# Effect of Three Population Densities and Fertilizer Levels on Yields of High Yielding Clones of Plantains at Two Locations[1, 2]

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ABSTRACT

**Three levels of fertilization, 2,240, 3,360 and 4,480 kg of 10-2-40/ha, did not affect plantain yields at any of three plant spacings at two locations. Population of 1,890, 2,500 and 3,460 plants/ha resulted in average yields of 29.2, 33.5 and 41.2 t/ha, respectively. The closest spacing (1.7 × 1.7 m equivalent to 3,460 plants/ha) resulted in the highest yields without decreasing fruit size below commercial standards. In commercial plantings where about 80% of the plants are harvested, yields at this population density are equivalent to 33 t of marketable fruits/ha containing 19.8 t of fresh pulp or 7.9 t of dry pulp/ha.**

## INTRODUCTION

This paper presents the results of two experiments which studied the effects of three population densities and three fertilizer levels, and their interactions on yield and fruit quality of high yielding clones of the Maricongo cultivar at two locations under intensive management practices.

Plantains (*Musa acuminata* × *M. balbisiana*, AAB) are a staple in the diet throughout much of the humid tropics. The green fruit contains about twice as many calories as Irish potatoes. Plantains, world-wide, are produced mostly for local consumption, and for this reason research with this crop is limited.

In Puerto Rico, the effects of plant spacings and fertilization on plantain yields have received considerable attention. Caro-Costas (1) and Irizarry et al. (5, 6) found that plantains can be spaced as close as 1.5 × 1.5 m (4,300 plants/ha) without effect on weight or number of fruits/bunch or size of the individual fruits. Caro-Costas et al. (2) found that plantains on a Humatas clay (Typic Tropohumults) responded to applications of 224, 98, 448 and 112 kg/ha of N, P, K and Mg, respectively. On the same soil, Vicente-Chandler and Figarella (11) found that plantains responded to applications of 224 and 98 kg/ha of N and P, respectively, but did not

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respond to applications of K or Mg. Del Valle et al. (3) reported an increase in bunch weight when P was increased from 0 to 56 kg/ha. Hernández-Medina and Lugo-López (4) and Samuels et al. (9) found that plantains responded to applications of Mg on a Corozal clay (Aquic Tropudults). Samuels et al. (10) found that plantains responded to N and K on a San Antón sandy clay (Cumulic Haplustolls) under irrigation on the South Coast. Recently, Irizarry et al. (8) found that plantains growing on a Mabí clay (Vertic Eutropepts) and a Corozal clay took up an average of 249, 21, 585 and 60 kg/ha of N, P, K and Mg, respectively. In some of the previous experiments the effect of plant spacing on plantain yields was tested with less than optimum fertilization and unselected planting material.

## MATERIALS AND METHODS

One experiment was conducted at the Gurabo Substation on a Coloso clay (Aeric Tropic Fluvaquents) with a pH of 6.5, 10 p/m of available P (Bray method); 71 p/m of exchangeable K, and 10.8 and 7 meq/100 g of soil of exchangeable Ca and Mg, respectively. Elevation is about 80 m with minimum and maximum temperatures of 18.5 and 30.5° C, respectively. Annual rainfall is about 1,450 mm.

The other experiment was carried out at the Corozal Substation on a Corozal clay (Aquic Tropudults) with a pH of 5.1; 9 p/m of available P; 271 p/m of exchangeable K; and 7.3 and 1.3 meq/100 g of soil of exchangeable Ca and Mg, respectively. Elevation is about 200 m, and minimum and maximum temperatures are 20 and 30° C, respectively. Annual rainfall is about 1,600 mm.

At both experimental sites, the soil was plowed and harrowed twice. Disease-free corms weighing about 1.5 kg from high-yielding Maricongo clones were planted August 1977. Nematodes, insects, leaf spot and weeds were controlled by recommended methods. During dry weather, irrigation at the rate of 70 mm every 2 weeks was applied with sprinklers.

Plant spacings tested were 1.7 × 1.7 m (3,460 plants/ha), 2.0 × 2.0 m (2,500 plants/ha) and 2.3 × 2.3 m (1,890 plants/ha). Fertilizer levels tested were 2,240, 3,360 and 4,480 kg of 10-2-40/ha with 6% MgO added at Corozal. In both experiments, 16 kg each of $B_2O_3$ and ZnO were added per ton of fertilizer.

A split-plot design was used with plant spacings as the main plots, and fertilizer levels as the subplots with four replications.

In the Gurabo experiment, 20, 30 and 50% of the fertilizer was applied 1.5, 5 and 8.5 months after planting, respectively. At Corozal, 10, 20, 30 and 40% of the fertilizer was applied 1.5, 5, 8 and 10 months after planting, respectively.

Fruits were harvested at the mature-green stage, and weight and number of fruit per bunch determined. The middle portion of the lamina in the third open leaf was sampled 7 months after planting and analyzed for N, P, K, Ca and Mg. Nitrogen was determined by the Kjeldahl macromethod; P, colorimetrically; K, by flame photometry; and Ca and Mg, by the Versenate method.

## RESULTS AND DISCUSSION

Fertilizer level differences had no significant effect on total yields or on any of the yield components in either experiment.

TABLE 1.—*Effect of three population densities on total yields and yield components of plantains at two locations*

| Plant density | Plant spacing | Total yields/ha | | Yield Components | | |
|---|---|---|---|---|---|---|
| | | Fruits | Weight | Fruits/ bunch | Weight of bunch | Mean weight of fruit |
| *No./ha* | *M* | *No.* | *t* | *No.* | *Kg* | *g* |
| | | *Gurabo* | | | | |
| 1,890 | 2.3 × 2.3 | 82,493 b[1] | 27.1 b | 46.9 a | 15.1 a | 321.1 a |
| 2,500 | 2.0 × 2.0 | 102,294 b | 30.0 b | 44.8 a | 13.1 b | 290.8 b |
| 3,460 | 1.7 × 1.7 | 133,892 a | 37.1 a | 40.7 b | 11.3 b | 276.5 b |
| | | *Corozal* | | | | |
| 1,890 | 2.3 × 2.3 | 91,459 c | 31.3 c | 55.2 a | 18.9 a | 343.5 a |
| 2,500 | 2.0 × 2.0 | 117,589 b | 37.0 b | 52.9 a,b | 16.7 b | 315.2 b |
| 3,460 | 1.7 × 1.7 | 153,650 a | 45.2 a | 49.5 b | 14.6 c | 295.1 b |

[1] Means followed by the same letters do not differ significantly at the P = 0.05 probability level (Duncan's multiple range test).

Irrespective of the amounts of fertilizer applied, yields in terms of both number of marketable fruits and kg of fruit/ha were highest with the highest population density tested (3,460 plants/ha) (table 1). Under these experimental conditions in which bunches were harvested from 95% of the plants, the highest population density yielded 133,900 marketable fruits or 37.1 t/ha at Gurabo and 153,600 fruits or 45.2 t/ha at Corozal. Assuming that 80% of the bunches are harvested under commercial conditions as has been determined on private farms, yields of marketable fruits would have been 107,100 (29.7 t/ha) at Gurabo and 122,900 fruits (36.2 t/ha) at Corozal. Those yields would produce 17.8 and 21.7 t of fresh pulp or 7.1 and 8.7 t of dry pulp/ha over a 14- to 15-month period at Gurabo and Corozal, respectively.

Plantains spaced at 2.3 × 2.3 m (1,890 plants/ha) yielded the largest bunches at both locations (table 1). Average number of marketable fruits and weights per bunch and per fruit were significantly higher with the

widest than with the closest spacing (1.7 × 1.7 m (3,460 plants/ha). However, even at the highest population density, weight of the individual fruit met or surpassed the standards (about 270 g/fruit) for marketable plantains of the Maricongo cultivar. The large number of marketable fruits/bunch obtained at both Gurabo and Corozal (over 50 at Corozal) shows the high yield capacity of the clone selected by Irizarry[4] and used in these experiments when grown under intensive management.

Although treatments and cultural practices were essentially the same at both locations, yields were about 15% lower at Gurabo than at Corozal. Possibly, the difference was due to the unfavorable effect of the heavy poorly drained soil at Gurabo on the root system of plantains, as shown by Irizarry et al. (7).

TABLE 2.—*Effect of three population densities on bunch emergence and days required by the fruits to reach the mature-green stage at two locations*

| Plant density | Plant spacing | Monthly bunch emergence | | | | | Time from bunch emergence to fruit harvest |
|---|---|---|---|---|---|---|---|
| | | April | May | June | July | August, 1978 | |
| *No/ha* | *M* | | | % | | | *Days* |
| | | | | *Gurabo* | | | |
| 1,890 | 2.3 × 2.3 | 70.0 | 24.4 | 5.6 | — | — | 100 |
| 2,500 | 2.0 × 2.0 | 50.8 | 32.2 | 14.9 | 2.1 | — | 109 |
| 3,460 | 1.7 × 1.7 | 29.0 | 35.8 | 25.5 | 9.4 | 1.3 | 121 |
| | | | | *Corozal* | | | |
| 1,890 | 2.3 × 2.3 | — | 11.7 | 82.4 | 5.9 | — | 109 |
| 2,500 | 2.0 × 2.0 | — | 1.7 | 74.4 | 22.2 | 1.7 | 111 |
| 3,460 | 1.7 × 1.7 | — | — | 48.5 | 48.2 | 3.3 | 119 |

Fertilizer levels had no apparent effect on flowering or bunch maturity at any plant density in either experiment. However, population density affected both characteristics (table 2). At both locations, early flowering was concentrated during a shorter period of time with low population density. Number of days from bunch emergence to harvest also was less with the wide spacing. At both locations average days required from flowering to the mature-green stage was 105 with the low population density, and 110 and 120 days for the intermediate and high densities, respectively.

Flowering peaks were about 2 months earlier at Gurabo than at Corozal.

The fertilizer levels tested did not affect the N, P, K, Ca or Mg content of the leaf laminas (table 3). Higher magnesium content of the leaves at Gurabo was due to the larger quantity of exchangeable Mg in the soil at this location. The data suggest that near optimum nutrient content for leaves of 7-month old plantains is N, 3.2%; P, 0.20%; K, 3.0%; Ca, 0.80%; and Mg, 0.30%.

[4] Unpublished data.

TABLE 3.—*Effect of three fertilizer levels on composition of the third open leaf of plantains 7 months after planting at two locations*

| Fertilizer level | Percent leaf composition | | | | |
|---|---|---|---|---|---|
| | *N* | *P* | *K* | *Ca* | *Mg* |
| *Kg/ha* | | | | | |
| | | *Gurabo* | | | |
| 2,240 | 3.04 | 0.18 | 2.43 | 1.05 | 0.59 |
| 3,360 | 3.08 | .18 | 2.67 | .91 | .55 |
| 4,480 | 3.07 | .17 | 2.48 | .99 | .57 |
| | | *Corozal* | | | |
| 2,240 | 3.18 | 0.19 | 3.03 | 0.84 | 0.28 |
| 3,360 | 3.19 | .18 | 2.84 | .84 | .26 |
| 4,480 | 3.20 | .19 | 2.96 | .83 | .29 |


## RESUMEN

El efecto de tres distancias de siembra y tres niveles de abonamiento en el rendimiento y calidad del plátano (*Musa acuminata* × *M. balbisiana*, AAB), cv. Maricongo se evaluaron en las Subestaciones de Gurabo y Corozal.

Las distancias de siembra usadas fueron: 1.7 × 1.7 m, 2.0 × 2.0 m y 2.3 × 2.3 m, equivalentes a densidades de 3,460, 2,500 y 1,890 plantas/ha, respectivamente. Los niveles de abonamiento fueron de 2,240, 3,360 y 4,480 kg de 10-2-40/ha. En Corozal, el abono fue suplementado con 6% de MgO, y en ambas siembras se aplicaron 16 kg/Tm de $B_2O_3$ y de ZnO.

Los niveles de abonamiento y la interacción de distancia de siembra y abonamiento no tuvieron efectos significativos en la producción. Las concentraciones de N, P, K, Ca y Mg en la lámina de las hojas no fueron afectadas por los niveles de abono.

En ambos experimentos los rendimientos más altos se lograron usando la distancia más corta (1.7 × 1.7 m ó 3,460 plantas/ha). Con esta distancia se lograron 133,900 frutas (37.1 Tm)/ha en Gurabo y 153,600 (45.2 Tm)/ha en Corozal. Partiendo de que en condiciones comerciales sólo se cosecha el 80% de los racimos, con esta distancia de siembra se producen 107,100 frutas ó 29.7 Tm/ha en Gurabo y 122,900 ó 36.2 Tm/ha en Corozal, equivalentes a 17.8 y 21.7 Tm de pulpa húmeda/ha ó 7.1 y 8.7 Tm/ha de pulpa seca/ha, respectivamente.


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