Impact of Poultry Manure on Growth Behaviour, Black Sigatoka Disease Response and Yield Attributes of Two Plantain (*Musa* spp. AAB) Genotypes

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Summary

Yield decline in plantain cultivation is a common occurrence after few production cycles due to low levels of soil organic matter and increased susceptibility to biotic stress. The use of improved varieties is a cheap and eco-friendly option to combat plant diseases; however, sustaining the yield of a new cultivar in the farmers' fields requires good soil fertility management which could be achieved through judicious use of poultry manure. The effects of three rates of decomposed poultry manure (0, 10 and 20 t.ha^{-1}) on growth, black Sigatoka disease response and yield attributes of 'PITA 24' (a plantain hybrid) and its maternal grandparent 'Mbi-Egome' (a landrace plantain) were evaluated at Onne (Nigeria), at the high rainfall station of the International Institute of Tropical Agriculture. The experiment was laid-out as a split plot in a randomized complete block design. Except for leaf area and chlorophyll content, results showed that both clones had similar growth variables. Notwithstanding the susceptibility of the hybrid genotype to the air-borne fungal leaf spot sigatoka disease, data on the components of yield showed that 'PITA 24' produced significantly (P< 0.05) higher values for number of hands and fingers per bunch, bunch yield and total biological yield, however, both genotypes had similar biomass distribution pattern. Manured plants had a significant (P< 0.05) yield improvement over the control plants; but, there was a yield decline at 20 t.ha^{-1} application rate. Increasing manure rates reduced days to harvest by over 30 days; similarly, plant stature, suckering, leaf chlorophyll content, index of non-spotted leaves, crop cycling and total biomass increased with increasing manure rate. It was apparent from our study that 10 t.ha^{-1} of poultry manure per annum supported the best yield attributes.

Résumé

Action du fumier de volaille sur la croissance, et la résistance à la cercosporiose noire et le rendement pour deux génotypes de plantain (*Musa* spp. AAB)

La baisse de rendement en culture de plantain est un phénomène fréquent après quelques cycles de production; elle est due à de faibles niveaux de matière organique du sol et à une sensibilité accrue à des stress biotiques. L'utilisation de variétés améliorées est une option bon marché et respectueuse de l'environnement pour lutter contre les maladies des plantes, mais le maintien du rendement d'un nouveau cultivar en bananeraie nécessite une bonne gestion de la fertilité des sols qui pourrait être obtenue par une utilisation judicieuse de fumier de volaille. Les effets des trois doses [(0, 10 et 20) t.ha^{-1}] de fumier de volaille décomposé sur la croissance, la réponse à la cercosporiose noire et le rendement de PITA 24' (un hybride de plantain) et de son grand-parent maternel 'Mbi-Egome' (une banane plantain locale) ont été évalués à Onne (Nigeria) dans une station à fortes précipitations de l'IITA. L'expérience a été menée selon un dispositif split plot en blocs aléatoires complets. Les résultats ont montré que les deux clones étudiés avaient des variables de croissance similaires, sauf pour la surface foliaire et la teneur en chlorophylle. Malgré la sensibilité du génotype hybride à la cercosporiose foliaire d'origine atmosphérique, les données sur les composantes du rendement ont montré que 'PITA 24' produisait significativement plus de mains et de doigts par régime, un meilleur rendement du régime et un meilleur rendement végétatif global, toutefois, les deux génotypes ont présenté un schéma similaire pour la répartition de la biomasse. Les plants fumés ont eu un rendement significativement amélioré par rapport aux plants témoins, mais il y a eu un rendement moindre pour la dose de 20 t.ha^{-1}. L'augmentation des doses d'engrais a réduit de plus de 30 jours le temps de récolte; de même, la taille des plants, le drageonnage, la teneur en chlorophylle des feuilles, l'indice des feuilles non contaminées, le cycle de production et la biomasse totale ont augmenté avec la dose de fumier appliquée. Notre étude a montré que l'application de 10 t.ha^{-1} de fumier de volaille par hectare et par an permettait d'obtenir les meilleures caractéristiques de rendement.

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Introduction

Bananas and plantains (*Musa* species L.) are important staple food crops and sources of rural income in most part of sub-Saharan Africa, particularly for the smallholders who grow them in compound gardens (12). Besides the production in heavily manured compound farms, *Musa* crops are produced in small fields under shifting cultivation and bush fallow, with yields declining rapidly after few production cycles (28).

This yield decline syndrome observed after one or two years of cropping, has been implicated as a major obstacle to plantain cultivation in West and Central Africa, and has been blamed to low levels of soil organic matter and the increased susceptibility of traditional cultivars to several pests and diseases (11), particularly the black Sigatoka (caused by *Mycosphaeralla fijiensis* Morelet).

'PITA 24', a secondary triploid plantain-derived hybrid, is among the genotypes recently selected by the International Institute of Tropical Agriculture (IITA) for its biotic stress tolerance and good horticultural traits. Besides disease tolerance and high yield, earliness and fast cycling, increased concentrations of pro-vitamin A (β-carotene), iron and zinc are the attractive features of 'PITA 24' hybrid. The use of resistant/ tolerant cultivars is considered the most appropriate component in efforts to control crop diseases as improved varieties could be readily adopted by farmers (27). However, sustaining the yield of a new cultivar in the farmers' fields requires appropriate crop management practices, especially soil fertility management. In the tropics, rapid population growth and continued land degradation pose major challenges to soil fertility management. Thus, external nutrient inputs are essential to improve and sustain yields on these soils.

For optimum growth and fruit yield, bananas require high amounts of nutrients which are often supplied only in part by the soil (24). Consequently, several inorganic fertilizer combinations have been recommended for optimum yield of plantains, but inorganic fertilizers are too expensive for the subsistence farmers and often scarce. Soil acidification and compaction with the consequent yield decline after a few years of continuous use have been reported as detrimental effects of mineral fertilizers on the strongly-weathered, poorly-buffered soils of the tropics (16). There is also a low efficiency as a result of losses through volatilization and leaching.

Plantains respond positively to large amounts of mulch and organic matter. The high productivity of plantains under a smallholder compound production system has always been attributed to continuous heavy applications of organic matter in the form of compound sweepings, livestock and kitchen wastes including miscellaneous waste water and wood ash thrown around the cultivation (24). Animal manure is a valuable source of crop nutrients and organic matter, which can improve soil biophysical conditions thereby making the soil more productive and sustainable (18). Organic fertilizers are very bulky, yet they manifest many important characteristics. They improve soil moisture and nutrient retention, stimulate root development, control weeds and soil erosion, minimize soil temperature fluctuation, improve soil porosity and enhance biological activities.

Earlier study on *Musa* performance evaluation suggested differential varietal behavior under contrasting cropping systems and soil fertility status (7). The hypothesis thereof was that high yielding hybrids would have a higher nutrient demand. This hypothesis was proven correct by Baiyeri and Ortese (8), but the clones evaluated were not genetically related. In the present study, we compared growth and yield responses of a plantain hybrid ('PITA 24') and its maternal grandparent landrace ('Mbi-Egome') to varying rates of poultry manure application.

Material and methods

Experimental site

The experiment was conducted at the High Rainfall Station of the International Institute of Tropical Agriculture, Onne (4^{0} 43'N, 7^{0} 01'E, 10 m a.s.l.), Rivers state, Nigeria between November 2006 and April 2008. The station is located in a degraded rainforest swamp area, characterized by an ultisol derived from coastal sediments, and an annual unimodal rainfall of 2400 mm. Average daily temperature of about 27 ^{0}C and solar radiation averaging 14 MJM^{-2} prevail. The experimental site was characterized as sandy loam (68% sand, 7% silt and 25% clay), and strongly acidic with moderate fertility (Table 1). The NPK and organic matter contents were considered moderate.

Design of experiment

The experiment was laid-out as a split-plot in a randomized complete block design (RCBD). Treatments comprised of three rates of poultry manure (0, 10 and 20 t/ha/yr), and two plantain genotypes- 'PITA 24' hybrid, and a landrace, 'Mbi Egome'. 'Mbi-Egome' is the "grandmother" of 'PITA 24'. Each treatment combination (i.e., subplot treatment) was replicated four times on a three-row plot of five plants per row, thus a total of 60 plants per treatment combination were used in the study.

Treatment application

Micro-propagated suckers were spaced 3 m x 2 m in planting holes measuring 0.4 x 0.4 x 0.4 m in dimensions. Poultry manure was split-applied as half the calculated dose during planting and the complement at the onset of the reproductive phase (six

Table 1
Chemical properties of the experimental site (High Rainfall Station, IITA, Nigeria) and poultry manure sample utilized for studying some attributes of two plantain (*Musa* spp. AAB) genotypes

Substrate	pH (in water)	Organic carbon	Organic matter	Total nitrogen	Total phosphorus	Zinc	Iron	Copper	Manganese
		(%)				(mg/kg)			
Top soil (0-15 cm)	4.5	1.72	2.97	0.17	0.01	6.15	298	1.65	43
Sub-soil (15-30 cm)	5.5	1.28	2.21	0.13	0.01	10.72	266	0.85	34
Poultry manure	6.5	35.40	61.02	1.56	1.40	11.36	313.2	-	-

	Exchangeable cations ($cmol^+.kg^{-1}$)					
	Potassium	Calcium	Magnesium	Sodium	Acidity	ECEC
Top soil (0-15 cm)	0.34	5.14	0.34	0.43	0.17	6.42
Sub-soil (15-30 cm)	0.30	3.72	0.26	0.43	0.42	5.53

months after planting). The poultry manure samples were obtained from a deep litter range previously left in piles for approximately six weeks for decomposition. Each plant received 15 g of Furadan 5G to control plantain weevil (*Cosmopolites sordidus* Germar) and nematodes. A follower-sucker was selected after flowering (shooting) and de-suckering (i.e., pruning of side shoots) was repeated routinely every 4-6 weeks. Weeds were controlled using a systemic herbicide ‘Round-up’ and bearing plants were propped against wind damage.

Data collection and analysis

Phenological, plant growth and leaf streak disease (black sigatoka) response traits were studied at flowering, while the yield parameters were studied at harvest. Phenological, disease response and plant growth parameters studied included number of days from planting to flowering, days to harvest at full bunch maturity as signalled by the yellowing of one or two finger tips, plant height (cm) determined as the distance from the ground level to the junction of the last two fully unfurled leaves, number of live leaves, leaf area (m^3) of the topmost three (most exposed) leaves following Obiefuna and Ndubizu (20), pseudostem girth (cm) taken at 1 m above ground level, number of suckers per stool recorded at the onset of flowering (i.e., 6 months after planting), height of the tallest sucker (cm) at the time of harvest of the mother plant. Cycling index (%) was determined at harvest as the ratio of the sucker (ratoon) height to plant crop height multiplied by 100. This ratio is an indication of the interval between two consecutive harvests. Response to black Sigatoka disease was assessed using the youngest leaf spotted criterion (26).

A non-destructive estimation of shoot nitrogen through an electronic quantitative measure of leaf chlorophyll was also done at six months after planting (onset of flowering) using a hand-held SPAD-502 CHLOROPHYLL METER. Readings were taken at six points across the widest width of leaves - 3, -6 and -9 (fully unfurled leaves from the pseudostem apex) on the right flank of the leaf lamina. The mean value for an individual leaf was recorded as the corresponding SPAD value. SPAD-502 METER determines the relative amount of chlorophyll in leaves by measuring transmittances at red (650 nm, where absorption is high) and near-infrared (940 nm, where absorption is extremely low) wavelength regions (17). The light transmitted by the leaf is converted into electrical signals, and the ratio of the intensities of the transmitted light at the two wavelength regions corresponds to the SPAD reading. Leaf relative greenness (RG) was also calculated as a ratio of number of green leaves to the total number of live leaves on the plant, thus is a rough estimate of the whole-plant chlorophyll content and photosynthetic ability.

The yield parameters studied at harvest included bunch weight (kg) per plant, annual bunch yield per hectare ($t.ha^{-1}.yr^{-1}$), number of hands (nodal clusters) per bunch, total fruit count per bunch. Fresh weights of the live leaves and pseudostem were measured at harvest to determine the total above-ground biomass ($t.ha^{-1}.yr^{-1}$) and the biomass distribution pattern to the bunch, pseudostem and leaf components. Leaf retention index (%) was also calculated as the ratio of live leaves at harvest to that recorded at flowering multiplied by 100. The experimental site and poultry manure sample used were duly characterized following the analytical procedures described in AOAC (4). Data were subjected to analysis of variance following RCBD model using GENSTAT 5.0 Release 7.22 DE (3).

Results

At flowering, both clones maintained fairly similar vegetative growth variables (Table 2). Although not significant, 'PITA 24' had higher values for plant height and pseudostem girth, but maintained significantly (P< 0.05) larger leaf area and a taller follower sucker. The number of days from planting to flowering for both clones was also similar. 'PITA 24' significantly (P< 0.05) sustained a greener canopy as evident from the relative greenness and SPAD values. Photo-active leaf area was also significantly (P< 0.05) larger in 'PITA 24', but 'Mbi-Egome' had a higher value for number of live leaves as well as index of non-spotted leaves.

Manure significantly (P< 0.05) influenced most of the plant growth characteristics and Sigatoka disease response parameters studied (Table 2). Number of days from planting to flowering was reduced by over 30 days (in both clones) over the control (no manure) plants by increasing the manure rate from 10 to 20 tons per hectare. Plant stature (height, girth, leaf area), number of suckers per stool, as well as the height of tallest sucker were significantly (P< 0.05) improved in both clones with an increase in manure rate. Relative greenness and SPAD values also improved with manure application. In both clones, a significant (P < 0.05) difference between the 10- and 20 tons plants was observed in the number of days to flowering and height of tallest sucker per stool. Index of non-spotted leaves, which is an indication of Sigatoka disease resistance also improved with an increase in manure rate meaning that better plant nutrition improved the leaf spot disease resistance of the plants.

A significant (P< 0.05) clonal variability was observed in most of the yield and harvest parameters presented in table 3. Harvest was 6 days earlier in 'PITA 24'. This clone also maintained a faster cycling as indicated by the higher crop cycling index (CCI) value. Both genotypes retained about 1% of the entire leaves at the time of harvest. This poor leaf retention index may be attributed to high incidence of Sigatoka leaf spot disease in the study area, and/or the time of harvest which coincided with peak of the dry season. 'PITA 24' produced significantly (P< 0.01) higher agricultural (bunch) and biological (total biomass) yields, however both genotypes had similar economic yield (harvest index), hence partitioned similar proportions of the accumulated biomass to the bunch, pseudostem and leaf components. The number of hands (nodal clusters) and fingers per bunch were also significantly (P< 0.01) higher in 'PITA 24' hybrid.

Manure application significantly (P< 0.05) influenced most of the harvest parameters shown in table 3. In both clones, the number of days from planting to harvest was reduced by 25 to 45 days (over the control) by the application of 10 and 20 tons of poultry manure per hectare. Cycling index, an indication of the time lapse between two consecutive harvests improved sequentially with increasing manure rate. Number of hands and fingers per bunch, bunch yield, total above-ground biomass, as well as, the accumulated vegetative mass all improved with manure application, but the harvest index value (i.e., proportion of the photo-assimilate partitioned to the bunch portion) declined significantly (P< 0.05) at 20 tons manure application rate. Bunch yield also declined at 20 tons rate particularly in 'PITA 24'. Leaf retention at harvest was not influenced by manure application. The 10 and 20 tons application produced similar effects in most cases, although individual-plant bunch weight and harvest index values (in both clones) were significantly (P< 0.05) higher in the former whereas harvest was earlier in the latter.

There was a significant (P< 0.05) clone-by-manure interaction in most of the yield and harvest traits studied (table 3). The sequential increase in cycling index observed with increasing manure rate was true for both clones, so were the number of hands and fingers per bunch, total biomass and the accumulated vegetative mass. The decline in bunch yield per plant and harvest index values observed at 20 tons application rate was significant (P< 0.05) only in 'PITA 24'. The annual bunch yield per hectare showed clearly that this yield decline was more pronounced in 'PITA 24' hybrid (table 3). In both clones, however, the highest values for bunch weight and harvest index were obtained at 10 tons application rate. This manure rate partitioned the least proportion of the accumulated biomass to the pseudostem, indicating a better efficiency in dry matter redistribution. The proportion of the photo-assimilate partitioned to the leaf component was similar for all the combinations.

Discussion

Plant stature (size) in *Musa* germplasm is often a function of the female parent, whereas the bunch and fruit characteristics depend on the resultant genome combination following hybridization (27). The non-significant growth difference between the two clones could be as a result of the maternal relationship that exists between the clones.

Variability in efficiency of resource conversion into dry matter has been observed in *Musa* species and may be related to differences in genomes (7). The higher bunch yield found in 'PITA 24' is, therefore, genetic and could be attributed to the larger photoactive leaf area and the higher leaf chlorophyll content (i.e., a stronger source) vis-à-vis a stronger competitive sink as seen in the greater fruit number per bunch. A significant correlation between the leaf chlorophyll and yield has been established in other species like rice (22), cotton (10) and strawberry (13). The size of source (essentially photosynthetic leaf area) has a direct relationship with the quantity of photo-assimilate produced. Whole-

Table 2

Effect of clone and varying manure rates on plantain growth and sigatoka disease response parameters studied at flowering

Clone	Poultry manure (t/ha)	DTF (days)	PHT (cm)	PG (cm)	NL (#)	LA (m^2)	INSL (%)	NS (#)	HTS (cm)	RG (%)	SPAD Reading L3	SPAD Reading L6	SPAD Reading L9	SPAD Reading Mean
PITA 24	0	320.6	324.8	55.5	8.8	4.1	57.9	3.0	61.3	86.2	55.0	54.9	37.1	49.0
	10	290.8	337.8	59.4	9.0	4.3	58.1	3.3	125.7	90.1	54.7	53.4	39.3	49.1
	20	280.2	345.9	60.0	9.1	4.5	61.1	5.2	188.9	95.5	53.2	56.6	51.7	53.8
	Mean	297.2	336.1	58.3	9.0	4.3	59.0	3.8	125.3	90.6	54.3	55.0	42.7	50.7
Mbi-Egome	0	327.9	316.5	55.5	9.5	3.4	59.4	2.5	70.9	80.3	53.5	48.0	20.3	40.6
	10	289.8	333.2	58.4	9.7	4.1	63.4	5.3	94.3	90.7	53.1	55.9	45.5	51.5
	20	280.6	348.3	60.5	10.0	3.7	64.2	6.0	143.7	91.7	53.0	56.0	47.1	52.0
	Mean	299.5	332.7	58.2	9.7	3.7	62.3	4.6	103.0	87.6	53.2	53.3	37.6	48.1
$LSD_{(0.05)}$ comparing clones		ns	ns	ns	0.2	0.1	1.5	ns	17.4	2.9	1.0	ns	4.4	1.7
$LSD_{(0.05)}$ Clone x Manure		9.3	10.6	1.7	0.3	0.2	2.6	1.8	30.2	5.7	ns	3.9	10.8	4.8

DTF= Number of days to flowering; PHT= Plant height; PG= Plant girth; NL= Number of live leaves; LA= Leaf area; INSL= Index of non-spotted leaves; NS= Number of suckers; HTS= Height of tallest sucker; RG= Relative greenness; SPAD= Electronic measure of leaf chlorophyll content; L= Leaf; #= Number; $LSD_{(0.05)}$= Least significant difference at 5% probability level; ns= Non-significant difference.

Table 3
Combined effects of clone and poultry manure on yield and harvest traits of plantain

Clone	Manure	DTH (days)	CCI (%)	LRI (%)	nHds (#)	nFgs (#)	Bwt (kg/plant)	YLD ($t.ha^{-1}yr^{-1}$)	AgBiom ($t.ha^{-1}yr^{-1}$)	Vegetative Mass ($t.ha^{-1}yr^{-1}$)	Biomass distribution pattern [%]: Bunch (Harvest Index)	Biomass distribution pattern [%]: Pseudostem	Biomass distribution pattern [%]: Leaf
PITA 24	0	416.0	19.0	1.5	10.4	173.3	16.5	24.2	98.4	74.2	23.8	76.1	0.1
	10	383.5	37.0	1.4	10.8	186.5	17.4	27.8	116.6	88.9	24.6	75.3	0.1
	20	371.1	54.4	1.3	11.0	186.0	15.3	25.2	113.6	88.3	22.2	77.7	0.1
	Mean	390.2	36.8	1.4	10.7	181.9	16.4	25.7	109.5	83.8	23.5	76.4	0.1
Mbi-Egome	0	416.3	22.2	0.7	6.7	79.4	11.3	16.7	74.7	58.0	22.4	77.5	0.1
	10	391.3	28.1	2.1	7.0	87.1	13.1	20.3	82.3	61.9	24.7	75.0	0.2
	20	380.9	41.3	0.5	7.2	91.0	12.9	20.7	90.3	69.6	22.9	77.0	0.1
	Mean	396.2	30.5	1.1	7.0	85.8	12.4	19.2	82.4	63.2	23.3	76.5	0.1
$LSD_{(0.05)}$ comparing clones		5.5	4.9	ns	0.1	2.5	0.6	1.2	3.1	4.2	ns	ns	ns
Clone x Manure		9.4	8.6	ns	0.3	7.0	1.1	2.0	6.5	5.3	1.6	1.5	ns

DTH= Number of days from planting to harvest; CCI= Crop cycling index; LRI= Leaf retention index; nHds= Number of hands (nodal clusters) per bunch; nFgs= Number of fingers per bunch; Bwt= Bunch weight per plant; YLD= Bunch yield per hectare per year; AgBiom= Total above-ground biomass; #= Number; $LSD_{(0.05)}$= Least significant difference at 5% probability level; ns= Non-significant difference.

plant biomass accumulation in *Musa* germplasm similarly has a direct effect on photo-assimilate partitioned to the storage organ (7). A high significant correlation between the bunch weight and number of fruits per bunch has been established (9); meaning that genotypes like 'PITA 24' that produce plenty of fruits are likely to produce heavy bunches.

Manure significantly (P< 0.05) influenced the general performance and productivity of the crops. The increased growth rate, earlier flowering, larger biomass, healthier canopy, earlier harvest and improved yield observed in this study as a result of manure application was made possible by nutrients released from the poultry manure. Similar response has been found in several other species including plantains (19), pearl millet (14), passion fruit (2), strawberry (21) and corn (23). Manure of animals and other origin is a slow-release fertilizer, and valuable source of crop nutrients and organic matter, which can improve soil biophysical conditions thereby making the soil more productive and sustainable for food production (18), thus a great proportion of plantain and banana crops benefits from the application of large doses of household refuse which is high in organic matter. In the present study, manure application also enhanced the sprouting of side shoots (suckers) in the field. Thus the use of organic substrates in nurseries for mass propagation of *Musa* germplasm is necessary (6) to enhance multiplication and subsequent plantlet growth.

The non-significant plant growth response between the 10- and 20 ton plants suggests that 10 t/ha of poultry manure may be regarded as the optimal annual dose for plantains in the study area considering the soil native fertility. This could be affirmed by the higher bunch yield and harvest index (economic harvest) values obtained at 10 tons application. A strong positive correlation exists between harvest index (HI) and crop yields (7). HI defined as the proportion of the total accumulated biomass partitioned to the harvestable product is an indication of a crop's physiological efficiency in assimilates partitioning.

The decline in bunch yield and harvest index values observed at 20 tons rate suggests that adequate quantities of nutrient elements were supplied by the 10 tons application rate. A similar depression in yield and HI was observed in 'Agbagba' plantain on application of urea-N above 448 kg per hectare (5). Organic amendments such as poultry manure are often applied to supplement soil N. Application of N-fertilizer to crops promotes vegetative growth, in some cases to the disadvantage of the harvestable product (5). The significant improvement in bunch yield and HI values observed at 10 tons poultry manure application rate, suggests a greater efficiency in dry matter accumulation and redistribution. This manure rate allotted a greater portion of the accumulated biomass to the harvestable portion. The 20 tons plants produced a large biomass, but to the detriment of bunch yield.

The yield decline observed at the high manure rate in the present study could be related to soil reaction and the consequent nutrient solubilities or fixation and imbalances which can occur when large amounts of poultry manure or compost are used (15). Soil pH increases progressively with the application and subsequent decomposition of poultry manure (1). Very high pH values (7.5 - 8.5) will adversely affect the availability of phosphorus (18) and most cationic micronutrients which are more available at low soil pH. Tisdale and Nelson (25) also noted the accumulation of copper in the soil as one of the problems of excessive use of poultry manure.

Conclusion

It was apparent from this study that 10 t/ha of poultry manure per annum gave the best yield attributes in both clones, indicating a similar nutrient demand pattern. This rate is, therefore, recommended for plantain growers on the highly weathered oxisols of the humid tropics for improved harvest, soil fertility maintenance and yield sustainability, particularly when the enormous non-utilizable residues (accumulated vegetative mass) are retained on the field after bunch harvest. Notwithstanding the susceptibility of both genotypes to black sigatoka disease, the improved yield variables observed in 'PITA 24' suggests that it is somewhat tolerant to the virulent air-borne fungal leaf spot disease, and is therefore recommended for adoption.

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