Effect of Planting Material on Yield and Quality of Two Plantain Cultivars (*Musa acuminata* X *M. balbisiana*, A A B)[1, 2]

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ABSTRACT

The effect of two types of suckers (sword and water) and of three sucker sizes on yields and plant, bunch and individual fruit characteristics of Maricongo and Common Dwarf plantains (*Musa acuminata* x *M. balbisiana*, AAB) was determined. With the tall Maricongo, yield in terms of weight and number of marketable fruits per ha was significantly affected only by the type of suckers planted, whereas in the Dwarf cultivar, both size and type of suckers affected total production. In the tall plantain, sword suckers regardless of size outyielded water suckers by 5.7 t/ha or 14,734 fruits per ha. In the Dwarf cultivar, the medium and small sword suckers outyielded their counterparts in the water type by 5.5 and 10.2 t/ha (15,870 and 26,360 fruits per ha respectively. Planting material of different types and size had no effect on fruit quality; using the largest sword or water suckers did not affect any of the plant or bunch characteristics.

INTRODUCTION

Two types of planting material are commonly used in establishing plantain (*Musa acuminata* x *M. balbisiana*, AAB) fields. The sword, spear or arrow type are young vigorous suckers that are still feeding from the parent plant and have only rather rudimentary root and foliage systems consisting of partially unfolded narrow leaves growing at an acute angle in relation to the axis of the pseudostem. The water suckers are older, both root and foliage systems are fairly well developed, and the leaves are wider and grow at a wide angle in relation to the axis of the pseudostem. These suckers can therefore absorb nutrients and manufacture much of their food. Suckers in both groups vary widely in size.

There is very little information on the best types of planting material to use with plantains. As a result, farmers use any kind of planting material available.

Evaluation of planting material for bananas (*M. acuminata*, AAA) has been reported, but the results are somewhat contradictory. Alva-Neyra and Carranza (1) reported a significant increase in number of hands and fruits per bunch and total yields per hectare when large suckers of the

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Gros Michel banana were compared with small and medium sized suckers. On the other hand, Bartolomé and Songcuan (3), and Gregory (5), working with different banana cultivars and various kinds of planting material, could not detect any influence of the propagating material on number of fruits per bunch, number of bunches and total yield. However, Gregory strongly recommended the use of sword suckers. Barriga and Montoya (2) also recommended the use of peeled sword suckers with a mean weight of 1.5 kg. With the Cavendish banana, Berrill (4) preferred medium sized sword suckers with a corm girth of about 30.5 cm.

This study was undertaken to determine the effect of type and size of suckers used as planting material on yield and other production indices of the plant, bunch and fruits of both the horn-type plantain cv. Maricongo and Common Dwarf.

MATERIALS AND METHODS

Two experiments were begun during February 1976 at the Gurabo Substation, located in the Caguas Valley at about 80 m above sea level. The soil was a Toa clay loam (Mollisol [Fluventic Hapludolls]) with a pH of 6.2, containing 10.2 p/m of P, determined by the Bray method; 78 p/m of K, determined by the flame photometer; and 8.9 and 4.8 meq/100 g of soil of Ca and Mg, respectively, determined by the versenate method.

Experiment 1 was with the Maricongo cultivar, which normally grows to a height of about 3.5 m at this location, and experiment 2 was with the Common Dwarf cultivar which grows only to about 2.5 m.

Two types of suckers (sword and water) of three sizes each were tested. They were arranged in a split-plot design with size as the main plot and type as subplots, with four replications. Sucker size (peeled corms without stalk) were large—1.6 to 2.4 kg (average 2 kg); medium—1.3 to 1.5 kg (average 1.4 kg); and small—0.4 to 0.8 kg (average 0.6 kg). Plant spacing was 1.8 m × 1.8 m. There were 10 experimental plants per subplot.

Planting material was obtained from apparently virus-free plants of both cultivars that had yielded 40 and 35 marketable fruits per bunch. Soil-borne insects and nematodes were controlled by immersing the peeled corms for 5 min in an insecticide-nematicide solution consisting of 25 ml Aldrin[4] (hexachloro-hexahydro-endo, exo-dimethanonaphthalene) and 11 ml DBCP (1,2-dibromo-3-chloropropane)/3.8 liters of water. At planting, 56 g of Chlordecone (decachlorooctahydro-1,3,4-metheno-2H-cyclo-buta [cd] pentalen-2-one) 5% dust was applied per hole. One and a half months later and every 6 mo thereafter 56 g per plant of 10% Carbofuran (2,3-dihydro-2,2-dimethyl-7-benzofuranyl, methylcarbamate) were applied.

[4] This paper reports the results of research only. Mention of a pesticide in this paper does not constitute a recommendation by the USDA or the Agricultural Experiment Station of the University of Puerto Rico, nor does it imply registration under FIFRA.

Both experiments were fertilized with a 10-5-20 analysis containing 75.3 kg of MgO and 45.4 kg of other minor elements per short ton. The fertilizer was applied at the rate of 3.5 t/ha at 2, 5, 8 and 10 mo after planting.

During early growth, weeds were controlled twice with rototiller cultivation. Thereafter, sporadic paraquat (1,1-dymethyl-4,4-bipyridinium dichloride) were made at the rate of 2.3 liters ha. Supplemental irrigation

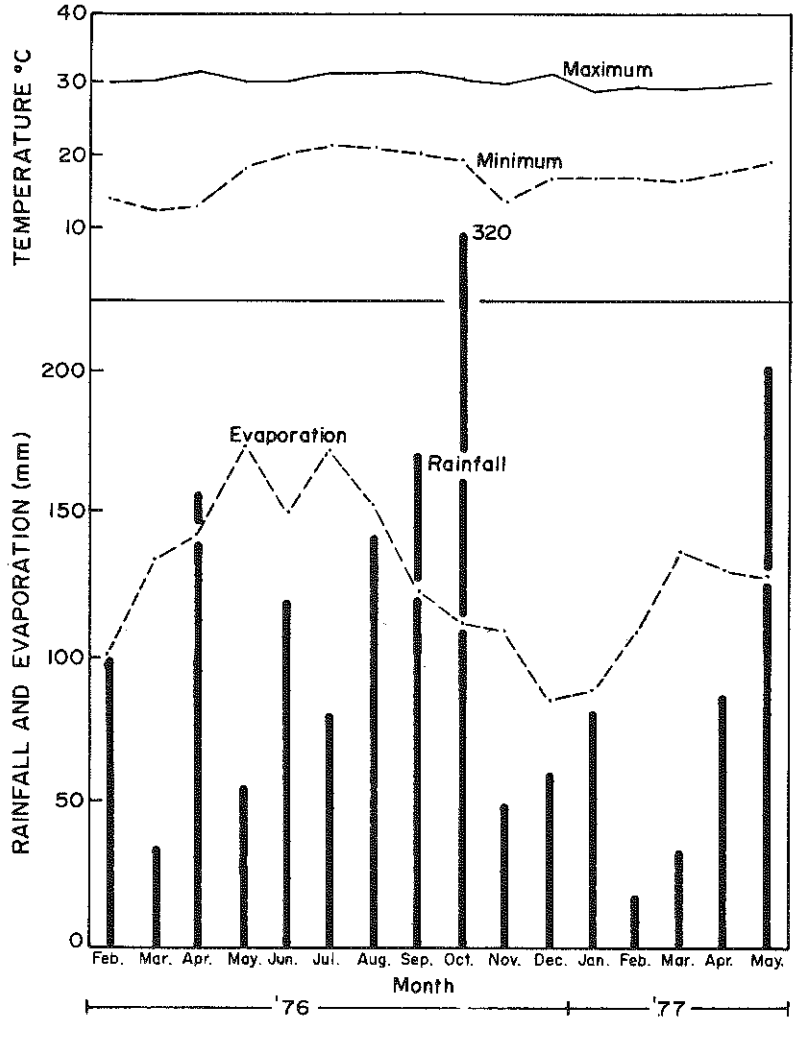


FIG. 1.—Monthly rainfall, air temperature and open pan evaporation at the Gurabo Substation from planting (February 10, 1976) to end of harvest (May 26, 1977).

was applied as needed.

The following information was recorded throughout the course of the experiments: rainfall, open pan evaporation, air temperatures; germination 1 and 2 mo after planting; number of leaves developed at 4, 6 and 8 mo and at bunch emergence; date of bunch emergence; plant height; pseudostem diameter; number of functional leaves at bunch emergence; and number of leaves and "followers" at harvest. All bunches were harvested at the mature-green stage, about 110 days from bunch emergence. The bunches were weighed and number of marketable fruits, hands and fruits in the first and second hands were counted.

Fruits from the third hand were used to determine mean fruit weight,

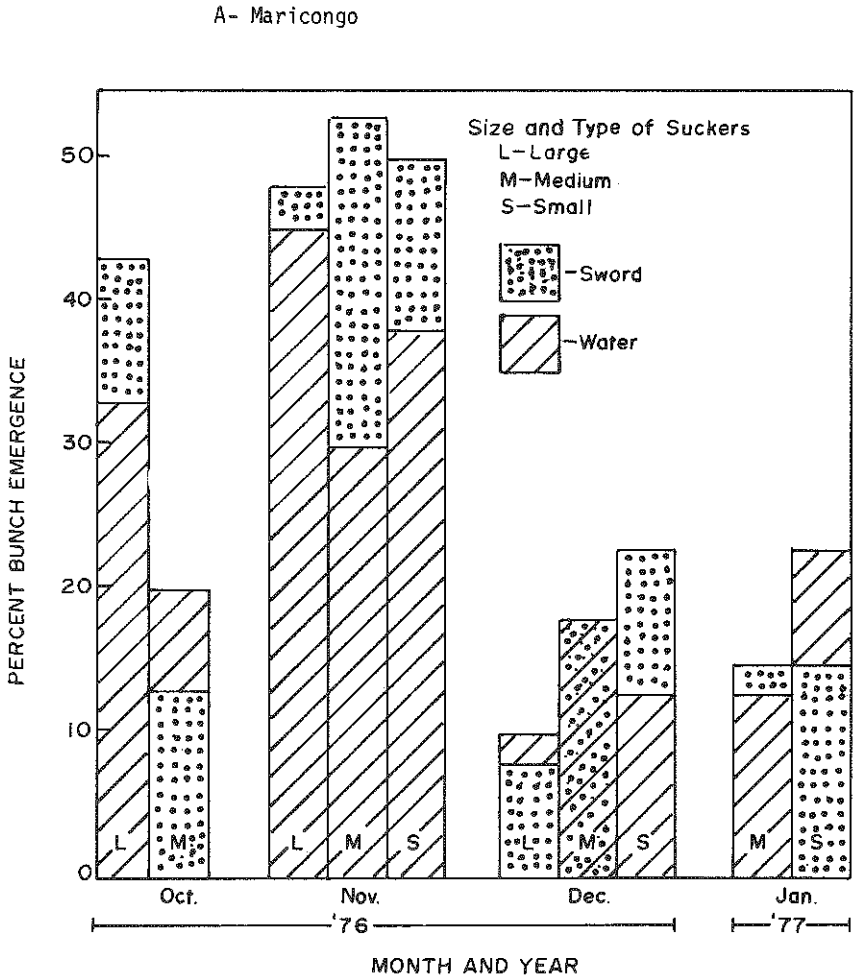


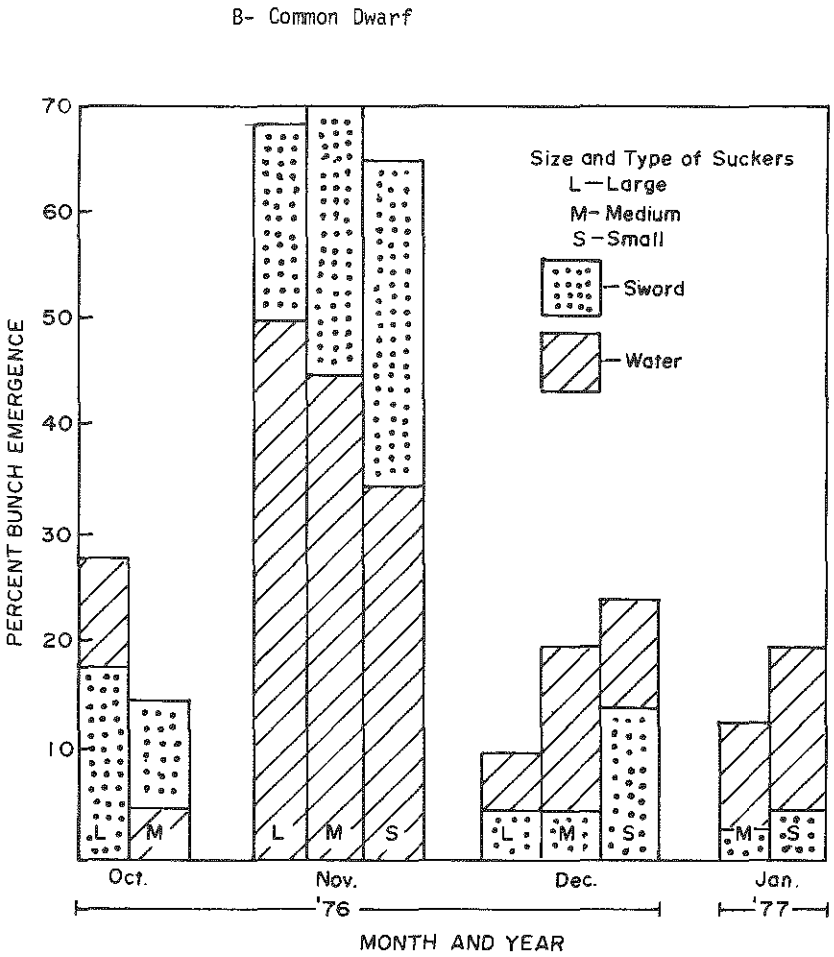
FIG. 2.—Distribution of bunch emergence from different planting materials.

fruit length and maximum and minimum diameters, pulp content, pulp: peel ratio, and texture index. These indexes were obtained with the procedures of Sánchez-Nieva et al. (7, 8).

All data obtained were analyzed statistically, and comparisons were made according to Duncan's multiple range test.

RESULTS AND DISCUSSIONS

Figure 1 shows monthly rainfall, open pan evaporation, and maximum and minimum air temperatures from planting through the last harvest. Evaporation was high and rainfall low during the 4th, 5th and 6th months after planting and after the beginning of bunch emergence (October 1976)



throughout the main harvest season (April 1977). However, 76.2 mm of sprinkler irrigation every 2 weeks provided enough moisture.

Germination of the small water suckers of both cultivars was 15% less than that for the larger suckers 1 mo after planting, but 2 mo later all treatments in both experiments had 100% germination.

Early bunch emergence peaks occurred about 8.5 mo after planting (October 1976) in plants grown from large and medium-sized suckers of both sword and water types of both cultivars (fig. 2-A,B). In the Maricongo cultivar, flowering peaks occurred earliest in plants grown from large sword suckers, whereas with the Common Dwarf early emergence was higher from plants growing from large water suckers. For all planting material the highest bunch emergence peaks occurred a month later

TABLE 1.—*Mean number of leaves at four growth stages with plants from different planting materials*

Months after planting	Size and type of suckers					
	Large		Medium		Small	
	Sword	Water	Sword	Water	Sword	Water
	Maricongo cultivar					
4	14.6	14.1	13.7	13.7	13.5	12.9
6	8.6	8.3	8.9	8.2	9.4	9.1
8	7.5	7.6	7.7	7.3	7.2	7.6
At bunch emergence	3.5	3.1	4.5	4.7	4.9	8.5
Total	34.2	33.1	34.8	33.9	35.0	38.1
	Common dwarf cultivar					
4	14.5	13.7	14.2	13.0	14.2	12.2
6	9.0	9.2	9.3	9.0	9.4	9.4
8	7.8	7.8	7.9	8.2	8.0	8.1
At bunch emergence	3.5	3.4	3.2	4.6	3.9	5.9
Total	34.8	34.1	34.6	34.8	35.5	35.6

(November 1976). Irrespective of sucker size, plants grown from sword suckers had the highest percentage of bunch emergence during the second month.

Since all plantains were harvested about 3.5 mo after bunch emergence, the main harvest period, like the bunch emergence period, also lasted 4 mo, (February through May 1977). Early harvest peaks occurred 12 mo after planting (February 1977) in plants grown from large and medium suckers and 1 mo later for plants grown from small suckers.

Although Maricongo and Common Dwarf cultivars have different growth habits, both formed leaves at the same rate (table 1). Leaf formation rate from planting to 8 mo was about the same for all treatments, about four leaves/plant/month. Thereafter, the rate appeared to change, depending on the time needed for plants in the various treatments

to reach the bunch emergence stage. Total number of leaves at the time of bunch emergence was similar for all treatments, about 35 leaves per plant.

MARICONGO CULTIVAR

Source of sucker had little influence on plant characteristics. Number of functional leaves and plant height at bunch emergence and number of leaves and "followers" (suckers) at harvest were not affected by the kind of suckers used. Mean number of functional leaves at bunch emergence was 12.4 and mean plant height was 3.5 m, whereas mean numbers of leaves and "followers" at harvest were 7 and 9.7, respectively.

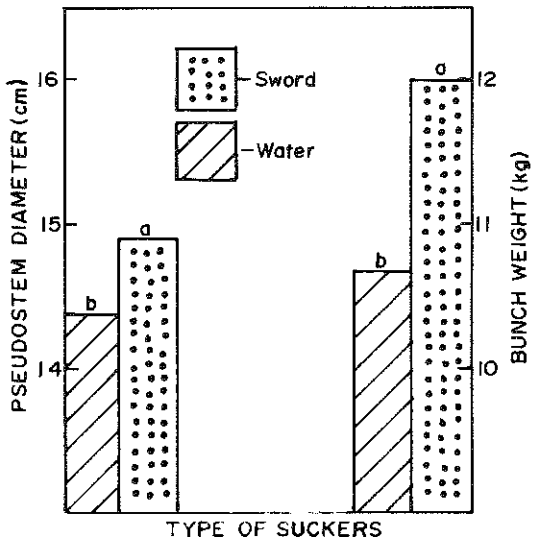


FIG. 3.—Influence of type of suckers used for planting on pseudostem diameter and bunch weight of Maricongo plantains. Within each characteristic, means showing a letter in common are not significantly different at P = 0.05.

Plants grown from sword suckers had a thicker pseudostem, and yielded significantly heavier bunches (fig. 3). Average pseudostem diameter was 14.8 cm, and average bunch weight 12 kg when sword suckers were used as planting material. Sucker size had no effect on trunk diameter or bunch weight.

Total number of hands per bunch and number of fruits in the first and second hands were not affected by size or type of suckers. Bunches averaged 6.2 hands, and 9 and 8 fruits in the first and second hands, respectively. However, bunches harvested from plants grown from small sword suckers had significantly more fruits than did those from small water suckers (fig. 4). Plants grown from large and medium sized sword

suckers yielded bunches with more fruits than did those produced from water suckers, but the differences were nonsignificant. Both large and medium water suckers yielded more fruits than did small water suckers.

Source of propagating material had no significant effect on seven characters observed in fruits from the third hand. Mean values for these characteristics were fruit weight, 278.3 g; fruit length and maximum and minimum diameters, 18.4, 4.6 and 4.2 cm, respectively; pulp content, 63.8%; pulp:peel ratio, 1.8; and texture index 42.3 kg/cm^2. These values were either comparable to or exceeded those reported by Sánchez-Nieva

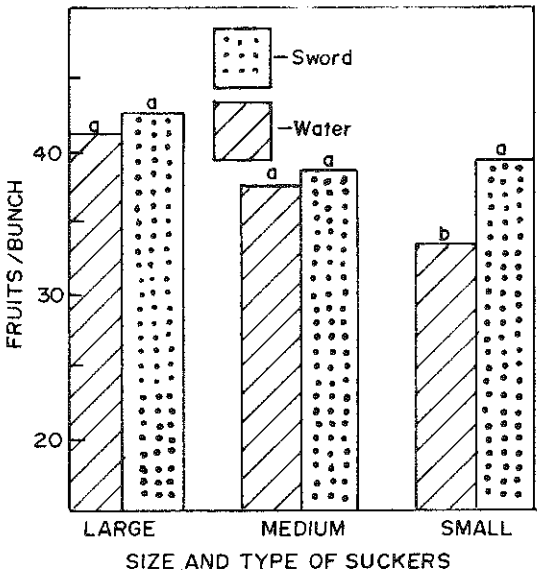


FIG. 4.—Influence of different types and sizes of suckers used as planting material on number of marketable fruits/bunch of Maricongo plantains. Means showing a letter in common are not significantly different at P = 0.05.

et al. (6, 7) and Irizarry et al. (8) for the Maricongo cultivar.

Yields in terms of weight and number of marketable fruits per ha were significantly higher when sword suckers rather than water suckers were used as planting material (fig. 5). Production of 38.9 t/ha or 135,866 marketable fruits per ha were obtained with sword suckers compared to 33.2 t/ha or 121,132 fruits per ha with water suckers. These estimates, from a planting-to-harvest cycle of 12 to 16 mo, represent 94 and 91% of the actual harvest of both types of propagating materials.

COMMON DWARF CULTIVAR

Pseudostem diameter at bunch emergence and number of "followers"

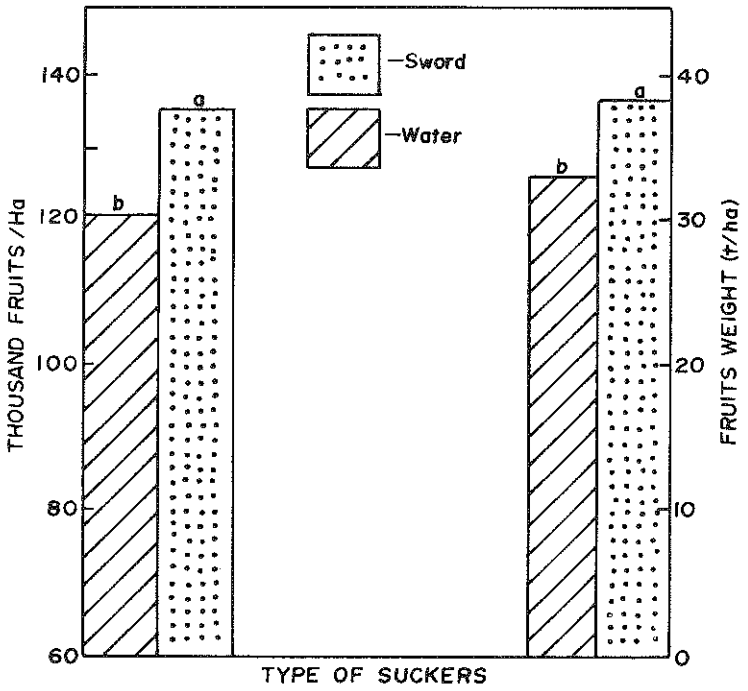


FIG. 5.—Yields of the Maricongo plantain as affected by type of suckers used as planting material. Within each kind of yield measurement, means showing a letter in common are not significantly different at P = 0.05.

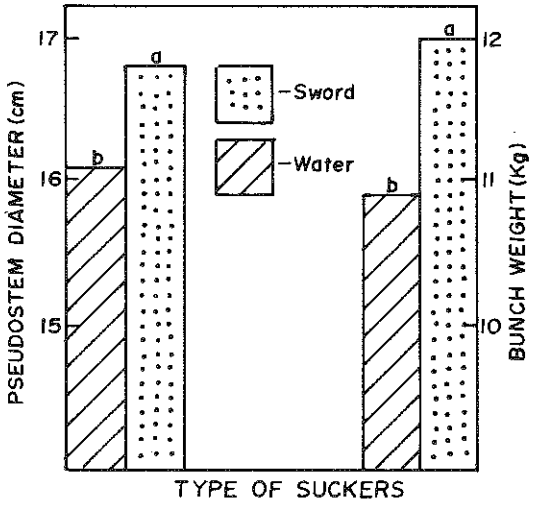


FIG. 6.—Influence of type of suckers used for planting on pseudostem diameter and bunch weight of the Dwarf plantain. Within each characteristic, means showing a letter in common are not significantly different at P = 0.05.

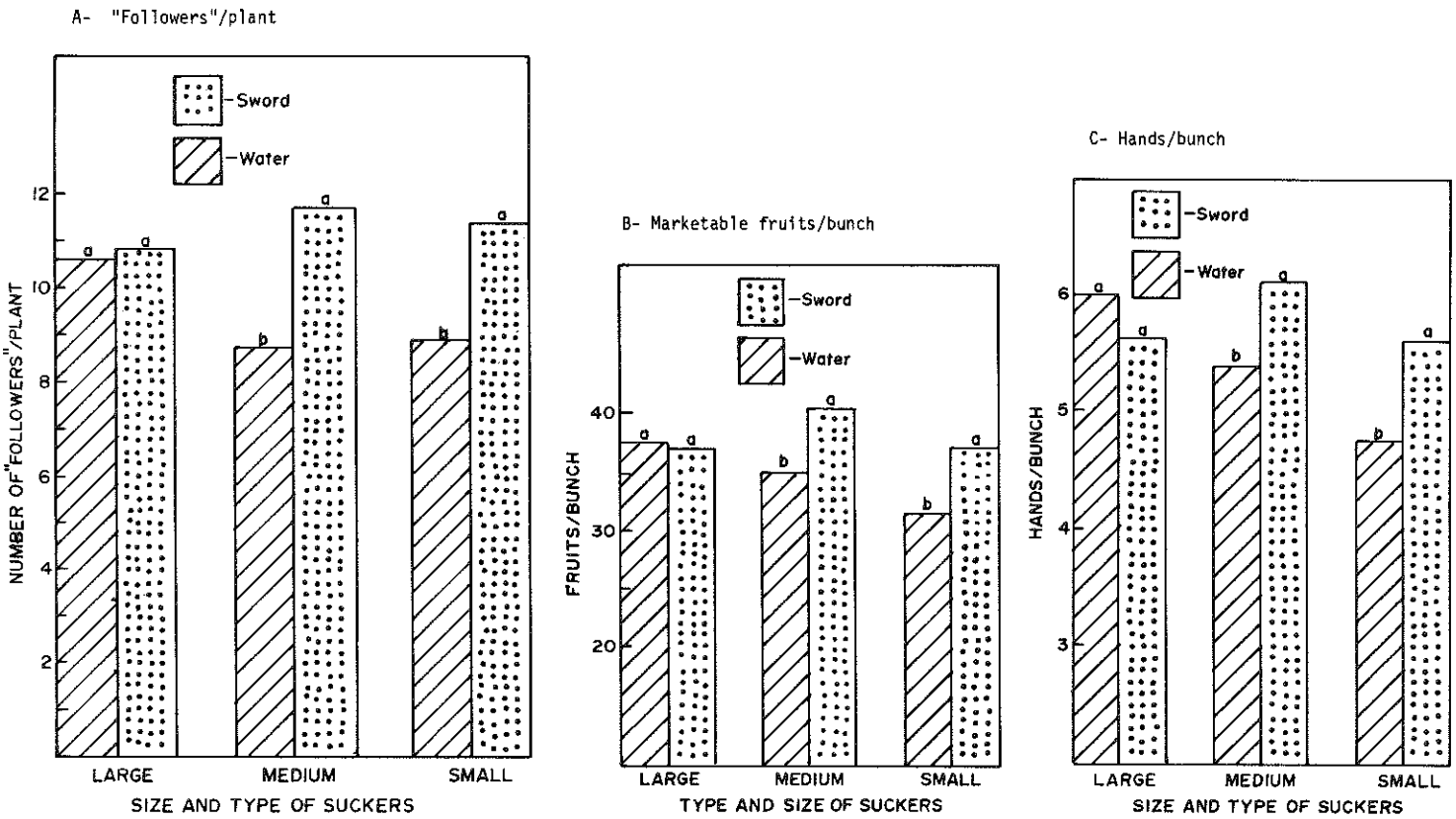


FIG. 7.—Influence of different types and sizes of suckers on number of: A- "followers"/ plant, B- marketable fruits/bunch and C- hands/bunch of the Dwarf plantain. Means showing a letter in common are not significantly different at P = 0.05.

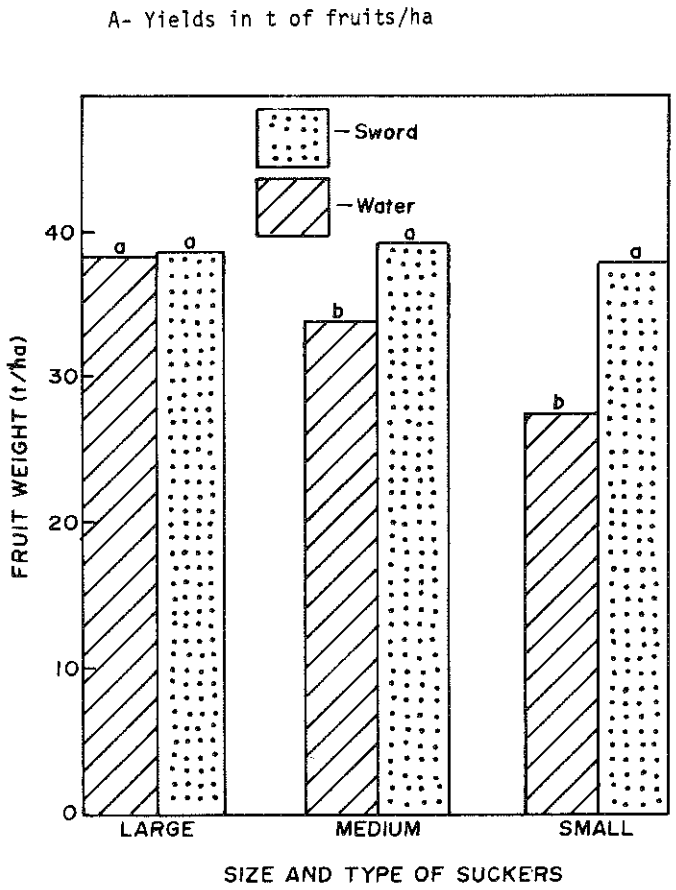
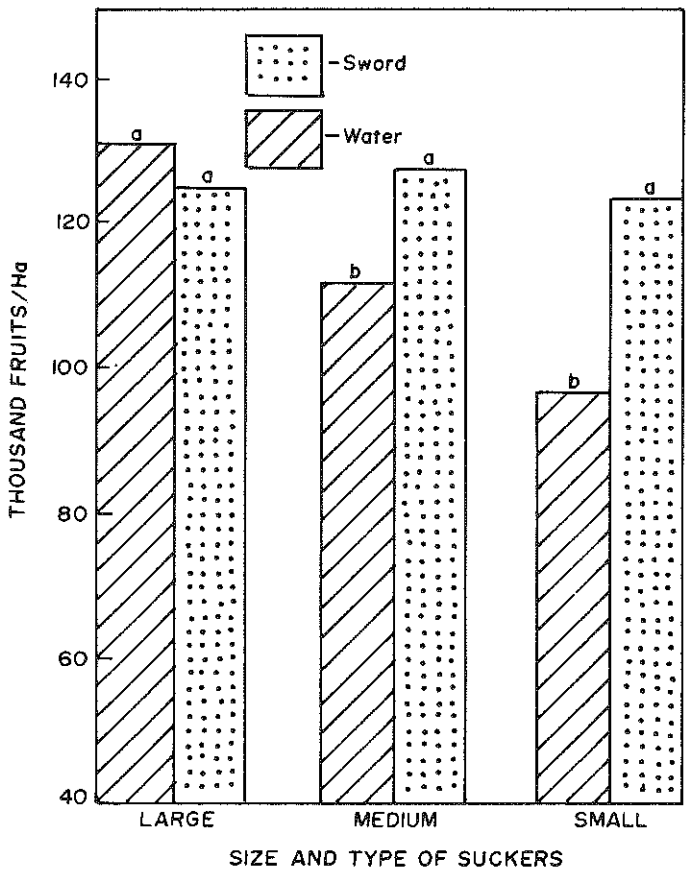


FIG. 8.—Yield in: A- t of fruits/ha and B- number of fruits/ha as affected by types and sizes of suckers used as planting material with the Dwarf plantain. Means showing a letter in common are not significantly different at P = 0.05.

B- Yields in number of fruits/ha



(suckers) at harvest were significantly affected by source of planting material. Irrespective of sucker size, pseudostems of plants grown from sword suckers had wider diameters—average 16.8 cm (fig. 6). Proliferation of "followers" from medium and small sword suckers was greater than that from similar sizes of water suckers (fig. 7-A). Also, large water suckers produced more "followers" than did medium or small suckers of the same type.

Plant height at bunch emergence and number of functional leaves at this time and at harvest were not significantly affected by sucker size or type. Mean height was 2.5 m; mean number of leaves at bunch emergence and at harvest, 13.2 and 7.7, respectively.

Number of fruits in the first and second hands was not significantly affected by source of planting material. Average number of fruits was 10 in the first hand and 9 in the second. Independent of sucker size, plants from sword suckers yielded heavier bunches, averaging 12.1 kg (fig. 6). Bunches harvested from plants grown from medium and small sword suckers had bunches with more fruits and hands than did those from water sucker of the same size (fig. 7-B,C). The number of fruits and hands produced from large suckers of both types were similar. Bunches harvested from plants growing from large water suckers were larger than those obtained from medium and small suckers of the same type.

There was no significant effect of sucker size and type in the fruit quality of the bunch third hand. Mean values for fruit characteristics were weight, 304.4 g; external length and maximum and minimum diameters, 18.9, 4.6 and 4.2 cm, respectively; pulp content, 62.5%; pulp:peel ratio, 1.7; and texture index 44 kg/cm^2. These indexes were similar and in some cases better than those recorded for the Maricongo cultivar.

Total yield, in terms of weight per ha and number of marketable fruits per ha, was significantly affected by both size and type of suckers used for planting (fig. 8-A,B). Plants from medium and small sword suckers yielded 5.5 and 10.2 t/ha, or 15,870 and 26,360 marketable fruits per hectare, respectively more than did those developed from water suckers of comparable size. Plants grown from large suckers of either type yielded about the same. On the other hand, within the water type, plants developed from large suckers produced significantly higher yields than did medium or small suckers.

RESUMEN

En la Subestación de Gurabo se establecieron dos experimentos con plátano (*Musa acuminata* × *M. balbisiana*, AAB) de los cultivares Maricongo y Enano Común, para evaluar el efecto del material de siembra en la producción y calidad del fruto. Con ambos cultivares se probaron tres tamaños de hijos: grande—2kg; mediano—1.2 kg; pequeño—0.6 kg,

y dos tipos de hijos: lanza y agua. Se sembraron utilizando un diseño de parcelas subdivididas, con el tamaño de los hijos como parcelas principales y el tipo de hijo como sub-parcelas, todas repetidas cuatro veces. Las plantas se abonaron con un fertilizante 10-5-20, que además contenía 75.3 kg de MgO y 45.4 kg de una mezcla de otros oligoelementos por tonelada. Las applicaciones se hicieron a razón de 3.5 Tm/ha a los 2, 5, 8 y 10 meses después de la siembra.

Las plantas desarrolladas de hijos grandes y medianos florecieron más temprano que las de hijos pequeños. El apogeo de la floración en todos los tratamientos occurrió unos 9.5 meses después de la siembra, apareciendo el más alto porcentaje de inducción en las plantas desarrolladas de hijos del tipo lanza. Todos los tratamientos produjeron alrededor de 35 hojas antes de la floración.

En ambos cultivares, independientemente del tamaño de los hijos, las plantas desarrolladas del tipo lanza tenían un tallo más grueso y produjeron racimos más pesados que las originadas de hijos del tipo agua. Las plantas del cultivar Maricongo desarrolladas de hijos del tipo lanza produjeron más frutas por racimo que las desarrolladas del tipo agua, pero solamente los racimos cosechados de hijos pequeños del tipo lanza fueron más grandes que los de los pequeños del tipo agua. En el cultivar Enano, las plantas de hijuelos medianos y pequeños del tipo lanza también produjeron significativamente más frutas por racimo que los producidos de hijos de igual tamaño del tipo agua. Cuando se usaron hijos grandes ninguno de los dos tipos afectó la producción.

Los tratamientos no afectaron la calidad de las frutas en la tercera mano del racimo.

La producción total del cultivar Maricongo en términos de peso y número de frutas comerciales por ha. fue afectada significativamente por el tipo de hijos, mientras que la del plátano Enano fue afectada tanto por el tamaño como por el tipo. Las plantas del Maricongo cosechadas de hijos de tipo lanza produjeron 5.7 Tm ó 14,734 frutas por ha. más que las cosechadas de hijos del tipo agua. Por otra parte, las plantas del Enano cosechadas de hijos medianos y pequeños del tipo lanza produjeron 5.5 y 10.2 Tm de frutas ó 15,870 y 26,360 frutas por ha, respectivamente más que las de peso similar del tipo agua.

LITERATURE CITED

1. Alva-Neyra, J. and Carranza, D., 1972. Estudio comparativo de seis clases de semillas de plátano clon Gros Michel, Proc. Ame. Soc. Hort. Sci. Tropical Region, 16: 195–204.
2. Barriga, R. and Montoya, R., 1972. Selección de semillas de banano y plátano, Bol. Agri. No. 623, Medellín, Colombia, 12874-12880 pp.
3. Bartolomé, R. and Songcuan, M. E., 1958. A comparison of three kinds of banana planting materials, Phillipp. J. Agri. 23 (1–4): 37–43.

4. Berril, F. W., 1960. Plant growth and yield in the Cavendish banana (*Musa cavendishii*, Lamb.) as affected by size and type of planting material, Queensl. J. Agr. 17: 69–81.
5. Gregory, E. J., 1950–51. Propagation studies: (a) The use of small suckers as planting material, (b) Performance of different types of Lacatan suckers, Investigations Dep. Agri. Jam., Bull. No. 49, 93–96 pp.
6. Irizarry, H., Green, J. J., and Hernández, I., 1975. Effect of plant density on yield and other quantitative characters of the Maricongo plantain (*Musa acuminata* × *M. balbisiana*, AAB), J. Agri. Univ. P. R. 59(4): 245–254.
7. Sánchez-Nieva, F., Colom-Covas, G., Hernández, I., Guadalupe, R., Díaz, N. and Viñas, C. B., 1968. Preharvest changes in the physical and chemical properties of plantains, J. Agr. Univ. P. R., 52(3): 241–255.
8. ——, Hernández, I., Colom-Covas, G., Guadalupe, R., Díaz, N. and Viñas, C. B., 1968. A comparative study of some characteristics of two plantain cultivars which affect yield and product quality, J. Agr. Univ. P. R. 52(4): 323–338.