THE JOURNAL OF AGRICULTURE
OF THE UNIVERSITY OF PUERTO RICO

Issued quarterly by the Agricultural Experiment Station of the University of Puerto Rico, Mayagüez Campus, for the publication of articles and research notes by staff members or others, dealing with scientific agriculture in Puerto Rico and elsewhere in the Caribbean Basin and Latin America.

VOL. 78 JANUARY AND APRIL 1994 NO. 1-2

Yield of five dwarf banana cultivars grown with minimum tillage in Puerto Rico's mountain region[1,2]

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ABSTRACT

Cultivars Johnson, Ziv, Grand Nain, Valery and Selection 3-A were evaluated with no-till at the Adjuntas substation during a 50-month period. The plants retained the standard 10 or more functional leaves normally required at the bunch-shooting stage to achieve fruit-fill, but cultivar Johnson consistently maintained a greater number of Sigatoka disease-free leaves. All cultivars performed similarly for bunch weight and total yield. Mean bunch weight was 18.1 kg; annual production, 31,027 kg/ha or 1,705 boxes of fruits. The pruning of 1, 2 and 3 lower hands from the immature racemes substantially reduced the size and the weight of the bunch and total yield, but the technique assists in upgrading fruit quality, which commands premium prices.

RESUMEN

Rendimiento de cinco cultivares de guineo (*Musa acuminata*, AAA) bajo labranza mínima en la zona montañosa de Puerto Rico.

En un suelo sin labrar de la subestación de Adjuntas se evaluaron los cultivares Johnson, Ziv, Grand Nain, Valery y la Selección 3-A de guineos durante 50 meses. Las plantas retuvieron 10 o más hojas funcionales hasta la etapa de floración, número mínimo requerido para engordar, pero el cultivar Johnson consistentemente mantuvo más hojas libres de sigatoka. Todos los cultivares se comportaron similarmente para el peso del racimo y la producción total. El peso medio del racimo fue de 18.1 kg y la producción anual 31,027 kg/ha ó 1,705 cajas de frutas mercadeables. La remoción de 1, 2 y 3 manos

[1]Manuscript submitted to Editorial Board 12 November 1992.

[2]This paper covers work carried out cooperatively between the Agricultural Research Service-USDA, Mayaguez, Puerto Rico and the Agricultural Experiment Station, University of Puerto Rico (AES-UPR), Río Piedras, Puerto Rico.

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inferiores del racimo inmaturo redujo substancialmente el tamaño y el peso del racimo y el rendimiento total. Sin embargo, esta práctica aumenta la calidad de las frutas y, por consiguiente, la obtención de mejores precios.

INTRODUCTION

Bananas can be grown in a wide range of soil types and climatic conditions. In Puerto Rico, most of the banana plantations are located in the mountain region at elevations ranging from 400 to 850 m. Typical soils of the region are highly weathered Ultisols and Oxisols with 30 to 40% slope. Annual rainfall varies from 1,775 to 2,050 mm with two dry periods occurring from December through March, and June to July. Average minimum and maximum monthly temperatures are 12.1 and 29.2° C, respectively.

About 85,000 megagrams of bananas are produced annually (7), 23% of which are sold as ripe fresh fruits (3). Most of the production comes from the tall Montecristo cultivar grown intercropped with coffee under limited management. Because bunch management practices are difficult to perform in tall cultivars, particularly when grown on steep land, fruit quality is poor and the farm-gate price is low.

The availability of high yielding dwarf banana cultivars, and the development of proper bunch management techniques offer growers the opportunity to increase production, improve fruit quality and hence obtain higher prices. At the Corozal substation, cultivars Grand Nain, Johnson and Valery, grown on a tilled Ultisol under transient drought yielded 44,160; 39,880 and 37,615 kg/ha year, respectively, during a 36-month production (5). The removal of the lower hands and bagging upgraded fruit quality of the 'Grand Nain' banana (6).

This paper reports on the performance of five dwarf banana cultivars grown with no-till during a 50-month production period at Adjuntas, Puerto Rico.

MATERIALS AND METHODS

An experiment was conducted at the Adjuntas substation of the UPR-AES from November 1985 through January 1990. The substation is located in the west-central humid highlands at an elevation of about 550 m. Throughout the experiment mean monthly rainfall was 150 mm and pan evaporation 110 mm. The wettest months were April, May and August through October, with an average of 227.4 mm. Months with a rainfall deficit were December through March, during which time pan evaporation exceeded rainfall by 39.3%. Average monthly minimum and maximum temperatures were 13.5 and 27.9° C, respectively, with variations of plus or minus 3.5° C. The lowest temperatures occurred from December through March; the highest, June through September.

The soil is an Alonso clay (Orthoxic Tropohumults-clayey, oxidic isohyperthermic) with a pH of 4.8. Limestone was broadcasted at the rate of 6.7 t/ha to raise the pH to about 5.2. The top 25 cm of soil contained 3.5 mg/kg of "available" phosphorus (Bray method 2) and 0.3, 0.8, and 1.6 cmol(+)/kg of exchangeable K, Mg and Ca, respectively.

The experimental site was hand-cleared of tree vegetation and planting holes were dug on the no-tilled soil. Suckers of cultivars Grand Nain, Valery, Ziv, Johnson and the local Selection 3-A, which weighed about 2 kg were planted in single rows of plants spaced 2.44 by 1.83 m, equivalent to about 2,240 plants per hectare. Cultivars and three bunch pruning subtreatments were arranged in a split-plot design with six replications. The sub-treatments consisted in the removal of the male flower bud with either 1, 2 or 3 hands from the immature bunches about 2 weeks after bunch-shooting. The main treatments (cultivars) contained nine experimental plants per plot.

The plant crop received 3,000 kg/ha of a 10-5-20-3 (N, P_2O_5, K_2O and MgO) fertilizer supplemented with a minor elements mixture at the rate of 25.4 kg/t of fertilizer. The fertilizer was applied at the rates of 500, 750, 1,000 and 750 kg/ha at 2, 5, 8 and 11 months after planting, respectively. Thereafter, the ratoon plants were fertilized with 750 kg/ha every 3 months.

Yellow sigatoka (*Mycosphaerella musicola*), nematodes and the corm-weevil (*Cosmopolites sordidus*) were controlled in accordance with published recommendations (4).

Weed growth was suppressed with postemergence applications of either paraquat (Gramoxone)[6] or glyphosate (Round-up) at the rate of 1.0% v/v. A desuckering program was carried out throughout the experiment to maintain in each stump the mother plant plus two suckers, which represent the first and second ratoon plant crops.

At bunch-shooting, the number of functional leaves was recorded. Bunches were harvested when the mature-green fruits were 3/4 full, about 125 days after flowering. At harvest, the bunches were weighed and the hands counted. Marketable weight was determined by subtracting the rachis weight from total bunch weight. For this experiment, marketable weight was 90% of the total bunch weight.

The collected data were submitted to an analysis of variance. Using Duncan's multiple range test, we compared treatment means.

[6]Trade names in this publication are used only to provide specific information. Mention of a trade name does not constitute a warranty of materials by the USDA/ARS or the UPR/AES, nor is this mention a statement of preference over other materials.

TABLE 1.—*Functional leaves recorded at the bunch-shooting stage in five dwarf banana cultivars grown with minimum tillage at the Adjuntas substation during a 50-month period.*

Cultivar	Plant crop	Ratoon crops	All crops
Johnson	11.9[a1]	12.9[a]	12.7[a]
Ziv	11.9[a]	12.4[a]	12.3[ab]
Grand Nain	11.9[a]	12.5[a]	12.3[ab]
Valery	10.9[a]	11.8[a]	11.6[b]
Selection 3-4	10.7[a]	11.9[a]	11.6[b]

[1]Means followed by the same letters in each column do not differ significantly at P = 0.05 probability level.

RESULTS AND DISCUSSION

All cultivars maintained the standard 10 or more functional leaves normally required at bunch-shooting to achieve fruit-fill throughout the 50-month production cycle (table 1). Cultivars Johnson, Ziv and Grand Nain ranked in the top for number of sigatoka disease-free leaves in the plant and ratoon-crops but statistical differences among cultivars were not significant. However, when the plant and ratoon crops data were pooled, cultivar Johnson maintained significantly more functional leaves than Valery and local Selection 3-A.

All cultivars randomly exhibited virus-like symptoms in the plant crop. The percentage of affected plants was 11.1% in cultivar Valery and Selection 3-A, 18.5% in Ziv, 20.4% in Johnson and 29.6% in Grand Nain. The presence of virus was never confirmed, but only 79.0% of the experimental plants produced a marketable bunch in the plant crop. The condition improved in the first and second ratoon crops, when 90.5% of the plants produced a marketable bunch. The experiment was terminated when 57.0% of the third ratoon plants were harvested. On the average, the cultivars produced 3.6 bunches per stump during the 50-month production period.

The peak plant crop harvest occurred 15 to 18 months after planting. At a lower elevation, about 200 m at the Corozal substation, banana peak harvest occurred 13 to 15 months after planting (5, 6). Aubert (1) estimated that for every 100 m increase in elevation the banana production cycle is prolonged about 45 days. The peak harvest for all crops at the Adjuntas experiment occurred during the months of December through April with 80.5% of the plants harvested. This production pattern coincided with dry weather and cool night temperatures, typical climate of the mountain region at the beginning of each year.

All cultivars performed similarly with respect to their yielding capacity regardless of the number of hands removed from the immature

TABLE 2.—*Production of five dwarf banana cultivars grown with minimum tillage at the Adjuntas substation during a 50-month period.*

Cultivar	Plant crop			Ratoon crops			All crops			Average annual production	
	Hands per bunch	Bunch weight	Total yield	Hands per bunch	Bunch weight	Total yield	Hands per bunch	Bunch weight	Total yield	Yield per ha	Boxes[*1] of fruit per ha
	No.	kg	kg/ha	No.	kg	kg/ha	No.	kg	kg/ha	kg	No.
Ziv	6.3[*2]	13.2	23,407.7	7.5	20.5	109,394.1	7.2	18.6	132,801.8	31,872.3	1,751
Johnson	5.8	12.6	22,284.7	7.2	20.8	110,243.1	6.8	18.7	132,527.8	31,806.7	1,748
Grand Nain	6.4	12.7	22,544.1	7.2	20.1	108,463.0	7.0	18.3	131,007.1	31,441.7	1,728
Valery	6.2	12.5	22,121.6	7.2	19.5	103,871.0	6.9	17.8	125,992.6	30,238.2	1,661
Selection 3-A	5.8	11.9	21,020.9	6.9	19.1	103,052.1	6.6	17.3	124,073.0	29,777.5	1,636
Average	6.1	12.6	22,275.8	7.2	20.0	107,004.7	6.9	18.1	129,280.5	31,027.3	1,705

[*1]One box of banana weighs 18.2 kg.
[*2]Means in each column were non significant at P = .05 probability level.

TABLE 3. — *Effect of lower hands removal on bunch size and total yield of five banana cultivars grown at the Adjuntas substation during a 50-month period.*

Number of hands removed	Plant crop			Ratoon crops			All crops		
	Hands per bunch	Bunch weight	Total yield	Hands per bunch	Bunch weight	Total yield	Hands per bunch	Bunch weight	Total yield
	No.	kg	kg/ha	No.	kg	kg/ha	No.	kg	kg/ha
One	6.9[a*1]	14.9[a]	26,363.1[a]	8.0[a]	22.5[a]	120,861.2a	7.7[a]	20.6[a]	147,224.3[a]
Two	6.3[b]	12.5[b]	22,115.3[b]	7.1[b]	19.7[b]	104,981.7[b]	6.9[b]	17.9[b]	127,097.0[b]
Three	5.1[c]	10.4[c]	18,349.0[c]	6.5[c]	17.8[c]	95,171.0[c]	6.1[c]	15.9[c]	113,520.1[c]

[*1]Means followed by the same letters in each column do not differ significantly at P = 0.05 probability level.

bunch (table 2). In addition to the reduced percentage of plants harvested in the plant crop, bunches were also undersized; they averaged 6.1. hands and weighed 12.6 kg. These factors contributed to an abnormal low mean yield of only 22,276 kg/ha in the plant crop. Thereafter, because of an increase in the percentage of plants harvested, and an increase in bunch size and weight, cultivar mean yield rose to 41,156 kg/ha per ratoon crop.

In the pooled data of the plant and ratoon crops, bunches averaged 6.9 hands and weighed 18.1 kg (table 2). Cultivar mean yield was 129,280 kg/ha, equivalent to an annual production of 31,027 kg/ha or 1,705 boxes of fruits. This yield is about 23.5% lower than the production obtained from cultivars Grand Nain, Johnson and Valery at the Corozal substation with complete land preparation (5), but 18.0% higher than the yield reported for the tall 'Montecristo' banana grown with no-till under monoculture at the Adjuntas substation (8).

Lower hands pruning reduced bunch size and weight, and consequently total yields in the plant and ratoon crops regardless of cultivars (table 3). At the termination of the 50-month production period, total yields were reduced by 13.7 and 22.9% with the pruning of two and three lower hands, respectively. However, this bunch management practice has proven to upgrade fruit quality by inducing a significant increase in size and weight of individual fruits in the distal hand (2,5). Therefore, it is expected that pruning of the banana bunch lower hands will also influence the size and weight of the fruits in all of the remaining hands. Hence, the use of pruning allows growers to obtain premium prices; this technique economically compensates for the reduction in yield.

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