Proc. Fla. State Hort. Soc. 120:1–3. 2007.

Performance of Five Cooking Banana Accessions at the National Germplasm Repository under Limestone Soil Conditions

Tomas Ayala-Silva*, Raymond Schnell, Alan W. Meerow, and Garry Gordon

USDA, ARS, National Germplasm Repository, Subtropical Horticulture Research Station, 13601 Old Cutler Road, Miami, FL 33158

Additional index words. *Musa, Cacambou,* bunch weight, *Gipungusi,* cultivar

Five cooking bananas cultivars from the USDA-ARS SHRS National Germplasm Repository in Miami, FL, were evaluated under local edaphic and environmental conditions. The number of pseudostems per mat, height at flowering, and cycling time were determined during the first fruiting cycle (we call this the mother crop), and bunch number and bunch weight were recorded. A productivity index (PIX), calculated as 100× mean bunch weight in kilograms/cycling time in days, was used to determine the productivity of the clones over time. In addition, the susceptibility of the clones to yellow Sigatoka, caused by *Mycosphaerella musicola,* was evaluated. Preliminary results demonstrated that all the clones have resistance/tolerance to yellow Sigatoka and should be recommended for production in areas that have problems with this disease. The clones 'Bom', 'Gipungusi', 'Pelipita', and 'Cacambou' produced moderate to high yields of good to excellent fruit, and are recommended for use in all areas with a dry tropical/subtropical climate and limestone soils.

Cultivated bananas and plantain originate from two wild diploid species, *Musa acuminata* and *M. balbisiana*, with many cultivars being hybrids of these two species. Edible bananas originated in the Indo-Malaysian Archipelago (Morton, 1987), with its center of origin reaching northern Australia. They were known only by hearsay in the Mediterranean region in the third century BC, and are believed to have been first carried to Europe in the 10th century AD (Morton, 1987). Bananas and plantains are perennial crops that grow quickly and can be harvested all year round. *Musa* sp. cultivars vary greatly in plant height, fruit size, plant morphology, fruit quality, and disease and insect resistance. Most bananas have a sweet flavor when ripe; exceptions to this are cooking bananas and plantains.

Approximately 9 million hectares were planted in year 2000, and world production averaged 92 million tons per year in 1998–2000, which was estimated at 99 million tons in 2001. These figures are an approximation because the bulk of world banana production (almost 85%) comes from relatively small plots and kitchen or backyard gardens, where statistics are lacking (FAO, 2003). Bananas and plantains are grown today in every humid tropical region and constitute the fourth largest fruit crop in the world, following grapes, citrus, and apples.

The plantain and the cooking banana are two of the most important starchy food crops in Puerto Rico and rank third in monetary value among agricultural crops, with a value of $30,000,000 annually. In the past, most of the plantains and cooking bananas in Puerto Rico were grown on humid mountainsides. Since then, high prices have prompted some farmers to develop plantations on level irrigated land formerly devoted to sugarcane (U.S. Census of Agriculture, 2002).

In tropical zones of Colombia, cooking bananas are not only an important part of the human diet, but the fruits and the plants provide indispensable feed for domestic animals as well. The total plantain area is about 1,037,820 acres (420,000 ha) with a yield of 5500 lbs per acre (5500 $kg \cdot ha^{-1}$) (CTA, FAO, ITC, Rome, 1998).

Bananas and plantains are casually grown in some home gardens in southern Florida. A few small commercial plantations exist in southern Florida that supply local markets (Degner et al., 1997). Banana, cooking banana, and plantain cultivars most often grown in Florida are 'Dwarf Cavendish', 'Apple', and 'Orinoco', and the 'Macho' plantain. The 'Red' and 'Lady Finger' bananas are only occasionally grown in sheltered locations (Crane et al., 2005). Worldwide, cooking bananas are especially important. For example, in some places, people eat close to 1 kg of cooking bananas every day. They can eat in 2 weeks what the average North American and European consume in a year (INBAP, 2005). Despite the history and importance of banana in southern Florida, the crop is poorly adapted to the limestone soil conditions.

Nearly all soil types in Miami–Dade County are shallow, and several inches below the soil surface is hard calcareous bedrock. The marl and rocky calcareous soils in Miami–Dade County usually contain from 30% to 94% $CaCO_3$. The pH values of calcareous soils are greater than 7, usually in the range of 7.4–8.4 (Noble et al., 1996). Textures of calcareous soils can be sandy, loamy, or gravelly and soil depths range from less than 5 inches to several feet. These soils are important for production of vegetable, fruit, and ornamental plants in Florida. Over 85% of Florida's tropical fruits are grown on calcareous soils in the southern part of the state (Li, 2001).

Due to the low interest in commercial banana growing and the disappearance of fertile soils, urban sprawl, and an increase of people with interest in cooking bananas in southern Florida, it was of interest to test the yielding potential of cooking banana cultivars under the climatic and soil conditions found in southern Florida.

*Corresponding author; tomas.ayala-silva@ars.usda.gov

Table 1. Amounts of potassium, phosphorus, magnesium, and calcium per plant (g) and per hectare (kg) with a 500-g planting hole application of fertilizer.

	Nutrient			
	Potassium	Phosphorus	Magnesium	Calcium
Application/plant (g)	75	26	9	75
Application/ha (kg)	138	48	17	139

Materials and Methods

The experiment was carried out at the National Germplasm Repository, USDA-ARS Subtropical Horticultural Research Station (SHRS) in Miami, FL. The soil is a sandy loam, muck, and calcareous marl with a pH ~7.0–7.5. Average annual precipitation is 1360 mm with a bimodal distribution. The wet season generally lasts from June to October, and the dry season lasts from November to May. About 70% of the annual rainfall occurs during the wet season.

The land was cleared of secondary grasses, and large stumps as well as larger rocks were removed from the land; all other biomass was retained. Natural fallow vegetation was mowed and controlled with herbicides. The slashed material was retained, not burned. The soil chemical properties of the site, determined at crop establishment, are described by Crane and Valerdi (2006). Fertilization and cultural practices were as recommended for banana production under South Florida conditions (Table 1).

Suckers of five cooking banana cultivars ('Blue Torres Strait Island', 'Bom', 'Cacambou', 'Gipungusi', and 'Pelipita'), weighing at least 1.5 kg, were harvested from our current *Musa* sp. collection (Table 2). All suckers were cleaned of soil and root stumps were cut off as described by Colbran (1967). The suckers were placed in containers and submerged in water at 52 °C for 20 min. The containers were agitated, thus assuring uniform temperature distribution within the containers. Then the suckers were treated with fungicides and nematicides.

Suckers were planted at a within-row distance of ~2 m and an inter-row distance of 3.63 m. Each replication contained four plants. Planting holes of 20 × 20 × 20 cm were dug. A layer of about 5 cm of topsoil was placed into the planting hole. The plots were weeded by slashing the growth at soil surface level with machetes and mowers as needed. Weekly microirrigation (MaxiJet®) and standard fertilization practices for banana were used for the duration of the experiment.

Four months after planting, the number of suckers were recorded weekly. Banana bunches were tagged at the time of flower emergence (shooting); plant height and the date of flower emergence of each plant were recorded so as to calculate the physiological age of the bunch at the time of harvest. At flowering, the plant height was measured from the pseudostem base to the overlap of the last two emerged leaves, and the height was recorded. Yield measurements and assessments of bunches were made on all plants. Bunches were harvested when the fingers had reached maximum width and before they began to turn yellow. At harvest, the number of hands were counted and then cut from the rachis. Number of hands, fruits/hand, thickness (mm) and length (mm), and total bunch weight were recorded.

Yields were based on fresh bunch weights and reported yields

Table 2. Variety, origin, genome/ploidy level, and accession numbers, synonyms, and usage for cooking bananas at USDA ARS SHRS.

Variety[z]	Origin	Genome[y]	Accession no.[x]	Synonyms	Usage
Blue Torres Strait Island	Australia	ABB	ITC-0338 MIA 34918	N/A	Cooking
Bom	Papua New Guinea	ABB	ITC-0053 MIA34907	Pisang awak	Cooking
Cacambou	Australia/India	ABB	ITC-0058 MIA 34914	('Blugoe' of the British)	Cooking
Gipungusi	Malaysia	ABB	ITC-0173 MIA 34910	N/A	Cooking
Pelipita	Philippines	ABB	ITC-0472 MIA 34923	Pelipia Pisang Kuri	Cooking

[z]Variety names are those assigned by the original donor the International Plant Genetic Resources Institute (IPGRI) and International Network for the Improvement of Banana and Plantain (INIBAP; Daniells et al., 2001).
[y]Genome (A and B) refer to the haploid contributions of *Musa acuminata* and *Musa balbisiana* to the ploidy of the cultivars.
[x]Accession numbers are for the International Transit Center (ITC) in Belgium, and the Miami Repository collection (MIA) in Miami, FL.

Table 3. Mean growth characteristics of five cooking cultivars of banana.

Variety[z]	Ht at fruiting (m)[y]	Plant diam (cm)	Pseudostems per mat	Cycling time (d)[x]
Blue Torres Strait Island	1.73 de[w]	40.0 cd	5.62 b	370 c
Bom	2.64 b	46.67 b	4.62 d	475 b
Cacambou	1.97 d	38.48 e	7.0 a	368 c
Gipungusi	3.52 bc	41.91 c	5.81 b	343 d
Pelipita	3.61 a	56.72 a	5.0 bc	500 a

[z]Variety source, genome are listed in Table 2.
[y]Height in meters from base of plant to top of peduncle.
[x]Days from planting to first fruit collected.
[w]Mean separation within columns by Tukey's test.

Table 4. Yield characteristics of five varieties of cooking banana.

Variety[z]	No. hands per bunch	Bunch wt (kg)	Total fruits	Productivity index[y]
Blue Torres Strait Island	4.5 c[x]	3.2 cd	41. 5 c	0.56 e
Bom	7.5 a	6.80 a	91.0 a	1.43 b
Cacambou	4.3 cd	4.4 bc	36.0 de	1.20 c
Gipungusi	4.0 cde	4.55 b	38.0 d	2.02 a
Pelipita	5.5 b	6.50 a	63.0 b	1.02 cd

[z]Cultivar source, genome are listed in Table 2.
[y]Productivity index = 100 × bunch weight/cycling time.
[x]Mean separation within columns by Tukey's test.

were cumulative for the reps. Harvested plants were cut at ground level and the largest sucker was retained to grow the ratoon crop and seed. Within treatments, accessions were completely randomized and replicated four times; replications were single plants. Data were submitted to analysis of variance and a mean separation by Tukey's test ($P = 0.05$).

Results and Discussion

Mean suckering rate per mat ranged from 4.62 to 7.0 during the initial harvesting cycle (Table 3). Height at fruiting and cycling time varied significantly among clones. 'Pelipita' was more than 2 m taller than both 'Blue Torres Strait Island' and 'Cacambou', but not much different from 'Bom' and 'Gipungusi'. Cycling time varied from 343 d for 'Gipungusi' to 500 for 'Bom' (Table 3). Bunch weight was highly correlated with accession, ranging from 2.8 kg for 'Blue Torres' to 6.8 for 'Bom' (Table 4). Productivity indexes ranged from 0.56 for 'Blue Torres Strait Island' to 2.02 for 'Gipungusi' (Table 4). Plant diameter was also significant among cultivars. Mean total fruits were highly significantly different for 'Bom' and 'Pelipita', with 91 and 63 total fruits, respectively.

All cultivars performed well under the limestone soil conditions and minimal irrigation. There were no significant differences (i.e., yield, height, diameter) from plants planted in raised beds or with supplementary water available (data not shown, field observation). However, it was noticed that plants planted without a bed remained standing during the entire year (no loss of plants due to high winds; personal observation). In addition, all clones showed a tolerance or resistance to yellow Sigatoka. This could have been the result of perhaps less water accumulated and the soil structure.

All the clones tested had an ABB genome and only 'Pelipita' had been grown here before. All clones but 'Blue Torres Strait Island' and 'Bom' showed ABB characteristics (plantain-like appearance). These two clones showed more characteristics of a dessert banana than a cooking banana. Even though these clones are not new (received in 1993–94) to the United States, very little is known. All clones showed good resistance to high winds, performed well under limestone soil conditions, and showed tolerance/resistance to yellow Sigatoka. In addition, most banana varieties are sensitive to cold weather (Stover and Simmonds, 1987); however, all these varieties demonstrated tolerance/resistance to cold weather.

Based on these preliminary results, these varieties should be considered for cultivation in South Florida. They could be used as a source for cooking bananas, windbreaker, or ornamental use. Fruit taste and appearance were evaluated but not reported here. Further research using a colorimeter to determine appearance, and level of ripeness (Brix) will be conducted during the second-year harvest.

Literature Cited

Biodiversity International. 2006. Why bananas matter. <http://bananas.bioversityinternationa.org/content/view/>.

Census of Agriculture. 2002. National Agriculture Statistics Service, USDA. Puerto Rico Vol. 1, Geographic Area Ser. Part 52.

Colbran, R.C. 1967. Hot-water tank for treatment of banana planting material. Advisory Lflt. No. 924. Div. Plant Ind., Dept. of Primary Ind., Queensland, Australia.

Crane, J.H., C.F. Balerdi, and I. Maguire. Banana growing in Florida home landscape, HS-10. University of Florida–IFAS, Coop. Ext. Serv., Gainesville, FL. p. 1–13 (published 1989; rewritten 1998; revised 2006). <http://edis.ifas.ufl.edu/MG040>.

Dadzie, B.K. and J.E. Orchard. 1997. Routine post-harvest screening of banana/plantain hybrids: Criteria and methods. Inibap Technical Guidelines 2. Intl. Plant Genet. Resources Inst., Rome; Intl. Network for the Improvement of Banana and Plantain, Montpellier, France; ACP-EU Tech. Ctr. for Agr. and Rural Cooperation, Wageningen, The Netherlands.

Daniells, J., D. Jenny, D. Karamura, and K. Tomekpe. 2001. Musalogue: A catalogue of *Musa* germplasm. Diversity in the genus *Musa*. E. Arnaud and S. Sharrock, compil. Intl. Network for the Improvement of Banana and Plantain, Montpellier, France.

Degner, R.L., S.D. Moss, and W.D. Mulket. 1997. Economic impact of agriculture, agribusiness in Dade County, Florida. FARMC Ind. Rpt. 97-1. Florida Agr. Mkt. Res. Ctr., Food Resource Econ. Dept., Univ. of Florida–IFAS, Gainesville.

FAO ROME .1998. Banana exports from Latin America and the Caribbean; the market, the evolving policy framework and development options. FAO, IICA, WB, Rome, 23–24 Nov. 1998.

FAO ROME. 2003. Prepared by P. Arias, Cora Dankers, Pascal Liu, and Paul Pilkauskas. The world banana economy 1985–2002. FAO, Rome, 2003.

INIBAP. 2005. Using the diversity of banana and plantain to improve lives. INIBAP Annu. Rpt. 2004. INIBAP, Montpellier, France.

Li, Y.C. 2001. Calcareous soils in Miami–Dade County. Fact Sheet SL 183, Florida Coop. Ext. Serv., Inst. Food Agr. Sci., Univ. of Florida. <http://edis.ifas.ufl.edu>.

Noble, C.V., R.W. Drew, and J.D. Slabaugh.1996. Soil survey of Dade County area, Florida, U.S. Dept. Agr., Natural Resources and Conservation Serv.

SAS Institute. 2004. The SAS system for windows. Release 9.1. SAS Inst., Cary, NC.