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Dwarfing effect of interstems on growth and yield components of mango¹

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ABSTRACT

Studies were conducted at the Fortuna Substation for 10 years to determine the effect of 5 interstems on growth and yield components of 2 commercial mango varieties. The interstems did not significantly affect the rootstock diameter when Edward variety was the scion; however, they did with Palmer variety as scion at the 3- and 6-year stages only. Irwin interstem diameter at the 3-year stage for Edward and Palmer, and at the 6- and 9-year stages for Edward, was significantly thicker than that of the other interstems. Edward on Manzano Tetenené had the thinnest interstems. In the two varieties studied, the scion diameter was scarcely affected by the interstems at 3, 6 and 9 years after transplanting. Edward and Palmer grafted on Irwin as interstems had significantly lower scion/interstem ratios. The opposite was true when these varieties were grafted on Julie. Three years after planting, the smallest trees were those of Edward and Palmer grafted on Malda; 6 and 9 years after planting, those of Edward grafted on Malda and Manzano Tetenené. Yield efficiency decreased significantly with tree age and size. Thus, there was a negative correlation between these parameters. Edward produced significantly more fruits than Palmer at the 3-year-old stage. Edward as interstem grafted on Eldon produced significantly more fruits at the 3-, 6- and 9-year stages than when grafted on the other interstems. Palmer grafted on Eldon was significantly more precocious than when grafted on the other interstems. Malda and Manzano Tetenené as interstems significantly reduced tree size of Edward; Julie as interstem reduced the size of Palmer.

RESUMEN

**Efecto enanizante de los injertos dobles en el crecimiento
y rendimiento del mangó**

Se realizaron estudios en la Subestación Experimental Agrícola de Fortuna por 10 años para determinar los efectos de 5 doble injertos sobre el

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crecimiento y los componentes del rendimiento de 2 variedades comerciales de mangó. Se encontró que los doble injertos no afectaron significativamente el diámetro del patrón cuando se usó la variedad Edward como injerto, pero tuvieron efecto significativo, aunque únicamente en la etapa de 3 y 6 años cuando se usó la variedad Palmer como injerto. La variedad Irwin como doble injerto desarrolló un diámetro significativamente mayor que las demás a los 3 años con Edward como injerto y a los 3 y 6 años con la variedad Palmer como injerto. El doble injerto más delgado se produjo con la variedad Edward sobre la Manzano Tetenené. El doble injerto causó muy poco efecto sobre el diámetro del injerto en las etapas estudiadas para ambas variedades. Los injertos de Edward y Palmer sobre Irwin como doble injerto arrojaron proporciones de injerto a doble injerto significativamente menores; ocurrió lo opuesto cuando se usó Julie como doble injerto. Los árboles más pequeños en la etapa de 3 años fueron los injertados sobre la variedad Malda como doble injerto; a los 6 y 9 años lo fueron los de la variedad Edward en combinación con Malda y Manzano Tetenené como doble injertos. La eficiencia de rendimiento disminuyó significativamente con la edad y el tamaño de los árboles, lo que sugiere una correlación negativa entre estos parámetros. La producción de la variedad Edward fue significativamente mayor que la de Palmer a los 3 años del trasplante. La variedad Edward sobre Eldon como doble injerto produjo significativamente más frutas a los 3, 6 y 9 años después del trasplante que las demás combinaciones de doble injertos. La variedad Palmer con Eldon como doble injerto fue significativamente más precoz que con los otros doble injertos. Malda y Manzano Tetenené como doble injertos redujeron significativamente el tamaño del árbol Edward; la variedad Julie tuvo un efecto similar sobre Palmer.

INTRODUCTION

The purpose of this experiment was to explore the possibility of reducing mango tree size by means of interstems of dwarfing mango varieties. No research has been conducted in Puerto Rico or elsewhere concerning the use of interstems (double grafting) to reduce mango tree size. However, this technique has been practiced in other crops to study the effect of interstems on scion nutrient content and yields.^{3,4} The importance of mango as a fruit crop has been stated previously.^{5,6} Trees that bear fruits easily picked by hand are important for mango production because fruits of good varieties are fiberless and soft and cannot be allowed to drop to the ground as in the usual commercial picking of native Puerto Rican varieties. Therefore, smaller trees must be produced by the use of dwarfing rootstocks and interstems.

³Abdalla, J. A., H. Khatomian and N. W. Miles, 1982. Effect of rootstocks and interstems on composition of 'Delicious' apple leaves. *J. Am. Soc. Hort. Sci.* 107: 730-33.

⁴Jones, O. P., 1976. Effect of dwarfing interstocks on xylem sap composition in apple trees: effect on nitrogen, potassium, phosphorus, calcium and magnesium content. *Ann. Bot.* 40:1231-1235.

⁵Cedeño Maldonado, A., A. Pérez and I. Reyes-Soto, 1987. Effect of dwarfing rootstocks on tree size and yield of selected mango varieties. *J. Agric. Univ. P. R.* 72(1):

⁶Pérez, A.; A. Cedeño-Maldonado, I. Reyes and J. López, 1987. Growth and yield of mango trees at three stages of development as influenced by rootstock and scion variety. *J. Agric. Univ. P. R.* 71 (4): 341-48.

MATERIALS AND METHODS

This research was conducted simultaneously with other research reported previously (3,5). Therefore, the management practices such as irrigation, fertilization, weeding and harvesting were similar and according to the recommendations of the Puerto Rico Agricultural Experiment Station.⁷

This experiment was planted October 1973. Ten treatments, 4 replications, 2 trees per replication were included in a randomized complete block statistical design. Eldon was used as the rootstock and cultivars Julie, Malda, Manzano Tetenené, Eldon and Irwin were used as interstems. Edward and Palmer were the commercial varieties used as scions.

Growth measurements were taken every year. However, instead of long tables, data of every third year are presented.

This report presents information 10 years after grafting (counting from transplanting date). The following data was recorded: rootstock diameter at several inches below the graft union, diameter of the middle of the interstem, scion diameter a few inches above graft union, scion to interstem ratio, tree height from the ground to the terminal buds, efficiency measured as the number of fruits per cubic meter of canopy, and number and weight of mature fruits per tree.

All data recorded were statistically analyzed.

RESULTS AND DISCUSSION

Rootstock Diameter

Table 1 indicates that the diameter of the rootstock used was not affected by the interstem after 3, 6 and 9 years of growth when Edward variety was the scion. Palmer variety was affected significantly at 3 and 6 years, but not at 9 years after transplanting. These results suggest that the effect of the interstem on the rootstock is either nonexistent or at most only temporary. Eldon was the only rootstock used in these experiments. The results also indicate a progressive increase in rootstock diameter with age.

Interstem Diameter

Interstem of Irwin was significantly thicker at 3 and 6 years with Edward variety as scion, and at 3 years after transplanting with Palmer. However, interstem was not significantly thicker at the ninth year for either variety; thus, the interstem effect on scion diameter is at most only temporary.

Manzano Tetenené had the thinnest interstem at the 3-, 6- and 9-year measurements for the Edward variety. However, for this variety there

⁷Agric. Exp. Stn., Univ. P. R., 1977. *Conjunto Tecnológico para la Producción de Mangó*, Publ. 114. Agric. Exp. Stn., Univ. P. R.

TABLE 1.—Rootstock and Interstem diameter at 3, 6 and 9 years after transplanting on Edward and Palmer mango varieties that were grafted on Julie, Malda, Manzano Tetenené, Eldon and Irwin interstocks

Years after planting	3	6	9
Interstem	Diameter (cm)		
I - Rootstock			
		<i>Edward</i>	
Julie	9.7 a ¹	21.1 ab	25.3 a
Malda	8.8 ab	19.4 ab	23.6 a
Manzano Tetenené	8.8 ab	17.8 ab	23.4 a
Eldon	9.60 ab	21.0 ab	27.6 a
Irwin	9.00 ab	20.1 ab	28.1 a
		<i>Palmer</i>	
Julie	9.1 ab	22.3 bc	27.4 a
Malda	7.9 c	20.7 ab	26.3 a
Manzano Tetenené	8.6 ab	21.0 ab	27.1 a
Eldon	8.1 b	21.0 ab	29.3 a
Irwin	9.0 ab	23.6 a	28.1 a
II - Interstems			
		<i>Edward</i>	
Julie	6.6 bc	14.3 bc	20.4 a
Malda	7.0 abc	15.0 bc	19.2 a
Manzano Tetenené	6.0 cd	13.4 c	17.1 a
Eldon	7.50 b	15.3 bc	21.2 a
Irwin	7.7 a	17.5 ab	24.4 a
		<i>Palmer</i>	
Julie	6.2 cd	17.2 ab	20.3 a
Malda	5.8 cd	20.1 a	22.2 a
Manzano Tetenené	6.3 cd	17.5 ab	24.2 a
Eldon	6.6 bc	16.6 abc	24.4 a
Irwin	7.3 ab	19.4 a	25.2 a

¹Means with different letters in all tables and figures are significantly different at the 0.05 level of significance.

was no significant variation between interstem diameters after 9 years of growth.

Three years after transplanting, Palmer as scion on Malda produced significantly thinner interstems than on Eldon and Irwin, but there were no significant differences between interstems at 6 and 9 years after transplanting. Results suggest that in Palmer, a fast growing variety, the effect of interstem diameter is lost sooner than in Edward, a slow growing variety.

Scion Diameter

The scion diameter was scarcely affected by the interstems at 3, 6 and 9 years after transplanting. At the third year after transplanting, a significantly thinner scion was found only for Edward on Manzano Tetenené. Results suggest that Edward could be more affected by the use of interstems than Palmer.

Scion Interstem Ratio

There was a significant difference between interstem varieties for scion-interstem ratio (table 2). Irwin interstems had the smallest ratio inasmuch as the scions of Edward and Palmer grafted on Irwin had a

TABLE 2.—*Scion diameter and scion to interstem ratio at 3, 6 and 9 years after transplanting Edward and Palmer mango varieties grafted on Julie, Malda, Manzano Tetenené, Eldon and Irwin interstems*

Interstem	Years after transplanting		
	3	6	9
Scion Diameter (cm)			
<i>Edward</i>			
Julie	8.0 a	16.6 ab	23.4 a
Malda	7.5 ab	15.3 ab	19.1 a
Manzano Tetenené	6.9 b	14.3 b	19.0 a
Eldon	7.8 a	17.2 ab	23.6 a
Irwin	7.5 ab	17.5 ab	23.6 a
<i>Palmer</i>			
Julie	7.5 ab	18.8 a	20.8 a
Malda	6.3 ab	16.6 ab	20.6 a
Manzano Tetenené	7.0 ab	18.1 ab	24.4 a
Eldon	7.0 ab	16.6 ab	24.1 a
Irwin	7.0 ab	17.8 ab	23.4 a
Scion interstem ratio			
<i>Edward</i>			
Julie	1.20 ab	1.15 a	1.16 a
Malda	0.06 bc	1.03 c	1.00 d
Manzano Tetenené	1.15 ab	1.08 b	1.10 abc
Eldon	1.04 bc	1.13 a	1.13 ab
Irwin	0.98 c	0.99 d	0.97 e
<i>Palmer</i>			
Julie	1.22 a	1.08 b	1.03 c
Malda	1.09 b	0.98 d	0.93 e
Manzano Tetenené	1.12 ab	0.04 bc	1.00 c
Eldon	1.05 bc	1.01 e	0.98 e
Irwin	0.96 c	0.93 e	0.93 e

thinner diameter than when grafted on the other interstems. Additional evidence to this respect is provided by table 1, which indicates Irwin had the thickest interstems. On the other hand, table 2 indicates that Edward and Palmer, when grafted on Julie, tended to have the higher scion interstem ratios because the scion is thicker than the interstem. This condition of unmatched growth apparently obstructs flow of sap, which induces abundant fruiting of those trees.

Tree Height

Edward and Palmer scions grafted on Malda were the smallest 3 years after transplanting (table 3), whereas Edward on Malda and Edward on Manzano Tetenené were the smallest 6 years after transplant-

TABLE 3.—Tree height and yield efficiency at 3, 6 and 9 year after transplanting on Edward and Palmer mango varieties that were grafted on Julie, Malda, Manzano Tetenené, Eldon and Irwin interstems

Interstem	Years after planting		
	3	6	9
	Tree height in m		
	<i>Edward</i>		
Julie	2.4 ab	3.6 b	4.7 abc
Malda	2.1 b	3.4 c	3.9 c
Manzano Tetenené	2.2 b	3.4 c	3.8 c
Eldon	2.4 ab	3.6 b	4.6 abc
Irwin	2.3 ab	3.7 b	4.9 abc
	<i>Palmer</i>		
Julie	2.6 a	4.9 a	5.3 abc
Malda	2.1 b	4.3 ab	5.6 abc
Manzano Tetenené	2.6 a	4.9 a	5.8 ab
Eldon	2.4 ab	4.7 a	6.1 a
Irwin	2.4 ab	4.6 a	6.1 a
	Efficiency (fruits/m ²)		
	<i>Edward</i>		
Julie	1.2 abc	2.6	1.1 ab
Malda	1.3 abc	3.0	1.0 ab
Manzano Tetenené	1.9 abc	2.3	1.1 ab
Eldon	1.5 ab	3.1	1.3 ab
Irwin	1.2 abc	1.9	0.8 ab
	<i>Palmer</i>		
Julie	8 abc	3.6	1.4 ab
Malda	6 abc	3.3	1.7 ab
Manzano Tetenené	3 c	2.6	1.4 ab
Eldon	1.8 a	1.9	1.7 ab
Irwin	4.6 bc	3.0	2.8 a

ing. Six years after transplanting, there was no statistically significant difference in tree height between interstems for Palmer.

Yield Efficiency

Table 3 presents yield efficiency (measured as number of fruits harvested per cubic meter of canopy). Efficiency decreased with age. Interstem had no effect on efficiency in either variety 3, 6 and 9 years after transplanting.

In the third year only Palmer on Eldon interstem was more efficient than Palmer on Manzano Tetenené, and only Palmer on Irwin was more efficient than Edward on Irwin 9 years after transplanting. Results indicate no clear-cut pattern of interstem effect on yield efficiency. There

TABLE 4.—*Number and weight of fruits produced per tree at 3, 6 and 9 years after transplanting on Edward and Palmer mango varieties that were grafted on Julie, Malda, Manzano Tetenené, Eldon and Irwin interstems*

Interstem	Years after planting		
	3	6	9
		Number	
		<i>Edward</i>	
Julie	16 ab	97 bc	128 b
Malda	10 ab	98 bc	76 b
Manzano Tetenené	9 ab	76 d	72 b
Eldon	30 ab	118 abc	100 b
Irwin	15 ab	80 cd	63 b
		<i>Palmer</i>	
Julie	7 b	188 a	225 ab
Malda	4 c	166 ab	121 b
Manzano Tetenené	3	126 abc	157 b
Eldon		91 bc	243 ab
Irwin		265 ab	471 a
		Weight (kg)	
		<i>Edward</i>	
Julie	7.4 abc	45.7 cd	59.3 b
Malda	4.7 abc	42.5 cd	35.2 b
Manzano Tetenené	4.1 abc	33.5 d	38.3 b
Eldon	12.2 a	54.0 bcd	39.9 b
Irwin	6.6 abc	36.5 d	27.6 b
		<i>Palmer</i>	
Julie	3.4 ab	92.5 a	98.7 ab
Malda	1.8 c	76.5 ab	59.9 b
Manzano Tetenené	1.9 c	67.2 abcd	71.6 b
Eldon	10.1 ab	49.3 bcd	111.6 ab
Irwin	1.7 c	87.3 ab	194.4 a

was no statistical significance between interstems for efficiency 6 years after transplanting.

Number and Weight of Fruits Per Tree

Edward, which is an early variety, bore more fruits 3 years after transplanting than Palmer, which is a late variety (table 4). Three years after transplanting, Eldon as interstem promoted precocity as well as high yields on Palmer and Edward (30 and 32 fruits per tree, respectively). Thus, Eldon as interstem induces precocity in Palmer variety and promotes high yields in Edward during early years of tree development.

Table 4 reveals that Eldon promoted a higher fruit production per tree on Edward variety at all ages studied. However, this high production was due entirely to tree size, which was significantly larger (table 3) than those of Malda and Manzano Tetenené. Results on the basis of yield efficiency as discussed earlier also support these statements.

Because there is a statistically significant effect of the interstems on tree height but not on the number of fruits per tree, interstems that induce dwarfism such as Malda and Manzano Tetenené, should be used to reduce tree size of Edward variety.

Palmer variety yielded lower number and weight of fruits than Edward at 3 years after transplanting, but it outyielded Edward twofold at 6 and 9 years after transplanting. This result is due to the greater yield efficiency of one variety over the other (table 3) during those years after transplanting.

Because there is very little statistical significance difference between interstems for the number and weight of fruits and because Julie interstem reduced height and increased yield at 9 years after transplanting, we recommend Julie interstem for limiting tree height on Palmer variety.