Southeast Nigeria. The main objectives of this study were to conduct agronomic and economic evaluation of the BS resistant hybrid plantains under smallholder management systems so as to assess its adoption potential by farmers. The post harvest and market potentials of the new plantain hybrid were also assessed under farmer-managed conditions. The purpose of the paper is to provide a feedback to breeders and agronomists and direct future biological work on plantain and banana in the study area.

METHODOLOGY

Choice of sites and farmers

The on-farm trial was conducted in the IITA's benchmark area located within the degraded forest zone of Southeast Nigeria. This benchmark was chosen because of its location in the major plantain producing area of Nigeria and its representativeness of the major features of the southeast agro-ecological zone. The degraded forest benchmark area in Southeast Nigeria comprises three blocks namely Port Harcourt, (long. 6.6667^{O}E to 7.5000^{O}E, lat. 4.8333^{O}N to 5.3333^{O}N) Umuahia (long. 7.0000^{O}E to 7.8333^{O}E, lat. 5.3333^{O}N to 5.8333^{O}N) and Abakiliki (long. 7.3333^{O}E to 8.1667^{O}E, lat. 5.8333^{O}N to 6.3333^{O}N). Three villages from each block were selected within the benchmark area. This gave nine villages that cut across six administrative states in Nigeria. From each village, four farmers were selected giving a total of 36 farmers. The farmers were selected based on previous knowledge on plantain farming, willingness to participate in the trial, good past record on field trials/demonstrations and availability of compound fields/plots. The distribution of villages and farmers across the blocks is presented in Table 1.

Field layout and establishment

There was no formal field layout or design. The planting was done in the normal way the farmers plant their plantain crop. Plantain production in Southeast Nigeria is compound-based with occasional few stands in fields outside the compound. In the compound, plantains are not grown in laid out fields or gardens, rather plantain mats which are perennials are located at various point in the compound (Nweke et al., 1988; Ajayi. and Baiyeri, 1999), most often, in mixture with compound arable crops. The on-farm trials were established in compound and nearby fields so as to provide opportunity for regular manuring and care. Five tissue-culture plantlets each of PITA14 and Agbagba were planted in each farmer's field. Both cultivars were planted in the same plots of field. To ensure that farmers treat the plants equally, they were informed

that all the suckers were hybrids; and, they were not informed of any varietal difference. This was done in order to avoid managerial bias towards the IITA hybrid (PITA14), or among the cultivars. Thus, the cultivars were subjected to the same environment, management and care to guarantee uniformity of input supply and use. The cultivars were however labelled to aid identification by researcher and field staff. Planting was done between July and August 1998, while field monitoring and data collection was carried out monthly up to May 2000.

Data collection

Data collection sheet was designed and used in collecting relevant agronomic and yield data. Data were collected on vegetative, reproductive (at flowering and harvest) and management parameters. The vegetative information collected were plant height, plant girth, number of leaves, height of ratoon, and total number of leaves. Reproductive information collected at flowering includes flowering date, plant height, total number of leaves, youngest leaf spotted (with BS), number of standing leaves and height of tallest sucker. At harvest, the data collected include the harvest date, height of ratoon, bunch weight (kg), number of hands, number of fingers, fruit length (cm), fruit circumference (cm), fruit weight (g), and presence/absence of banana streak virus (BSV). Information on management practices collected includes those of weeding, manuring, mulching and any other observed by the farmers. Data on vegetative performance, reproductive performance, and management practices were collected on monthly basis. In addition, structured questionnaire was designed for the collection of post harvest information on farm resources, prices and farmers' overall performance assessment of the varieties.

Data analysis

Analyses of data collected were based on simple descriptive statistics such as percentages, frequencies and means, and the ordinary least square regression method. Resistance to Black Sigatoka by the cultivars was assessed through the resistance index approach (Wilson et al., 1999) as follows:

Where,

$$BSI = \frac{YLSF}{NSLF} - \frac{1}{X}100.....(I)$$

BSI = Black Sigatoka resistance index (%)
YLSF = youngest leaf spotted at flowering
NSLF = number of standing leaves at flowering

The responses of agronomic and yield parameters to management and Black Sigatoka indices were assessed by the ordinary least square (OLS) method using the generalised linear model as follows:

$Y = f(bX)$……(*II*)

Where,

Y = agronomic (yield) parameter
b = coefficient; and
X = management index; black Sigatoka resistance index

Management index was obtained by dividing the sum of the number of times of manure application, weeding and mulching by the sum of expected number of applications, and expressed in percentage as follows:

Where,

$$MI = \frac{(Mno + Wo + Mlo)}{(Mne + We + Mle)} x100.....(III)$$

MI = Management Index (%)
Mno = Observed number of manure application,
Wo = Observed number of weeding,
Mlo = Observed number of mulching,
Mne = Expected number of manure application,
We = Expected number of weeding,
Mle = Expected number of mulching.

The expected number of manuring, weeding and mulching was derived from the number of months from planting to harvesting. The farmers were advised that the plants be manured, weeded and mulched at least once every month.

In assessing the overall post harvest performance of the varieties, the farmers were asked to assess the various important agronomic, yield and consumption qualities of the varieties by scores. The attributes assessed include growth habit, time of maturity, yield, resistance to drought, lodging, pest and disease, fruit size, ripening period, height, quality of the processed product, cooking quality, taste, flavour, pulp colour, texture and cooking time. Attribute with a score of 1 denotes 'best' in assessment.

RESULTS AND DISCUSSION

Susceptibility to black Sigatoka

All known land races of plantain and banana are susceptible to the BS disease (Banful, 1999; Vuylsteke, 2001). The susceptibility or otherwise of the plants to BS was assesses through the BS resistance index (BSI) obtained from the 'youngest leaf spotted' technique. The level of resistance increases with increase in the value of BSI while the level of susceptibility increases with decreasing value of BSI (Wilson et al., 1999). The average BS resistance index ranged from 70 to 100% with a mean of 95.76% for PITA14, and 30.8 to 100% with a mean of 48.56% for Agbagba (Table 2) . The hybrid exhibited very high level of BS resistance as against the very low level by the landrace. Earlier trials carried out on station and on-farm (researcher managed) has all showed very high level of BS resistant by the hybrid (Wilson et al., 1999; Ortiz and Vuylsteke, 1998). The high level of BS resistance by the hybrid is maintained across all the locations (Table 3) in spite the relatively low level of management index (46%). The management index for Agbagba was 42% while the overall was 44%. The slight difference in the management index between the two varieties could not have accounted for the high differential BS resistance index. A regression model fitted to evaluate the level of impact of management index on black Sigatoka resistance index yielded non-significant

Table 2. On-farm agronomic and yield performance of PITA14 and Agbagba in Southeast Nigeria.

Performance Index	PITA14		Agbagba	
	Range	Mean	Range	Mean
No. of days from planting to flowering	179 – 661	376.40	186-638	420.44
No. of days from flowering to fruit maturity/fruit filling	75 – 465	129.20	66-321	98.35
No. of days from planting to harvest	318 – 649	468.73	319-623	481.30
Black Sigatoka resistance index (BSI)	70.00 – 100	95.76	30.8-100	48.56
Bunch weight (Kg)	4.2 – 19.2	13.34	3.5-12	7.03
Number of hands	4 – 10	6.90	4-8	5.73
Number of fingers	46 – 124	91.26	11-33	22.00
Fruit length (cm)	12–28	21.25	16-35	26.61
Fruit circumference (cm)	10–16	13.23	10-19	15.04
Fruit weight (g)	80 – 400	213.03	100-500	281.82

Source: on-farm data, August 1998 – May 2000

Table 3. On-farm agronomic and yield performance of PITA14 and Agbagba across the degraded forest benchmark areas of Southeast Nigeria.

Benchmark Location	Variety	Agronomic and yield performance								
		DFPTF	BSI	DFFTF	DPTH	BUNWT	NOHND	NOFING	FINCIRC	FINWT
Abaomege	PITA14	437.45	100	121.88	535.75	10.46	6.78	78.13	12.88	162.50
	Agbagba	449.82	50.49	85.38	502.25	7.71	5.63	20.63	16.38	300.00
Amauzam	PITA14	459.83	96.92	127.00	511.33	13.13	7.00	98.33	13.00	150.00
	Agbagba	614.75	75.05	-	-	-	-	-	-	-
Isuawa	PITA14	426.58	100	119.75	505.25	12.77	6.50	80.33	12.83	191.67
	Agbagba	393.75	52.50	91.67	449.00	8.40	6.00	25.50	16.00	350.00
Ikpe	PITA14	319.40	95.45	119.83	428.83	14.57	7.25	102.50	13.83	237.58
	Agbagba	367.18	43.99	106.44	470.78	7.38	6.11	25.22	14.56	333.33
Okwe	PITA14	444.86	96.43	125.17	560.33	15.17	7.17	93.33	13.83	175.00
	Agbagba	-	-	-	-	-	-	-	-	-
Umuasua	PITA14	319.50	97.69	120.83	456.00	15.72	6.17	87.67	13.17	216.67
	Agbagba	447.00	49.86	94.80	506.40	8.20	5.20	20.80	16.00	340.00
Obeama	PITA14	341.00	88.74	127.68	444.67	14.27	7.33	100.89	13.89	233.33
	Agbagba	380.00	49.74	138.80	465.40	6.24	5.40	20.00	15.00	200.00
Okposi	PITA14	389.36	95.45	125.57	446.43	11.29	6.71	72.43	12.29	254.29
	Agbagba	408.67	45.60	87.71	502.29	5.88	5.00	18.50	13.83	175.00
Rumuekpe	PITA14	309.69	92.84	152.13	432.63	12.93	6.88	95.56	13.00	223.13
	Agbagba	394.45	41.27	91.78	462.56	6.32	6.33	23.33	14.44	283.33

DFPTF = Days from planting to flowering, BSI = Black Sigatoka resistance index (%), DFFTF = Days from flowering to fruit filling, DPTH = Days from planting to harvest, BUNWT = Bunch weight (kg), NOHND = Number of hands, NOFING =Number of fingers, FINCIRC = Finger circumference (cm), FINWT = Finger weight (g).
Source: on-farm data, August 1998 – May 2000.

effect (Table 4). The slight difference in management index between the varieties might have resulted from slight shift in care towards PITA14 by farmers when they might have seen its superior yield over Agbagba at the later stage of the trial (when farmers started getting harvests).

Agronomic and yield performance

The agronomic and yield indices considered included the number of days from planting to flowering, bunch weight, number of hands, number of fingers, and finger weight, among others. The average number of days from planting to flowering ranged from 179 to 661 with a mean of 376.4 for PITA14 and 186 to 638 with a mean of 420.44 for the landrace (Table 2). This gave an average of 10.5% reduction in flowering period. Apart from breeding for disease resistance, IITA aimed at shortening the cropping cycle through reduced flowering period, thereby increasing the food and income stream for the farmers. The reduced flowering period is in consensus with earlier results by Ortiz and Vuylsteke (1998), and the ratoons

Table 4. Parameter estimates of the effect of management index (MI) on some performance indices of plantain (based on OLS).

Performance index	Parameter estimates		R^2	F-Value	No. of observations
	Intercept	MI			
DFPTF	5.8913	-0.0002	0.0001	0.013	124
	(78.056)***	(-0.114)			
BSI	69.7299	0.1552	0.0085	1.024	120
	(9.446)***	(1.012)			
BunchWt	1.5357	0.2065	0.0206	2.377	114
	(3.037)***	(1.542)			
DFPTH	475.5987	-0.0800	0.0002	0.024	116
	(19.778)***	(-0.156)			
Nofings	52.2838	0.2919	0.0129	1.479	114
	(4.611)***	(1.216)			
Nohands	6.1952	0.0063	0.0065	0.741	114
	(17.996)***	(0.861)			

DFPTF = Number of days from planting to flowering, BSI = Black Sigatoka resistance index (%), BunchWt = Bunch weight (Kg), DFPTH = Number of days from planting to harvest, Nofings = Number of fingers, Nohands = Number of hands. ***Significant at P <= 0.01.
Source: on-farm data, August 1998 – May 2000

took about half that number of days (Vuylsteke, 1998). The result was consistent in all the locations (Table 3). Management index gave expected direction of relationship, though insignificant (Table 4). Improved management induces early flowering and fruiting, and this accounts for the usual superior performance of plantains in compounds compared to distant fields (Nweke et al., 1988).

Bunch weight ranged from 4.2 to 19.2 kg with a mean of 13.34 kg for PITA14 and 3.5 to 12 kg with a mean of 7.03 kg for the Agbagba (Table 2). Thus, the bunch weight of PITA14 is about twice that of Agbagba, and this is consistent in all the locations (Table 3). This corroborated earlier results by Ortiz and Vuylsteke (1998). The bunch weight was reflected in the number of fingers and hands (Tables 2 and 3). The average figures were higher for PITA14 than for Agbagba, showing that fruits, rather than stalk accounted for the superior bunch weight. The relatively bigger bunch size has great positive implication for its market potential. This is because plantain/banana producers and consumers prefer cultivars with big bunches (Nowakunda et al., 2000). The insignificant relationship of these yields indices to management index (Table 4) showed that good management practices are essential for optimum performance, and the superior yield performance of the PITA14 relative to Agbagba is the result of inherent attributes of the hybrid variety.

The average finger length, finger circumference and finger weight was slightly higher for Agbagba than for PITA14 (Table 2). Though PITA14 recorded a bit lower finger length, circumference and weight, the large number of fingers has more than compensated for this, and in some of the locations, the figures were higher for PITA14 than for Agbagba (Table 3). Thus, the superiority of Agbagba with respect to finger size and weight is not consistent. As one moves northwards, away from the high rainforest zone (i.e. the Port Harcourt block), the finger size (weight) of Agbagba declines, thus, giving PITA14 a complete performance edge over Agbagba. In these northern zones (blocks), varieties such as the 'French horn', which has same morphological fruit characteristics as PITA14, are cultivated.

The yield indices were positive and significantly related to the level of BSI (Table 5). In other words, the high level of BSI recorded by the hybrid contributed significantly to the high yield performance. In assessing the market potential of black Sigatoka resistant cooking bananas, Ferris et al. (1997) also pointed out that due to the higher level of BS resistance, cooking bananas significantly out-yielded Agbagba, producing 2 to 3 fold increase in bunch weight. The above result is of significant importance since farmers will switch to new technology only when the new technology, not only fits into their existing system and resource endowments, but demonstrates significant superiority over the existing technology in critical assessment indices, particularly output.

Economic performance

The assessment of the economic performance of the varieties under the smallholder environment is tied to food and income generating abilities, which is a function of the yield capabilities of the varieties. Yield capability is assessed by the harvests, and harvest frequency of the varieties within the period data were collected. Bunches were harvested from 81 mats of PITA14 by 83.3% (30) of

Table 5. Parameter estimates of the effect of black Sigatoka resistance index (BSI) on some performance indices of plantain (based on OLS).

Performance index	Parameter estimates		R^2	F-Value	No. of observations
	Intercept	BSI			
DFPTF	6.0200	-0.0011	0.011	1.630	153
	(85.053)***	(-1.277)			
BunchWt	2.0978	0.1141	0.444	87.928***	111
	(2.125)**	(9.377)***			
DFPTH	481.6078	-0.1090	0.001	0.144	115
	(20.664)***	(-0.379)			
Nofings	-33.7707	1.2685	0.771	369.285***	111
	(-6.306)***	(19.217)***			
Nohands	4.9776	0.0192	0.195	26.634***	111
	(16.458)***	(5.161)***			

DFPTF = Number of days from planting to flowering, BunchWt = Bunch weight (Kg), DFPTH = Number of days from planting to harvest, Nofings = Number of fingers, Nohands = Number of hands. ***Significant at P <= 0.01, **Significant at 0.01 < P <= 0.05. Source: on-farm data, August 1998 – May 2000.

the farmers, giving an average of 2.7 mats per farmer (the range was 1 to 5 per farmer). On the other hand, harvests were made from 52 mats of Agbagba by 55.5% (20) of the farmers, giving an average of 2.6 mats per farmer (Table 6). In some of the villages, 100% of the farmers have got harvest from PITA14. From the 81 mats of PITA14, 124 bunches were harvested, giving an average of 4.1 bunches per farmer (the range was 1 to 13 bunches per farmer), and 1.5 bunches per mat (with a range of 1 to 3 bunches per mat). The corresponding figures for Agbagba were 62 bunches, ranging from 1 to 10 bunches per farmer with an average of 3.1; and 1 to 2.5, with an average of about 1 bunch per mat. This translates to 2499 bunches per hectare of PITA14 (at 2 m x3 m spacing), giving 33.34 metric tons per hectare (i.e., 13.34 kg/bunch). The corresponding figures for Agbagba are 1833 bunches per hectare and 12.89 metric tons per hectare (i.e., 7.04 kg/bunch). While harvests were made from PITA14 in all the villages, harvests were recorded in 7 of the 9 villages from Agbagba as at the time collection of data was stopped. Therefore, apart from yielding higher bunch weights, the hybrid gave more number and frequency of harvests than the landrace, resulting in higher yield per hectare.

To evaluate the cash income equivalent of the harvests, prices of plantain from January to December 1999 were obtained from the farmers in all the locations. The prices for big, medium and small bunches were obtained (sizes were based on the farmers' local assessment). The average prices for the various sizes for the whole year (see Table 7) were obtained and applied to obtain the equivalent of cash income derived by farmers from the varieties. Data collected in 1999/2000 from five villages in Rivers state, Southeast Nigeria gave the average weights for the various sizes of plantain as follows: big bunch – 16.59 kg, medium bunch – 10.37 kg, and small bunch – 6.73 kg. As indicated earlier (Tables 2 and 3), the bunch weight of PITA14 ranged from 4.2 – 19.2 kg with a mean of 13.34 kg, while the mean weight across the locations ranged from 10.46 – 15.72 kg. The average price of medium to big bunch ($2.085) was therefore applied to derive average cash income equivalent per farmer, and per mat for the hybrid. Also, the bunch weight of Agbagba ranged from 3.5 – 12 kg with a mean of 7.03 kg, while the average weight across the locations ranged from 6.24 – 8.4 kg. The average price of small to medium bunch ($1.396) was thus applied to derive the average cash income equivalent per farmer, and per mat. Following the above steps, each farmer would earn the sum of US$8.62 from 4.133 bunches of PITA14, while US$3.05 would be earned from each mat, giving an estimate of $5081.30 per hectare. The corresponding figures for Agbagba were US$4.33 per farmer and US$1.58 per mat, giving an estimate of $2632.28 per hectare. This indicates that the farmers would earn more cash income from PITA14 than from Agbagba due to reduced cropping cycle and increased yield associated with the hybrid, relative to the landrace. Relative advantage and economic viability are critical factors that positively influence the adoption of new technologies by farmers, apart from compatibility with existing systems. The above figures were based on the 1999 prices. At current 2003 prices, the average bunch of plantain sales from $0.75 to $7.19 depending on the size (Lemchi et al., 2003), with a mean of $3.97. When relevant production costs are deducted, PITA14 will yield higher net income than the landrace since both were planted in the same plot, and given equal management attention. Therefore irrespective of a change in prices, the improved high breed would still earn higher income and net returns to the farmer.

Table 6. Yield and income assessment of PITA14 and Agbagba under smallholder management system.

Location	No. of mats harvested		No. of mats harvested per farmer		No. of bunches harvested		No. of bunches harvested per farmer		No. of bunches harvested per mat per farmer		Cash income per farmer (US$)		Cash income per farmer/mat (US$)	
	PITA14	Agbagba	PITA14	Agbagba	PITA14	Agbagba	PITA14	Agbagba	PITA14	Agbagba	PITA14	Agbagba	PITA14	Agbagba
All locations	81 (30)	52 (20)	2.7	2.6	124	62	4.13	3.1	1.5	1.1	8.62	4.33	3.05	1.58
Abaomege	8 (3)	9 (2)	2.7	4.5	10	9	3.3	4.5	1.4	1.0	6.95	6.28	3.01	1.40
Amauzam	4 (3)	0	1.3	-	4	-	1.3	-	1.0	-	2.78	-	2.08	-
Ikpe	14 (4)	10 (4)	3.5	2.5	19	16	4.75	4.0	1.25	1.38	9.90	5.58	2.61	1.92
Isuawa	8 (3)	3 (1)	2.7	3.0	8	3	2.7	3.0	1.0	1.0	5.56	4.19	2.08	1.40
Obeama	10 (3)	5 (4)	3.33	1.25	20	5	6.67	1.25	2.03	1.0	13.90	1.75	4.23	1.40
Okposi	6 (3)	9 (3)	2.0	3.0	14	10	4.67	3.33	2.33	1.11	9.73	4.19	4.86	1.55
Okwe	8 (4)	0	2.0	-	8	-	2.0	-	1.0	-	4.17	-	2.08	-
Rumuekpe	16 (4)	10 (3)	4.0	3.33	32	13	8.0	4.33	1.9	1.25	16.68	6.05	3.96	1.75
Umuasua	7 (3)	6 (3)	2.33	2.0	9	6	3.0	2.0	1.28	1.0	6.26	2.79	2.66	1.40

Figures in parenthesis = Number of farmers
US$1.00 = ₦92.08
Source: on-farm data, August 1998 – May 2000.

Table 7. Average price of different sizes of plantain bunch in Nigeria, 1999.

Bunch size	Average bunch price (US$/bunch)*	
	Range	Mean
Small bunch (6.73kg)	0.487 –2.063	1.103
Medium bunch (10.37kg)	0.896 – 2.896	1.689
Big bunch (16.59kg)	1.339 – 3.937	2.480
Small to medium bunch	0.692 – 2.480	1.396
Medium to big bunch	1.118 – 3.417	2.085

*US$1.00 = N92.083
Source: Market/field data, 1999/2000.

Table 8. Percentage distribution of farmers by overall assessment of hybrid plantain (PITA14) relative to Agbagba (by ranks).

Performance criterion/attribute	Percentage of farmers by rank of attribute (rank 1 = best)	
	Rank 1	Rank 2
Growth habit	93.75	6.25
Time of maturity	100.0	0.0
Yield	96.0	4.0
Drought resistance	96.9	3.1
Lodging resistance	84.4	15.6
Disease resistance	100.0	0.0
Pest resistance	100.0	0.0
Fruit size	20.0	80.0
Ripening period	92.0	8.0
Height	92.0	8.0
Processes product	64.0	36.0
Cooking quality	80.0	20.0
Taste	84.0	16.0
Flavour	70.8	29.2
Colour	83.3	16.7
Texture	40.0	60.0
Cooking time	100.0	0.0
Mean	82.2	17.8

Source: on-farm data, August 1998 – May 2000.

Post harvest potential

In addition, the cultivars were evaluated through the overall post harvest assessment of the varieties by the farmers. Seventeen technology attributes were assessed, ranging from growth habit to cooking time (Table 8). On the average, PITA14 was assessed as best in all the attributes by 82.2% of the farmers, relative to Agbagba. Apart from fruit size and texture, PITA14 was assessed as best in all the attributes by greater proportion of the farmers. Maturity period, resistance to diseases and pests as well as cooking time of PITA14 was assessed best by 100% of the farmers. Farmers' subjective assessments and perceptions of agricultural technologies and their attributes influence adoption decisions and behaviour (Adesina and Baidu-Forson, 1995; Adesina and Zinnah, 1993; Nowak, 1992). The high post harvest assessment recorded by the hybrid (PITA14) is an indication of high and favourable consumer potential, and by extension, high adoption potential.

Conclusion

Farmer participatory on- farm trial has become a crucial link between technology generation and transfer, and a key component of agricultural research and development process. This study assessed the performance of the newly developed BS resistant hybrid plantain, PITA14 developed by IITA, under smallholder environment through the on-farm trial process. Results showed good performance of the hybrid under farmer-managed system not only in respect of resistance to black Sigatoka and compatibility with the local plantain cropping system, but also in yield and cash income. The average BS resistance level was close to 100%, and out-yielded the landrace by about 100%. It also recorded a high overall post harvest assessment level by the farmers indicating high economic advantage and adoption potential. It is therefore recommended that the new plantain hybrid (PITA14) be multiplied and disseminated to farmers through the existing formal extension system in Nigeria, involving relevant farmer groups, non-governmental and community-based organisations.

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