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Agronomic and Physio-Chemical Evaluation of FHIA-21 in Ghana

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Abstract: The agronomic evaluation of FHIA-21 was conducted at three locations in the semi-deciduous forest region of Ghana. The physio-chemical composition of the green stages of the fruits was also determined. Pulp and peel colours were measured with a Chromatometer (Minolta). Results indicated that the hybrid was very tolerant to the black Sigatoka disease with high number of functional leaves at flowering and at harvest. The crop cycle was comparable to the False Horn plantains. The yield performance of the hybrid was high ranging from 34 and 38 t ha^{-1} across the locations. The yield values have been stable over the three-year study period. In addition, the FHIA hybrid plants were relatively short. The physio-chemical composition results showed that the hybrid had high fat (1.94%) and water (60%) contents. The potassium content was also high (1060 mg/100 g dry weight) however the iron content (0.45%/100 g dry weight) was low. The high potassium level in the hybrid may be an advantage for use as a therapy. FHIA-21 had bright orange pulp colour which was indicative of the presence of provitamins and carotenoids.

Key words: Musa, FHIA-21, agronomy, physio-chemical composition

Introduction

As starchy foods, plantains and bananas (*Musa* sp.) are important sources of high-calorie energy in the entire West African sub-region (Stover and Simmonds, 1987). They are also of great socio-economic importance in the producing countries. Nearly 90% of the total plantain and banana produced worldwide (63 million tones) are consumed locally in the producing countries leaving only 10% for export (CGIAR, 1992, 1993). Plantain and banana are also very important sources of rural income (Ortiz and Vuylsteke, 1996).

Plantains are known to be a great source of calcium, vitamins A, B1, B2, B3, B6, C and minerals such as potassium and phosphorous. Ripe mashed plantain is an excellent food for babies after the six month exclusive breast feeding. This advantage is due to the easy digestibility and the mineral and vitamin content. For elderly people, the fruit can be consumed in large quantities without being fattening or causing digestive disturbances (http://www.turbana.com/index.htm, Accessed August 14, 2003).

Plantain is known to be low in sodium (Chandler, 1995). It contains very little fat and no cholesterol; therefore it is useful in managing patients with high blood pressure and heart disease. They are free from substances that give rise to uric acid therefore, they are ideal for patients with gout or arthritis. Due to the low sodium and protein content, plantain is used in special diets for kidney disease sufferers. The capacity of the plantain to neutralize free hydrochloric acid suggests its use in peptic ulcer therapy (http://www.turbana.com/index.htm, Accessed August 14, 2003).

A fully ripe plantain mixed with milk powder is especially recommended for ulcer patients. For patients with gastritis and gastro-enteritis, banana is one of the first foods to be introduced after nausea and vomiting are brought under control. The low lipid/high palatability combination is ideal for the diet of obese people (http://www.turbana.com/index.htm, Accessed August 14, 2003). The plantain plant has also some medical properties. The leaves can be pounded and applied to the wound to suppress bleeding.

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In Ghana, plantain contributes about 13.1% of the Agricultural Gross Domestic Product (AGDP) and its per capita annual consumption is 96.4 kg per head (Lescot, 2000). It is of great socio-economic and nutritional significance and generates considerable employment.

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*) (IITA, 1992; Stover and Simmonds, 1987; 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% (Hemeng and Banful, 1994). Unfortunately all the landraces in Ghana are susceptible to the Black Sigatoka disease except a cooking banana. In view of this, new hybrids were introduced to supplement the landraces. The tetraploid hybrids are high yielding and disease tolerant, however their nutritional composition was not determined. It was therefore necessary to evaluate the hybrids alongside the landraces. This study was to evaluate the agronomic performance of FHIA-21 multi-location and also determine the physio-chemical composition.

Materials and Methods

Agronomic Study

Tissue culture plantlets of FHIA-21 were received from Fundacion Hundurena de Investigacion Agricola (FHIA) in Honduras for evaluation. The plantlets were hardened under a hardening shed for six weeks before field planting.

The trials were established in 1996 at three locations namely Fumesua (1°37'W, 5°43'N,) in the Ashanti region, Assin-Fosu (1°25'W, 5°40' N) in the Central region and Bunso (1°33W, 5°21'N) in the Eastern region. 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). Bunso on the other hand is characterized by heavy topsoil with dark humus (Andosols). The annual rainfall across the locations range between 1400 and 1800 mm. The minimum and the maximum temperatures were 22 and 33°C, respectively. The design was randomized complete block with three replications. Three kilograms (3 kg) of poultry manure was applied as soil amendment at planting. Plant spacing of 3×2 m was used giving a plant population of 1667 plants ha^{-1}. Data was collected on plant height at flowering and at harvest, pseudostem girth at one metre 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 and number of fingers. The black Sigatoka disease evaluation was done using the Stover scale of 1 to 10 (1 as very low and 10 as very severe disease incidence (Stover and Simmonds, 1986) as observed on the 3rd leaf.

Physio-Chemical Analysis

Moisture, crude fat, ash, crude protein and crude fibre contents were determined on Official Methods of Analysis (AOAC, 1994). All the minerals (i.e., sodium, potassium, iron, phosphorus and calcium) were determined using atomic absorption spectrophotometer after acid digestion of the sample.

Colour Determination

The pulps were sliced into thin slices of 5 mm thickness and placed on a petri dish. The colour was determined using the Chromameter (Model Cr-200 Minolta Camera Co. Ltd., Japan) on the L*, a* and b* scale colour notation. The sensor of the Chromameter was placed on the sliced pulp and the colour measured at three randomly selected positions and the mean calculated. The Chromameter was calibrated using a standard white tile [L* = 100.01; a* = -0.01; b* = -0.02]. The L coordinate is a

measure of lightness (white-black and ranges from no reflection L = 0 to perfect diffuse reflection L = 100), the a scale ranges from negative value for green to positive values for red and the b scale ranges from negative values for blue to positive values for yellow.

Results and Discussion

At each of the three locations, FHIA-21 exhibited stable performance in yield and growth characteristics over the three years of study (Table 1). These results suggested that performance of FHIA-21 was not influenced by seasons or locations. It implies that under good management practices, farmers would be assured of good yields irrespective of time or season of planting so long as there is adequate supply of moisture.

In a study (Dzomeku *et al*., 2004a, b) the growth and yield performances of FHIA-21 was superior to the land races. FHIA-21 was 21% shorter in height and 8% thicker in pseudostem circumference than Apem pa (land race) suggesting that plants of FHIA-21 were sturdier. The crop cycle of local Apem pa is between 18 and 24 months (Hemeng and Banful, 1994) and is often susceptible to stem lodging. It is therefore more likely that FHIA-21 would escape stem lodging. Earlier study by Hemeng *et al*. (1994), indicated that plants with thicker pseudostem girth experienced less stem lodging. FHIA-21 also retained more functional leaves at flowering and harvest (Table 1) which possibly contributed to the higher yield.

Moisture level was appreciably high in FHIA-21 (60%) compared to values reported by Chandler (1995). This could be attributed to the banana characteristic in the FHIA 21 hybrid. This shows that FHIA-21 had lower dry matter than the triploid. Water content is known to have influence on general energy and nutrient density. The low water content in plantain is reported to have an influence on general energy and nutrient density (Gowen, 1995). The low water content has greater energy content. However the high pulp to peel ratio (1.36) indicated that there was more edible portion per unit weight. In FHIA-03, Cuerno, Bluggoe cultivars, pulp to peel ratios of 0.98, 1.70 and 1.33, respectively were observed (Dadzie, 1993). However the thin peels of the cultivars could predispose the fruits to mechanical damage. Their transportation over long distances would require care especially in Ghana where the roads are not very good.

Fat content was high in the hybrid (1.94%) compared to reported values (Chandler, 1995). This could be an added advantage of the hybrid over the triploids. There was no difference in the ash contents of FHIA-21 and Apem. Iron level was lower in the hybrid compared to reported values (Chandler, 1995). However, potassium was higher in the hybrid plantain. It is reported that plantains are rich in vitamin B6 and the combination of the vitamin B6 and potassium makes it nature's brain food, since these two substances are essential for proper brain function (http://www.turbana.com/index.htm, Accessed August 14, 2003). The sodium levels are low while potassium levels are high; however, the high potassium provides a protective effect against excessive sodium intake (Meneely and Batterbee, 1976). The high potassium level in the hybrid may be an added advantage of the hybrid for use as a therapy. As regards iron, plantain is poor source (0.5 mg/100 g) however, unlike other foods; the iron provided by plantain is 100% utilizable by human body.

Calcium and phosphorous on the other hand are vital for bone. The calcium contain was slightly higher in Apem compared to FHIA 21. The soft nature of the hybrid makes it easy to cook and for mastication when prepared as slice compared to the local (Dzomeku *et al*., 2004).

The results of the study showed that the nutritional composition of the hybrid related very well with the findings of Chandler (1995). FHIA-21 could be described as a high energy yielding carbohydrate. The fat content of the hybrid was high signifying higher calorific value. The nutritional composition of the hybrid matches the reported values for triploids. The hybrid could be recommended as a good starchy staple for consumers of plantain (Table 2).

Table 1: Means for growth and yield parameters of FHIA-21 in each environment (location/cycle)

Location	Cycle	DF	DH	NLF	NLH	PH	PG	Y	NHB	NF
Fumesua	PC	331	411	14	8	269	55	38	8	107
	RC1	323	403	13	7	241	56	37	8	102
	RC2	315	395		6	250	51	36	8	105
Bunso	PC	335	420	13	6	254	50	34	8	100
	RC1	321	406	13	6	240	47	34	7	104
	RC2	315	400	13	6	248	48	36	8	101
Assin-Foso	PC	330	411	13	5	241	51	37	7	100
	RC1	318	398	12	4	233	52	36	8	105
	RC2	310	390	12	6	230	48	34	7	102
$LSD_{0.05}$ (L)		1	1.1	ns	ns	2	0.2	0.2	ns	ns
$LSD_{0.05}$ (C/L)		3	2	ns	0.2	4	2	3	ns	ns

PC = Plant Crop; RC1 = 1st ratoon crop; RC2 = 2nd ratoon crop; DF = Days to Flowering; DH = Days to Harvest, NLH = Number of Leaves at Harvest; PH = Plant Height; PG = Plant Growth; Y = Yield in ton/ha; NHB = Number of Hands per Bunch; NF = Number of Fingers per bunch; LSD 0.05 (L) = Least square difference between locations at 5% level LSD 0.05 (C/L) = Least square difference between environments at the 5% level

Table 2: Nutritional composition of FHIA 21 (Composition (per 100 g dry weights)

Parameter	Variety FHIA 21
Moisture (%)	60.62±0.49
Fat (%)	1.94±0.55
Ash (%)	1.02±0.14
Crude fibre (%)	1.02±0.05
Crude protein (%)	2.08±0.03
Carbohydrate (%)	41.52±0.03
Pulp to peel ratio	1.36±0.06
Potassium (mg)	10.60±0.002
Calcium (mg)	11.2±0.01
Iron (mg)	0.45±0.05
Sodium (mg)	49.5±0.02

Table 3: Peel and Pulp colour of FHIA-21 (hybrid)

Peel colour		Pulp colour	
L	63.9±0.15	L	100.36±0.21
a*	-17.4±0.16	a*	0.11±0.00
b*	35.6±0.24	b*	27.0±0.01

The peel and pulp colour of the plantain was assessed as they serve as major criteria used by consumers, growers and research workers to determine whether a fruit is ripe or unripe. In Ghana, most consumers tend to associate the colour of the pulp to maturity. If the colour of the pulp of plantains were orange/yellow or light orange then the fruit was matured, if on the other hand it was white it indicates that the fruit was immature. In general the hybrid studied had green peel colour (at matured unripe stage) as indicated by the L, a, b values (Table 3). Like plantains the pulp colour of FHIA-21 was light or bright orange comparable to the pulp colour of triploid French plantain (Dzomeku *et al*. 2004a, b). The orange colour of the pulp is an indicative of the rich provitamins and carotenoids (Gowen, 1995). The results for the peel and pulp colours of the cultivars studied were similar to the results of (Dadzie, 1993).

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