Yield potential and fruit traits of the French-type 'Dwarf Superplátano' clone evaluated at three locations[1,2]

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ABSTRACT

The French-type 'Dwarf Superplátano' (*Musa* AAB), a reverted clone selected from the local false horn-type 'Common Dwarf' plantain, was subjected to various bunch management treatments at three locations. The immature bunches were pruned to either three, four or five uppermost hands. Those pruned to four and five hands were either sprayed with a gibberellic acid solution or not sprayed. Both sprayed and unsprayed bunches were immediately bagged or left unbagged. Spraying with gibberellic acid and bagging, alone or combined, had no significant effect on bunch yield components nor on fruit traits. Regardless of location, pruning significantly reduced bunch size and the time needed for fruit filling. Bunches pruned to five, four and three hands averaged 79, 66 and 50 fruits, respectively. Pruning from five to three hands significantly reduced fruit filling to 112 days. Pruning also affected bunch yield and bunch mean fruit weight, but the effect varied with location. A reduction in bunch size from five to four hands at Corozal and from four to three hands at Salinas and Yauco substantially reduced bunch yield by 12 and 23%, respectively. Bunch mean fruit weight significantly increased at the expense of reducing bunch size to three hands at Corozal and to four hands at Salinas and Yauco. Bunch mean fruit weight at Corozal was always superior to that at Yauco. Regardless of location, pruning significantly brought about an increase in fruit size in the distal hand. The thickest and largest fruits were produced in bunches pruned to three hands. Likewise, pruning significantly increased mean fruit weight in the distal hand, but the effect varied with location. At Corozal, fruits in the distal hand of bunches pruned to three hands attained the heaviest mean weight, 355 g. Regardless of location, a reduction in hands from five to four upgraded fruits in the distal hand from non-marketable to marketable by in-

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creasing their weight to over 270 g. We inferred that under intensive management the French-type 'Dwarf Superplátano' clone with the bunch pruned to four uppermost hands has the potential to yield 173,000 fruits per hectare, equivalent to 57.6 t of fruits per hectare. These fruits conform to the local marketing standards established for the 'Maricongo' plantain.

Key words: French-type 'Dwarf plantain', Musa AAB, bunch pruning, fruit quality, yield

RESUMEN

Rendimiento y características de las frutas del 'Superplátano' francés-enano evaluado en tres localidades

El 'Superplátano' tipo francés-enano (*Musa* AAB), una selección clonal del plátano local 'Enano-Común' tipo cuerno, se sometió a varios tratamientos de manejo del racimo en tres localidades. Dos semanas después de emerger los racimos tiernos, estos se podaron hasta dejar las tres, cuatro o cinco manos superiores del racimo. Algunos de los racimos podados a cuatro y cinco manos se asperjaron con una solución de ácido giberélico mientras que otros se dejaron sin asperjar. Algunos de los racimos asperjados y sin asperjar se enfundaron con bolsas de polietileno y otros se dejaron sin enfundar. Los tratamientos con el regulador de crecimiento y el enfundado, solos o combinados, no tuvieron efectos significativos sobre los componentes de rendimiento y las características de las frutas. Irrespectivo de la localidad, la poda redujo significativamente el tamaño del racimo y los días necesarios para el engorde de las frutas. Los racimos podados a cinco, cuatro y tres manos promediaron 79, 66 y 50 frutas, respectivamente. La poda a tres manos redujo el tiempo de engorde de las frutas a 112 días. La poda también afectó el peso del racimo y el peso medio de las frutas en el racimo pero el efecto varió por localidad. La reducción en el tamaño del racimo de cinco a cuatro manos en Corozal y de cuatro a tres manos en Salinas y Yauco redujo sustancialmente el rendimiento en 12 y 23%, respectivamente. El peso medio de todas las frutas en el racimo aumentó significativamente a expensas de la reducción en el tamaño del racimo a tres manos en Corozal y a cuatro manos en Salinas y Yauco. El peso medio de las frutas en Corozal fue siempre superior al obtenido en Yauco. Irrespectivo de la localidad, la poda incrementó significativamente el tamaño de las frutas en la última mano del racimo. Las frutas de mayor grosor y largo se produjeron en los racimos podados a tres manos. Igualmente, la poda aumentó sustancialmente el peso medio de las frutas en la última mano pero el efecto dependió de la localidad. En Corozal las frutas en la última mano de los racimos podados a tres manos alcanzaron el mayor peso promediando 355 g. Irrespectivo de la localidad, la reducción en el tamaño del racimo de cinco a cuatro manos promovió la clasificación de las frutas en la última mano de no mercadeables a mercadeables al adquirir un peso mayor a los 270 g. Inferimos que bajo manejo intensivo el clon Superplátano francés-enano con el racimo podado a cuatro manos superiores tiene el potencial de producir 173,000 frutas mercadeables por hectárea, equivalente a 57.6 t de frutas por hectárea. Estas frutas cumplen con los requisitos locales de mercadeo establecidos para el plátano 'Maricongo'.

INTRODUCTION

The cost of plantain production in Puerto Rico has increased about 27% since 1986 (Irizarry and Montalvo-Zapata, 1986; Anonymous, 1995). During the same period the farm-gate value of the crop has increased by only 16.7% (Soto-Santiago et al., 1996). For plantain to remain a profitable crop without affecting the consumer price, it will be necessary to increase yield to compensate for the increased cost of production.

Currently, about 90% of the local plantain production originates from the false-horn 'Maricongo' clone, and the local market grading system is based on its fruit traits. A 'Maricongo' fruit is considered marketable if it weighs 270 g or more, and attains a superior grading when the outer length of the intact fruit reaches 25.4 cm or more (Soto-Santiago, 1994). The yield potential of 'Maricongo' is about 45 marketable fruits per bunch; however, the clone is unstable for bunch genotype and number of hands and fruits (Irizarry et al., 1985; Krikorian et al., 1993). Under conventional propagation, bunch reversion from false-horn to French-type is relatively low (Irizarry et al., 1985), but depending on pre-existing factors such as the presence of chimerism in the primary explant, the problem is exacerbated when in vitro micropropagation is used (Krikorian et al., 1993).

The use of French-type plantain clones for commercial production is increasing in popularity. Current genetic improvement programs focus on the development of disease resistant French-type tetraploid hybrids for the export market (Vuylsteke et al., 1993; Rowe, 1994). The 'Superplátano', a stable French-type triploid clone selected from the reverted false-horn 'Maricongo', has the capacity to yield over 20% more than its counterpart if proper bunch management is used (Irizarry and Goenaga, 1995; 1997). Both clones, however, develop a tall pseudostem (over 3.5 m), which renders the plant susceptible to wind damage, and makes bunch management more difficult, particularly when grown on steep land.

In an attempt to overcome these problems, a French-type 'Dwarf Superplátano' clone (*Musa* AAB) was selected from the false-horn Common Dwarf plantain. This stable clone develops a shorter pseudostem, 2.4 to 2.6 m in height, and produces bunches containing 8 to 9 hands with 120 to 135 undersized and underweight fruits (Unpublished data). These fruits, however, are not marketable in Puerto Rico unless the size and weight is increased.

The technique of pruning lower hands of a bunch has been successfully used to improve fruit traits in French-type plantains (Irizarry et al., 1991). Bunch bagging (González and Soto, 1985) and gibberellic acid (GA_3) applications (Tadros et al., 1984) have also been reported to increase yield and improve fruit quality in bananas, *Musa* AAA.

To upgrade fruits from non-marketable to marketable, and to determine the yielding capacity of the clone, we applied various bunch treatments to 'Dwarf Superplátano' at three locations.

MATERIALS AND METHODS

Three experiments were established May, June and July 1994 in the municipalities of Yauco, Salinas and Corozal, respectively. The Yauco experiment was located on a private farm in the Barinas ward, about 35 m elevation. Mean historical annual rainfall is 990 mm, and class A pan evaporation is 2,040 mm (Hadeen, 1990). The soil is a San Antón silty clay (Cumulic Haplustolls, fine loamy, mixed, isohyperthermic) (Lugo-López et al., 1995). Soil from the top 25-cm layer had pH of 7.4, contained 9.8 mg/kg of P (Olsen method) and had an exchangeable cation capacity of 31.9 cmol (+)/kg of soil. Throughout the duration of the experiment the plants were drip irrigated at the weekly rate of 55 L/plant, somewhat less than the 0.75 Class A pan factor recommended for the region (Goenaga and Irizarry, 1995).

The Salinas experiment was carried out on a private farm in the Aguirre ward, about 20 m elevation. Mean historical annual rainfall and Class A pan evaporation are 1,070 and 2,150 mm, respectively (Hadeen, 1990). The soil is a Fraternidad clay (Typic Haplusterts, fine, montmorillonitic, isohyperthermic) (Lugo-López et al., 1995). Soil from the top 25-cm layer had a pH of 7.5, contained 10.3 mg/kg of P (Olsen method) and had an exchangeable cation capacity of 28.3 cmol (+)/kg of soil. During the planting-to-harvest cycle the plants were drip-irrigated. Each plant received approximately 85 L of water weekly, equivalent to the region estimated Class A pan factor of 1.0 (Goenaga and Irizarry, 1995). Both Yauco and Salinas experiments were located in the semiarid region, where rainfall is low and evaporation high. However, an appreciable amount of rainfall occurs during the months of May and August through November. During these months the irrigation scheme was modified to consider the amount of rainfall recorded the previous week.

The Corozal experiment was located at the Corozal substation (AES-UPR) in the north-central upland region, about 200 m elevation. Throughout the experiment the mean monthly minimum and maximum temperatures were 19.8 and 31.1°C, respectively. Annual rainfall was 1,590 mm; Class A pan evaporation 1,400 mm. In addition to the rainfall, the plants received supplemental drip irrigation at the weekly rate of 25 L/plant. The actual weekly irrigation applied depended on the amount of water lost through evapotranspiration after subtracting any recorded rainfall from the previous week (Goenaga and Irizarry, 1995). The soil is a Corozal clay (Aquic Haplohumults, clayey, mixed, isohyperthermic) (Lugo-López et al., 1995). In the top 25-cm layer the pH was raised to about 5.2 with the application of limestone at the rate of 5.0 t/ha. The soil contained 6.2 mg/kg of P (Bray method 2), and had an exchangeable cation capacity of 9.9 cmol (+)/kg of soil.

The planting material was originated from in vitro micropropagated plants, that had reached about 25-cm height. Cultures had been initiated from shoot tips and male floral stem tips (Krikorian et al., 1993). The plants were spaced 1.22 m apart in the row with 3.05 m between rows, approximately 2,628 plants per hectare. Each row accommodated 18 experimental plants per replication. The experiment was surrounded by guard rows.

At planting, plants were fertilized with 11 g of P as triple superphosphate placed on the bottom of the furrow. Two weeks later, plants in Salinas and Yauco experiments began receiving weekly applications of N and K through the drip system at the rate of 7.8 and 16.1 kg/ha, respectively. A total of 280 kg/ha of N and 581 kg/ha of K were applied until the plants reached the bunch-emergence peak, about nine months after planting. The Corozal experiment was fertilized with 2,800 kg/ha of a 10-0-25-3 (N, P_2O_5, K_2O, MgO) fertilizer. The granular mixture was applied at the rate of 600, 800, 800 and 600 kg/ha, respectively, at 2, 5, 8 and 10 months after planting. In addition, plants at Corozal received two applications of kieserite (Mg $SO_4.H_2O$, 17.5% Mg) at the rate of 147 kg/ha.

Two weeks after bunch-emergence, the immature bunches were subjected to nine treatments. Bunches were pruned to either three, four or five uppermost hands. Those pruned to four and five hands were either sprayed with a Pro-Gibb[6] solution containing 50 ml/L of gibberellic acid or not sprayed. The solution was supplemented with 3 ml of the sticker X-77 Spreader per 3.8 L of water. Both sprayed and unsprayed bunches were immediately bagged with clear polyethylene bags or left unbagged. Bunches pruned to three hands were neither sprayed nor bagged. Bunch pruning (main-treatment) and hormone spraying and bagging (subtreatment) were arranged in a split plot design with four replications. Each subtreatment contained ten observations per replication.

Yellow sigatoka, nematodes, corm-weevil and weeds were controlled by following the recommendations contained in the plantain and banana technological package of practices (Anonymous, 1995). Yellow sigatoka is not a problem on plantain grown in the semiarid region. Therefore, foliar spraying was not necessary at Salinas or Yauco.

The bunches were harvested when fruits reached the mature-green stage, 112 to 117 days after bunch emergence. At harvest, the bunches were weighed, fruits per hand counted, and bunch mean fruit weight

[6]Mention 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

was determined. Four fruits from the two rows in the middle section of the distal hand of each bunch were sampled to determine fruit diameter, inner and outer lengths and mean weight. Fruit length was measured following the inner and outer curvature of the fruit from the pedicel to the butt. The data were statistically analyzed by using the ANOVA procedure and the means compared by using Tukey's HSD test at $P \leq 0.05$.

RESULTS AND DISCUSSION

Spraying with gibberellic acid and bagging subtreatments alone or combined had no significant effect on bunch and fruit traits of the 'Dwarf Superplátano' (data not shown).

Regardless of location, bunch pruning significantly affected bunch size and days needed for fruit filling (Table 1). The 'Dwarf Superplátano' bunch pruned to five, four and three uppermost hands contained 79, 66 and 50 fruits, respectively. This production was similar to that attained by the tall Superplátano clone at Corozal but with the bunch pruned to six, five and four hands (Irizarry and Goenaga, 1997). A marked yield component difference between the two clones is the mean number of fruits in the uppermost hands. The 'Dwarf Superplátano' with the bunch pruned to five hands averaged 15.8 fruits per hand, whereas the tall 'Superplátano' pruned to five hands averaged only 12.2 fruits per hand. A reduction in hands from five to three also hastened bunch harvest by reducing the time needed for fruit filling from 117 to 112 days (Table 1).

Pruning significantly affected bunch weight and bunch mean fruit weight, but the effect depended on location (Tables 2 and 3). A reduction in hands from five to four at Corozal and to fewer than four at Salinas and Yauco caused a substantial reduction in bunch weight. Bunches pruned to three and five hands at Corozal and to five hands at Salinas were significantly heavier than those pruned to a similar number of hands at Yauco. This reduction in bunch weight may be due to the reduced amount of irrigation applied by the farmer at the Yauco experiment. Plants at this site did not receive the equivalent of a Class A pan factor of 0.75 recommended for the region (Goenaga and Irizarry, 1995).

Bunch mean fruit weight significantly increased at the expense of a reduction in bunch size from five to three hands at Corozal and to four hands at Salinas and Yauco (Table 3). Regardless of pruning treatments, bunch mean fruit weight at Corozal was always significantly superior to that at Yauco. The Corozal bunches pruned to three hands yielded the heaviest fruits, with a bunch mean fruit weight of 376 g.

TABLE 1.—*Effect of bunch pruning on size of bunch and time needed for fruit filling in the 'Dwarf Superplátano' clone.*

Pruning treatment	Fruits per bunch	Days needed for fruit filling
	no.	no.
Five hands	79.2 a[1]	117.0 a
Four hands	66.1 b	115.2 ab
Three hands	50.4 c	111.7 b

[1]Means within a column followed by the same letter do not differ significantly at the 0.05 probability level.

TABLE 2.—*Effect of bunch pruning on bunch weight of the 'Dwarf Superplátano' clone planted at three locations.*

	Location		
	Corozal	Salinas	Yauco
Pruning treatment	Bunch weight	Bunch weight	Bunch weight
	kg	kg	kg
Five hands	24.2 a[1,2]	24.2 a	22.2 a
Four hands	21.4 b	22.5 a	21.7 a
Three hands	18.8 b	17.2 b	16.6 b

[1]Means within a column followed by the same letter do not differ significantly at the 0.05 probability level.

[2]Means within a row do not differ significantly at the 0.05 probability level unless the difference exceeds 1.7.

TABLE 3.—*Effect of bunch pruning on bunch fruit mean weight of the 'Dwarf Superplátano' clone planted at three locations.*

	Location		
	Corozal	Salinas	Yauco
Pruning treatment	Fruit mean weight	Fruit mean weight	Fruit mean weight
	g	g	g
Three hands	376.7 a[1,2]	342.0 a	325.0 a
Four hands	339.9 ab	337.5 a	315.7 a
Five hands	310.7 b	299.3 b	281.5 b

[1]Means within a column followed by the same letter do not differ significantly at the 0.05 probability level.

[2]Means within a row do not differ significantly at the 0.05 probability level unless the difference exceeds 20.9.

TABLE 4.—*Effect of bunch pruning on the size of fruits in the distal hand of the 'Dwarf Superplátano' bunch.*

Pruning treatment	Fruit diameter	Fruit inner length	Fruit outer length
	mm	cm	cm
Three hands	43.9 a[1]	21.9 a	28.0 a
Four hands	43.6 a	20.6 b	26.2 b
Five hands	41.9 b	18.5 c	24.2 c

[1]Means within a column followed by the same letter do not differ significantly at the 0.05 probability level.

Regardless of location, pruning significantly affected fruit size in the distal hand of the 'Dwarf Superplátano' bunch (Table 4). A reduction in hands from five to either four or three caused a significant increment in fruit diameter, and inner and outer lengths. On the basis of the outer length, these fruits surpassed the superior grading criteria established for the 'Maricongo' plantain (Soto-Santiago, 1994). Likewise, mean fruit weight in the distal hand significantly increased at the expense of reducing bunch size but the effect varied with the location (Table 5). A reduction in hands from five to four upgraded fruits in the distal hand from non-marketable to marketable, over 270 g at all locations. At Corozal, however, the bunch pruned to three hands yielded the heaviest fruits, with a mean weight of 355 g. These fruits were of a grade superior to those harvested from similarly pruned bunches at Salinas and Yauco.

We infer that under intensive management, regardless of location, the 'Dwarf Superplátano' clone with the bunch pruned to the four uppermost hands has the potential to yield 173,000 fruits/ha, about 57.6 t of fruits/ha. These yields compared to those reported for the tall 'Superplátano', but with the bunch pruned to five hands at Corozal (Irizarry and Goenaga, 1997). Except for inner length, other fruit traits in the distal hand of the 'Dwarf Superplátano' bunch pruned to four hands surpassed those of the tall 'Superplátano' bunch pruned to five hands.

TABLE 5.—*Effect of bunch pruning on the mean weight of fruits in the distal hand of the 'Dwarf Superplátano' clone planted at three locations.*

	Location		
	Corozal	Salinas	Yauco
Pruning Treatment	Fruit mean weight	Fruit mean weight	Fruit mean weight
	g	g	g
Three hands	355.1 a[1,2]	304.9 a	281.8 a
Four hands	291.9 b	288.6 ab	285.7 a
Five hands	237.5 c	256.9 b	218.8 b

[1]Means within a column followed by the same letter do not differ significantly at the 0.05 probability level.

[2]Means within a row do not differ significantly at the 0.05 probability level unless the difference exceeds 17.9.

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