

Yield and fruit quality of the Superplátano grown on an Ultisol with supplemental irrigation^{1,2}

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ABSTRACT

The French-type Superplátano (*Musa*, AAB) clone planted on a highly weathered soil under supplemental irrigation was subjected to various bunch (raceme) treatments. Two weeks after bunch emergence the immature racemes were pruned to either four, five or six uppermost hands. Subsequently, some of the pruned racemes were sprayed with a growth regulator (Pro-Gibb) solution containing 50 ml/L of gibberellic acid, whereas others were not sprayed. Both sprayed and unsprayed bunches were immediately bagged and others were left unbagged. The false-horn type Maricongo plantain with unpruned, unsprayed and unbagged racemes was used as a control. Growth regulator spraying and bagging had no significant effect on bunch and fruit traits. Pruning, however, significantly affected bunch number of fruits and weight, bunch mean fruit weight, and individual fruit traits in the distal hand. A reduction in number of hands from six to four substantially increased bunch mean fruit weight, thickness, length and weight of individual fruits in the distal hand. The Superplátano with the bunch pruned to five hands averaged 66 marketable fruits and weighed 20.7 kg. Bunch mean fruit weight was 314 g, well over the 270 g weight criterion used for local marketable grade fruits. These bunches contained significantly more fruits and were heavier than the unpruned Maricongo racemes with 7.4 hands. Only bunches pruned to four hands, however, had a bunch mean fruit weight similar to that of the unpruned Maricongo. Fruits in the distal hand of the Superplátano bunch pruned to either four or five hands compared in thickness, outer length and weight to those corresponding to the same numerical hand of the unpruned Maricongo raceme.

Key words: plantain clones, bunch treatment, yield, quality

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RESUMEN

Rendimiento y calidad de las frutas del Superplátano sembrado en un suelo Ultisol con riego suplementario

Se determinó el potencial de producción del clon Superplátano (*Musa*, AAB) sembrado en un suelo Ultisol con riego suplementario y sometido a varios tratamientos del racimo. A las dos semanas después de emerger el racimo inmaduro, se removieron la yema floral (pámpano) y las manos inferiores hasta dejar las cuatro, cinco o seis manos superiores del racimo. Algunos de los racimos se asperjaron con una solución de un regulador de crecimiento (Pro-Gibb) que contenía 50 ml/L de ácido giberélico mientras que los otros racimos se dejaron sin asperjar. Algunos racimos podados y asperjados y sin asperjar se enfundaron inmediatamente con bolsas de polietileno mientras que otros se dejaron sin enfundar. El clon Maricongo con racimos sin tratar sirvió como control. Los tratamientos con el regulador y el enfundado no tuvieron efectos significativos sobre los atributos del racimo y las frutas individuales. El tratamiento de poda, sin embargo, afectó significativamente el número de frutas y el peso del racimo, el peso medio de todas las frutas en el racimo y el tamaño y peso individual de las frutas en la última mano. La reducción en el número de manos de seis a cuatro aumentó sustancialmente el peso medio de todas las frutas en el racimo y el grosor, largo y peso individual de las frutas en la última mano. El Superplátano con el racimo podado a cinco manos produjo un promedio de 66 frutas mercadeables con un peso de 20.7 kg. El peso medio de todas las frutas fue de 314 g, un peso mayor de los 270 g que se utiliza localmente como criterio para clasificar las frutas como mercadeables. Estos racimos tenían un número significativamente mayor de frutas y eran más pesados que los racimos sin podar del Maricongo con 7.4 manos. Sin embargo, sólo los racimos podados a cuatro manos produjeron frutas con un peso medio comparable al Maricongo. Las frutas en la última mano del racimo del Superplátano podado a cuatro y cinco manos compararon en grosor, largo externo y peso medio con las frutas correspondientes a la misma mano numérica del racimo sin podar del Maricongo.

INTRODUCTION

Plantain (*Musa*, AAB) is the second most economically important crop in Puerto Rico (Ortiz-López, 1992). From 1988 through 1994 the mean annual production was about 295 million fruits with a crop value of \$35 million. This represents an average farm gate price of \$0.12 per fruit (J. Ortiz-López, Agricultural Experiment Station, Corozal, PR, personal communication). All the production was consumed locally. In order for plantains to maintain this high competitive farm price, the production has to be kept at about 300 million fruits per annum.

Local plantain growers have access to updated production technology (Anonymous, 1995), and most of them have the capacity to expand production but are restricted by the limitation of the local market. Currently, there are no economic incentives to justify an increase in production, unless efforts are made to explore the export market or to rehabilitate the plantain processing industry. Puerto Rican growers have an excellent opportunity to export quality plantains to the U.S.

market, particularly to those metropolitan centers with large concentrations of hispanic consumers (Vicente-Chandler, 1994). Both local and export markets demand mature-green fruits that are uniform in size and weight.

The French-type Superplátano clone produces bunches containing a large number of hands and underweight fruits. This clone offers growers the opportunity to increase yields and produce fruits uniform in size, if the bunch is properly managed. The technique of removing the lower hands of the immature bunch has been effective in increasing fruit size and weight, and improving the shape of the fruits that remained in the pruned Superplátano raceme (Irizarry et al., 1991). In Puerto Rico, a mature-green plantain fruit is considered marketable if it weighs 270 g or more.

In addition to bunch pruning, bagging (González and Soto, 1987) and gibberellic acid (GA₃) applications (Mishra et al., 1981; Tadros et al., 1984) have been reported to increase yield and improve fruit quality in bananas (*Musa*, AAA).

This study reports the effect of various bunch treatments on yield and individual fruit traits of the Superplátano plantain clone grown on an Ultisol with supplemental irrigation.

MATERIALS AND METHODS

An experiment was established 1 July 1993 at the Corozal Substation (AES-UPR), located in the north-central region of Puerto Rico at about 200 m elevation. The substation's 26-year mean monthly maximum and minimum temperatures are 29.5 and 19.6°C, respectively. Mean annual rainfall is 1,860 mm and Class A pan evaporation is 1,390 mm (Goyal and González, 1989). Table 1 shows the monthly weather data and irrigation applied during the experimental period.

The soil is a Corozal clay, an Ultisol (Aquic Haplohumults, clayey, mixed, isohyperthermic (Lugo-López et al., 1995). In the top 20-cm layer the pH was 5.0, containing 5 mg/kg of P (Bray method 2), and an exchangeable cation capacity of 9.1 cmol (+)/kg of soil.

The French-type Superplátano clone was subjected to twelve bunch treatments arranged in a split plot design with four replications. Bunch pruning (main treatment) consisted in the removal of the male flower bud and lower hands from the immature Superplátano racemes to maintain either four, five or six uppermost hands. The pruned bunches were either sprayed with a Pro-Gibb³ solution containing 50 ml/L of

³Mention of a trade name in this publication is only to provide specific information. It does not constitute a warranty of materials by the USDA-ARS or the AES-UPR, nor is this mention a statement of preference over other materials.

TABLE 1.—*Monthly maximum and minimum temperatures, rainfall and evaporation recorded, and irrigation water applied to plantain during 1 July 1993 through 31 August 1994 at the Corozal Substation.*

Month	Temperature		Rainfall mm	Evaporation mm	Irrigation Applied L/plant
	Maximum °C	Minimum °C			
July 1993	30.9	21.8	156.7	151.9	—
August ¹	31.8	21.9	69.3	160.8	68
September	31.6	21.2	228.3	112.8	6
October	31.2	20.9	35.1	105.7	149
November	29.6	20.4	179.8	103.9	235
December	29.1	18.9	36.6	88.9	159
January 1994	28.3	18.4	58.7	93.7	152
February	29.1	17.8	18.8	108.5	247
March	30.6	18.1	23.4	148.6	317
April	30.2	18.7	151.4	129.5	85
May	32.2	20.2	64.5	155.4	242
June	33.1	20.8	9.1	176.3	395
July	32.4	20.8	67.1	184.2	334
August	32.5	21.2	131.1	151.9	207

¹First irrigation applied: 10 August 1993.

gibberellic acid and 3 ml of the sticker X-77 Spreader/3.8 L of water, or not sprayed (sub-treatment). Both sprayed and unsprayed bunches were either covered with clear plastic polyethylene bags or left uncovered. Each sub-treatment contained a total of 24 individual observations. Treatments were applied about two weeks after bunch emergence. The false-horn Maricongo plantain was used as a control but the racemes were not subjected to bunch treatments.

The experiment consisted of thirteen rows 7.32 m long. Each row accommodated six experimental plants spaced at 1.22 m between plants and 3.05 m between rows, about 2,628 plants per hectare. These rows represented the twelve bunch treatments and the control. The experiment was surrounded by guard rows.

The planting material consisted of medium size corms weighing about 2 kg and obtained from sword suckers. At planting, 11 g of P as superphosphate was placed under the propagating corms. The experiment was drip irrigated from the outset on alternate days, Monday through Friday, by replenishing each week the water lost through evapotranspiration and after subtracting any recorded rainfall from the previous week (Goenaga et al., 1993). No irrigation was applied

when the total rainfall of the preceding week exceeded 20 mm. About 45 days after planting, the plants began receiving through the drip system weekly applications of N, K and Mg at the rate of 7.2, 16.4 and 1.6 kg /ha, respectively. The source of nutrients were urea, potassium nitrate and magnesium sulfate (Epsom salts). Because six months after planting the nitrogen content in the third uppermost leaf was excessively high and magnesium critically low, the nitrogen applications were reduced to 6.0 kg/ha and the source of magnesium was changed to granular Kieserite applied at the rate of 112 g/plant every three months. When irrigation was not necessary, the weekly fertigation was postponed and applied at a double rate the following week.

Yellow Sigatoka, nematodes, soil-borne insects and weeds were controlled in accordance with the recommendations contained in the plantain and banana technological package of practices (Anonymous, 1995).

Plant measurements (pseudostem height and diameter) and number of functional leaves were recorded at the stage of bunch-shooting. These measurements were taken from the base of the plant to about 1 m above ground for pseudostem diameter and at the point of bunch emergence for pseudostem height. Between 100 and 110 days after bunch-shooting, the racemes were harvested, weighed, and the hands per bunch and fruit per hand counted. Four fruits from the two rows in the middle section of the distal hand of the pruned Superplátano bunch, and from the fourth, fifth and sixth hands of the unpruned Maricongo raceme were sampled. We proceeded to determine fruit diameter, inner and outer lengths and mean weight. The recorded data were statistically analyzed by using the ANOVA procedure and the means compared by using LSD at $P \leq 0.05$.

RESULTS AND DISCUSSION

There were no significant differences between Superplátano and Maricongo clones for pseudostem height and number of functional leaves at bunch-shooting (data not shown). All plants developed about the same pseudostem height, 3.5 m, and contained 10 functional leaves, which is considered acceptable for normal fruit filling. However, Superplátano plants developed a significantly thicker pseudostem, 17.8 cm, than Maricongo, whose pseudostems averaged 16.8 cm.

Bunch pruning, growth regulator application and fruit bagging had no significant effect on the number of days required for fruit filling (data not shown). All bunches were harvested about 105 days from bunch-shooting.

TABLE 2. — *Yield of the Superplátano clone with the bunch pruned to a reduced number of hands and the Maricongo with the unpruned raceme.*

Clone and bunch pruning treatment	Bunch yield		Bunch mean fruit weight g
	Fruits no.	Weight kg	
Superplátano - pruned to six hands	78.1	19.3	252.9
Superplátano - pruned to five hands	66.1	20.7	313.7
Superplátano - pruned to four hands	52.8	18.0	340.8
Maricongo - unpruned with 7.4 hands	48.2	17.6	365.1
LSD (0.05)	3.5	1.4	34.1

Regardless of the number of hands that remained in the Superplátano bunch after pruning, growth regulator and bagging subtreatments, alone or combined, had no significant effect on bunch and fruit traits (data not shown). Pruning, however, significantly affected bunch yield and bunch mean fruit weight in the Superplátano (Table 2). The Superplátano bunch pruned to either four, five or six hands contained significantly more fruits than the unpruned Maricongo with 7.4 hands. However, on the basis of the local marketable bunch mean fruit weight criterion of 270 g, only fruits of the Superplátano pruned to four, and five hands attained a marketable grade. Bunch mean fruit weight significantly increased at the expense of reducing bunch size from six to five hands.

There were no significant differences between the Superplátano bunch pruned to four hands and the unpruned Maricongo raceme for marketable weight and bunch mean fruit weight (Table 2). Both attained similar marketable weight, which averaged 17.8 kg, and produced the heavier fruits with a mean fruit weight of 353 g.

Bunch pruning significantly affected fruit traits in the distal hand of the Superplátano (Table 3). Fruit diameter, inner and outer lengths

TABLE 3. — *Effect of bunch pruning on fruit traits of the distal hand of the Superplátano bunch pruned to either four, five or six uppermost hands.*

Bunch pruning treatment	Fruit diameter mm	Fruit inner length cm	Fruit outer length cm	Fruit mean weight g
Four hands	43.9	24.9	26.3	282.6
Five hands	42.7	24.8	25.7	271.7
Six hands	38.1	22.0	22.1	173.7
LSD (0.05)	1.6	1.5	2.8	18.2

TABLE 4. — Comparison of fruit traits in the distal hand of the Superplátano bunch pruned to either four, five or six uppermost hands with fruits corresponding to the same numerical hand of the unpruned Maricongo raceme.

Clone	Fruit diameter			Fruit inner length			Fruit outer length			Fruit mean weight			Fruits per hand		
	Fourth	Fifth	Sixth	Fourth	Fifth	Sixth	Fourth	Fifth	Sixth	Fourth	Fifth	Sixth	Fourth	Fifth	Sixth
	----- mm -----			----- cm -----			----- cm -----			----- g -----			----- no. -----		
Superplátano	43.9	42.7	38.1	24.8	24.9	22.0	26.3	25.7	22.2	282.6	271.7	173.7	12.3	12.2	12.2
Maricongo	45.7	45.9	44.9	27.5	27.0	25.6	27.6	27.4	26.0	333.3	306.4	287.3	6.6	5.5	4.3
LSD (0.05)	NS	NS	3.2	1.2	1.4	NS	NS	NS	3.7	NS	NS	42.6	1.5	1.4	0.7

TABLE 5.—*Estimated total yield obtained in the Superplátano clone with the bunch pruned to a reduced number of hands and in Maricongo with the unpruned raceme.*

Clone and bunch pruning treatment	Yield per hectare	
	Fruits no.	Weight kg
Superplátano - pruned to six hands	205,247	52,034
Superplátano - pruned to five hands	173,711	54,400
Superplátano - pruned to four hands	138,758	47,304
Maricongo - unpruned with 7.4 hands	126,670	46,253
LSD (0.05)	9,198	3,679

and individual fruit weight were substantially increased at the expense of reducing bunch size from six to either four or five hands.

Fruits harvested in the distal hand of the Superplátano bunch pruned to either four or five hands were similar in thickness, outer length and mean weight to those corresponding to the same numerical hand of the unpruned Maricongo raceme (Table 4). Fruit inner length, however, was significantly greater on the unpruned Maricongo. This evidenced a more pronounced fruit curvature, an undesirable marketable trait that is typical of most fruits in the middle hands of the Maricongo. The additional beneficial effect of bunch pruning on fruit shape has been previously reported (Irizarry et al., 1991). All fruits harvested from the distal hand of the Superplátano bunch pruned to six hands were inferior in size, weight and grade to fruits harvested in the same numerical hand of the unpruned Maricongo raceme. The Superplátano bunch always contained significantly more fruits in the four, five and six hands, which averaged 12.2 fruits. The Maricongo raceme averaged only 5.5 fruits in the same numerical hands.

Total yield per hectare was significantly affected by bunch pruning. The Superplátano clone with the bunch pruned to five hands always yielded more than the Maricongo with the unpruned raceme for number and weight of fruits per hectare (Table 5). About 47,000 more fruits per hectare of comparable size and weight to that of the unpruned Maricongo, and of acceptable local marketable grade, can be harvested in the Superplátano clone grown on an Ultisol with supplemental irrigation, and with the bunch pruned to five hands. This yield difference was greater than when both clones were evaluated under a similar management system on a Mollisol of the semiarid region (Irizarry and Goenaga, 1995). Moreover, on the basis of individual fruit traits, the

Superplátano with the bunch pruned to five hands was capable of yielding superior marketable grade fruits at Corozal.

LITERATURE CITED

- Anonymous, 1995. Conjunto tecnológico para la producción de plátanos y guineos. Publ. 97., Esta. Exp. Agric. Univ. P.R.
- Goenaga, R., H. Irizarry and E. González, 1993. Water requirements of plantains (*Musa acuminata* × *Musa balbisiana*, AAB) grown under semiarid conditions. *Trop. Agric. Trinidad* 70(1):3-7.
- González, M. and M. Soto, 1985. Effect of bagging on the fruit quality of the banana (*Musa* AAA), Cavendish "Great Dwarf". Proc. ACORBAT, 7th Meet. (Sept. 23-27), San José, Costa Rica 347-350.
- Goyal, M. R. y E. A. González, 1989. Datos climatológicos de las subestaciones experimentales agrícolas de Puerto Rico. Publ. 88-70, Esta. Exp. Agric. Univ. P.R.
- Irizarry, H., E. Rivera, A. D. Krikorian and J. A. Rodríguez, 1991. Proper bunch management of the French-type superplantain (*Musa acuminata* × *M. balbisiana*, AAB) in Puerto Rico. *J. Agric. Univ. P.R.* 75(2):163-171.
- Irizarry, H. and R. Goenaga, 1995. Yield and quality of 'Superplátano' (*Musa*, AAB) grown with drip irrigation in the semiarid region of Puerto Rico. *J. Agric. Univ. P.R.* 79(1-2):1-11.
- Lugo-López, M. A., F. H. Beinroth, R. L. Vick, G. Acevedo and M. A. Vázquez, 1995. Updated taxonomic classification of the soils of Puerto Rico, 1994. Bull. 294, Agric. Exp. Sta. Univ. P.R.
- Mishra, S. D., B. M. Desai and B. K. Gaur, 1981. Effect of gibberellic acid spraying on banana fruit development. *Current Sci.* 50(6):275-277.
- Ortiz-López, J., 1992. Plátanos y guineos: Situación y perspectivas—Empresas agrícolas de Puerto Rico 1989-90, 1990-91. Esta. Exp. Agric. Univ. P.R.
- Tadros, M. R., A. S. Khalifa, A. Z. Bondok and M. B. Bastauros, 1984. Effect of GA₃ application on the growth of banana bunches. *Annals Agric. Sci., Fac. Agric., Ain Shams Univ., Cairo, Egypt* 29 (1):485-492.
- Vicente-Chandler, J., 1994. Una agricultura para los 90 e inicios del 2000. Depto. Agric. de Puerto Rico, Santurce, P.R.