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 72 JANUARY 1988 No 1

Effect of dwarfing rootstocks on tree size and yield of selected mango varieties[1]

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ABSTRACT

A 10-year study was conducted at the Fortuna Research and Developing Center to determine the effect of dwarfing rootstock on tree size and yield of selected mango varieties. Eldon as rootstock significantly reduced scion diameter of all varieties studied. However, its effects on average number of fruits produced per tree were inconsistent. Eldon as rootstock also produced significant reductions in tree height when Palmer and Irwin were used as scions. Significant reductions in tree height of the Edward variety were obtained with the combination of Julie as rootstock. Palmer produced the tallest trees and Irwin the smallest; the same pattern was observed for canopy volume. Eldon was most effective in reducing canopy volume for Palmer and Irwin as scions, whereas the greatest reduction in canopy volume for Edward was obtained on Julie. Irwin had the greatest yield efficiency regardless of the rootstock used; Palmer was the least efficient. Irwin was also superior in terms of total fruit weight per tree. There was no consistent influence of rootstock on total fruit weight per tree.

INTRODUCTION

Soil and climate conditions in the tropics are conducive to aggressive tree growth. Fruit trees such as mango usually occupy all the space available to them in the orchard within 10 to 15 years after planting (8, 11). Consequently harvesting and the application of cultural practices become increasingly difficult and expensive. Overcrowding because of excessive growth is also conducive to microclimate conditions favoring the spread of pests and diseases. The mango presents a peculiar situation in which most of the fruit is produced from buds in the periphery of the canopy. As a result, a smaller percentage of the total canopy volume is available for production in each successive fruiting cycle. After several crops, the tree becomes very massive but inefficient as a production unit.

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Methods for obtaining dwarf trees have been employed successfully in deciduous fruit trees such as apple. Techniques for controlling tree size such as pruning and the use of dwarfing rootstocks have been studied extensively in those crops (1,4,5). Similar work in tropical fruit crops is almost nonexistent although the needs are much greater. In mango, only recently some exploratory work particularly related to the use of dwarfing rootstocks has begun.

In Israel, Openheimer (6) found that the effect of dwarfing rootstock, when effective, was only temporarily so, disappearing after several years. Majumbar in India (7) found that growth parameters such as bark percentage of stems as well as roots could be used to determine vigor of seedlings at the nursery stage and to predict their dwarfing potential. Pérez et al. (9) recently reported studies in which growth and yield were associated with specific scion-rootstock combinations. Successful breeding for obtaining dwarf progenies was recently reported by Ranjith (12). Several authors have found that varieties normally producing vigorous seedlings may not impart the same vigor to scions (6,9,13).

In Puerto Rico as in many other countries of the Caribbean Basin the production of improved varieties of fruits such as mango is a new industry with great potential. More than 1,500 acres of mangoes have been planted on the island during the last decade. In 1985-86, more than 20 million fruits were produced with an estimated farm value of approximately $1.25 million (3). Production is expected to double within the next 5 years. Given the growth characteristics of mango in the tropics, it is evident that the application of methods of reducing tree size should increase even further the production potential of mango.

The research reported herein was conducted to gather information on the effect of dwarfing rootstocks on tree size and yield of commercial mango varieties in Puerto Rico and to complement a previous publication on the same subject (9).

TABLE 1.—*Combination of rootstocks and scions used in experiments determine effects on tree size and yield*

Treatment	Rootstock	Scion
1	Julie	Edward
2	Julie	Palmer
3	Julie	Irwin
4	Malda	Edward
5	Malda	Palmer
6	Malda	Irwin
7	Manzano Tetenene	Edward
8	Manzano Tetenene	Palmer
9	Manzano Tetenene	Irwin
10	Eldon	Edward
11	Eldon	Palmer
12	Eldon	Irwin

MATERIALS AND METHODS

The experiments were conducted at the Fortuna Research and Development Center near Ponce, P. R. Climate in this area is semi-dry with an average annual rainfall of 1020 mm. Trees were planted in a San Antón fine loam under drip irrigation. Planting distance was 9.1 x 9.1 m. Fertilization; weed control and other management practices were performed according to the technological package for mango production in Puerto Rico (2).

The experiment was set as a complete randomized block design with 12 treatments and 4 replications. A replication consisted of 2 trees. Table 1 shows the combination of scion and rootstocks used as treatment. Rootstock selection was based on experience as confirmed in previous publications (9,10).

Data on tree growth and production parameters were collected for 8 consecutive years starting the third year after planting. Stock and scion diameter, tree height and canopy width were measured annually in July. Fruits were harvested weekly at the turning point identifiable by skin coloration and softness of the pulp. Canopy volume was calculated with the formula c.v. = $4/3\ \pi\ a^2b$ where, a = 1/2 canopy width and b = 1/2 tree height. Yield efficiency was calculated by dividing the number and/or weight of fruits per tree by the canopy volume.

TABLE 2.—*Rootstock and scion diameters, and average number and weight of fruits produced per tree per year on Edward, Palmer and Irwin mango varieties that were grafted on Julie, Malda, Manzano Tetenene and Eldon rootstocks*

Rootstocks	Rootstock diameter	Scion diameter	Number of fruits produced/years
	cm	*cm*	
		Edward	
Julie	34.9 abc[2]	29.8 abc	190 b
Malda	32.4 bc	31.4 abc	190 b
Manzano Tetenene	35.3 abc	31.9 ab	203 b
Eldon	29.5 c	28.9 abcd	169 b
		Palmer	
Julie	42.8 a	34.3 a	200 b
Malda	39.3 ab	34.8 a	134 b
Manzano Tetenene	38.4 ab	31.5 abc	195 b
Eldon	31.9 bcd	26.8 bcd	119 b
		Irwin	
Julie	25.4 cd	24.1 cd	381 a
Malda	27.8 cde	23.6 de	364 a
Manzano Tetenene	23.5 e	22.3 d	311 a
Eldon	24.0 cd	19.8 e	190 b

[1]*Means of 8 years.*

[2]Means followed by same letters do not differ significantly at the 0.05 probability level.

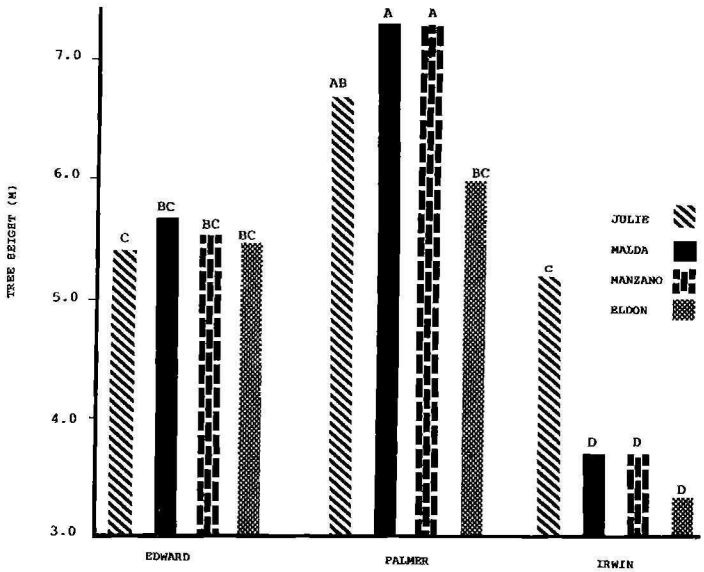

FIG. 1.—Effect of 4 rootstocks on the tree height of Edward, Palmer and Irwin mango varieties. Means with different letters, in all figures, are significantly different at the 0.05 level. (Data represent average value of 8 crops)

RESULTS AND DISCUSSION

Table 2 presents results obtained on rootstock and scion diameter and on the average number of fruit produced per year.

As a rootstock, Eldon was the most effective in reducing scion diameter of the Edward variety without significantly affecting yield. It also had a significant effect on trunk diameter when Palmer was used as scion. When Irwin was used as scion Eldon decreased trunk diameter significantly, but it also significantly decreased fruit production.

Julie, Malda and Manzano Tetenene showed no prominent effects on stock diameter. Irwin with any rootstock combination produced consistently thinner scions and in combination with Eldon produced the thinnest trees.

Figures 1 and 2 show the effects of four different rootstocks on tree height and canopy volume. In terms of height, Palmer produced the tallest trees irrespective of the rootstock used, and Irwin the smallest. Eldon induced the most prominent dwarfing effects, most effectively in

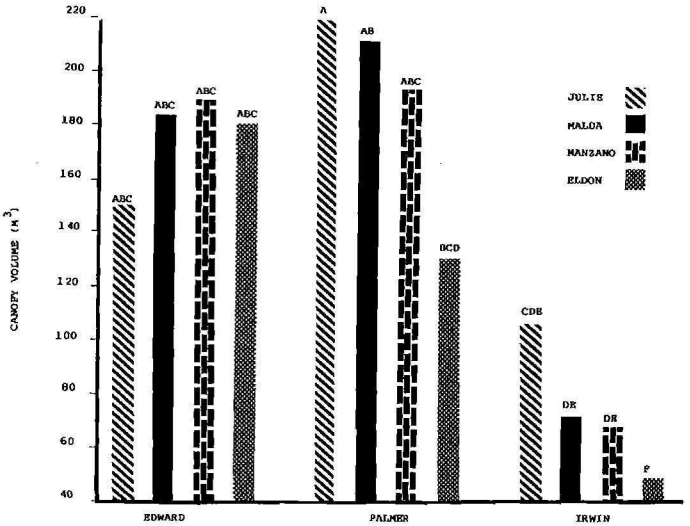

FIG. 2.—Effect of 4 rootstocks on the canopy volume of Edward, Palmer and Irwin mango varieties. (Data represent average values of 8 crops)

reducing the height of Palmer and Irwin. The effects of rootstocks in reducing the height of Edward were not very pronounced except for that of Julie, which significantly reduced the height of Edward trees.

The same trend as for tree height was observed in canopy volume. The largest canopy volume was observed in the Palmer variety and the smallest in Irwin. Eldon reduced canopy volume the most on Irwin and Palmer, but Julie did so on Edward.

Figures 3 and 4 show the number of fruits harvested per cubic meter of canopy volume (yield efficiency) and fruit weight per tree. Irwin was the most efficient producer; it outyielded the other varieties in number of fruit per unit volume of canopy regardless of the rootstock used. Palmer was the least efficient. Irwin grafted on Manzano and Malda was a particularly efficient producer with ratios approaching and exceeding 5 fruits per cubic meter of canopy. No significant effect of the rootstock was observed on Edward and Palmer.

Irwin was also superior in total weight of fruits per tree. The heavier loads of fruit were produced on rootstalks Julie and Malda. The influence of Irwin rootstock on fruit weight was very inconsistent among the differ-

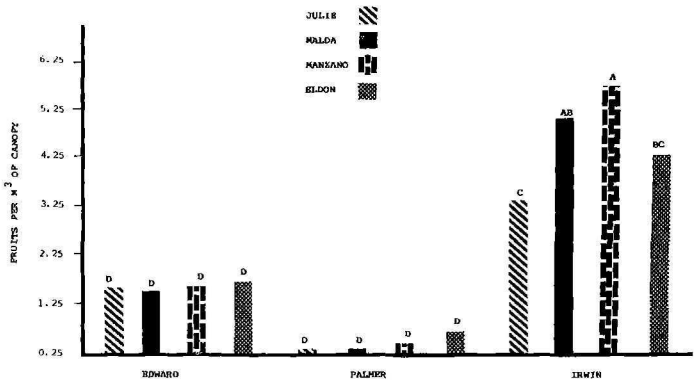

FIG. 3—Effect of 4 rootstocks on the number of fruits per cubic meter of canopy volume on Edward, Palmer and Irwin mango varieties. (Data represent average value of 8 crops)

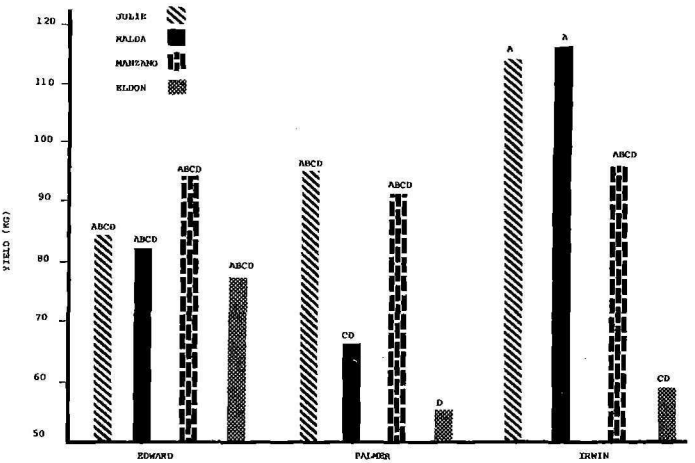

FIG. 4—Effect of 4 rootstocks on the weight of fruits per tree on Edward, Palmer and Irwin mango varieties, (Data represent average values of 8 crops)

ent varieties. Julie, Malda and Manzano Tetenene significantly outyielded Eldon. Significantly higher yields were obtained with Palmer when grafted on Julie and Manzano Tetenene. Edward was more consistent; it showed no significant effects on total fruit weight due to rootstock influence.

Results obtained in this research confirm previous findings (6, 9, 13) indicating that varieties producing vigorous seedlings may not impart the same vigour to scions. In our experiments Eldon, which produces vigorous monoembrionic seedlings, was very effective in reducing scion diameter, tree height and canopy volume. Our results also indicate that effects on scion are dependable on rootstock variety and that specific stock/scion combinations should be better for various varieties. For example, our results indicate that Julie would be a better rootstock than Eldon for reducing tree height and canopy volume of the Edward variety. An observation of the relationship between canopy volume and yield efficiency shows that large canopies such as that of Palmer on Julie are associated with low yield efficiency. Evidently in programs of rootstock evaluation and selection, yield efficiency should be one of the most important criteria to be considered since a high yield efficiency would permit high outputs per unit of land area used.

RESUMEN

Efecto de los patrones enanizantes sobre el tamaño y la producción de los árboles de algunas variedades de mangó

Durante 10 años se estudió en la Subestación de Fortuna el efecto de los patrones sobre el tamaño de los árboles y el rendimiento de algunas variedades de mangó. Cuando se usó la variedad Eldon como patrón el diámetro del injerto de todas las variedades estudiadas se redujo significativamente. Sin embargo, su efecto sobre el número medio de frutas producidas por árbol no fue consistente. Como patrón también Eldon redujo significativamente la altura de los árboles de las variedades Irwin y Palmer. Julie como patrón redujo significativamente la altura de la variedad Edward. Los árboles de la variedad Palmer fueron los más altos y los de la variedad Irwin los más bajos. El patrón Eldon fue el que más redujo el volumen de la copa de las variedades Irwin y Palmer. La variedad Edward produjo su copa más pequeña al injertarlo sobre Julie. La variedad Irwin fue la que más frutas por metro cúbico de copa produjo independientemente del patrón sobre el que se injertara; la variedad Palmer fue la que menos frutas produjo. La variedad Irwin fue la que más produjo en términos del peso total de frutas por árbol. El efecto del patrón no fue consistente sobre el peso total de frutas por árbol.

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