

Behavior of Ten Chironja Clones at Three Sites. I. Growth and Yield¹

A. Pérez, C. J. Torres, E. Pérez, J. Green²

ABSTRACT

The behavior of 10 chironja clones, studied at the Isabela, Corozal and Adjuntas Substations, demonstrated that graftage of chironja on sour orange rootstock is incompatible as determined by the scion to rootstock ratio. This incompatibility increased with tree age and was greatest in Adjuntas, intermediate in Corozal, and least in Isabela.

The Adjuntas trees had significantly thinner trunk (either rootstock or scion) diameter, and smaller canopy volume than those of Isabela and Corozal. This probably accounted for the smaller size of fruits and the lower fruit production in Adjuntas as compared to those of Isabela and Corozal.

The Isabela trees had significantly greater trunk (rootstock and scion) diameter and smaller scion/rootstock ratio and canopy volume than those of Corozal.

The weight and number of fruits per tree increased with age from 1970-1972, while the weight per fruit was reduced at the same time.

The chironja clone 2-4 produced significantly the highest crop and the heaviest fruits; therefore, its multiplication should be encouraged.

INTRODUCTION

During the first 30 years of the present century the commercial production and exportation of citrus fruits in Puerto Rico was very important (5). However, from there on, it started to decrease, and now both the local production and the importations are not enough to supply the great demand.

According to Espinet-Colón (4), the citrus industry is showing some progress as indicated by the interest in the growers for new citrus varieties. The chironja is a new type of citrus fruit described by Moscoso (6) as a possible natural hybrid between *Citrus sinensis* and *C. paradisi*. The feasibility of processing and storing this fruit has been reported by Cruz-Cay (2) and Díaz (3), respectively.

This research was initiated because the chironja is virtually a new citrus fruit that should be studied further.

MATERIALS AND METHODS

Ten chironja clonal varieties previously selected from a seedling orchard established at the Corozal Substation (7) and grafted on sour orange (*Citrus aurantium* L) rootstock were established in a Coto clay (Oxisol) at Isabela, Humatas clay (Ultisol) at Corozal, and in an Alonso clay (Ultisol) at Adjuntas.

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² Horticulturist, Assistant Horticulturist, Instructor, and Research Assistant, respectively, Agricultural Experiment Station, College of Agricultural Sciences, Mayagüez Campus, University of Puerto Rico, Río Piedras, P.R.

The experimental design was a randomized complete block with four replications per clone and two trees per plot. The planting distance between trees was 7.62 m \times 7.62 m. The orchard was managed in accordance with the recommendations of the Puerto Rico Agricultural Experiment Station (1).

The data collected was: 1) Rootstock and scion diameter measured at two inches below and above graft union, respectively; 2) scion to rootstock ratio calculated by dividing the scion diameter by that of the rootstock. The data in 1) and 2) was collected when the trees were 6 and 11 years old, respectively. 3) canopy volume calculated with the Wutscher and Shull formula (8) $v = \frac{d^2 \times h}{4}$, where d is canopy diameter and h is tree height; 4) number and weight of fruit per tree during several years of production; 5) fruit weight calculated from the mean weight of 10-fruit samples.

All the data was analyzed as a factorial experiment and the means were compared by the Duncan's multiple range test.

RESULTS AND DISCUSSIONS

Figure 1 and table 1 show that there were highly significant differences among clones, locations, years and in the interaction of substations \times years. Table 1 also shows that in 1976 the rootstock and scion diameter and the scion to rootstock ratios were highly significant, higher than in 1971. These results show the natural increase in stem growth. However, the scion to rootstock ratios greater than 1.00 show that there is a great incompatibility when grafting chironja on sour orange rootstock, and that this incompatibility is greater as the tree is older, i.e. 1.07 in 1971 as compared to 1.12 in 1976.

Figure 1 and table 1 also show that the rootstock and scion diameter were thickest at Isabela, intermediate at Corozal and thinnest at Adjuntas. Figure 1 also shows that the canopy volume was significantly largest for the trees in Corozal (27 m³), intermediate in Isabela (18 m³) and smallest in Adjuntas (8 m³).

The scion/rootstock ratio was highly significant: highest in Adjuntas, intermediate in Isabela and smallest in Corozal. If 1.00 can be considered as a perfect graft union, it may be concluded that the 1.18 scion to rootstalk ratio at Adjuntas may greatly contribute to the small size of the trees.

Table 2 shows that as the age of trees increased from 1970 to 1972 the number and weight of fruits per tree increased significantly, and that in the same magnitude of significance, fruit size was reduced. These results confirm the well-known tendency in fruit culture indicating that the number of fruits increases with the age of the tree but at the same time fruit size is reduced.

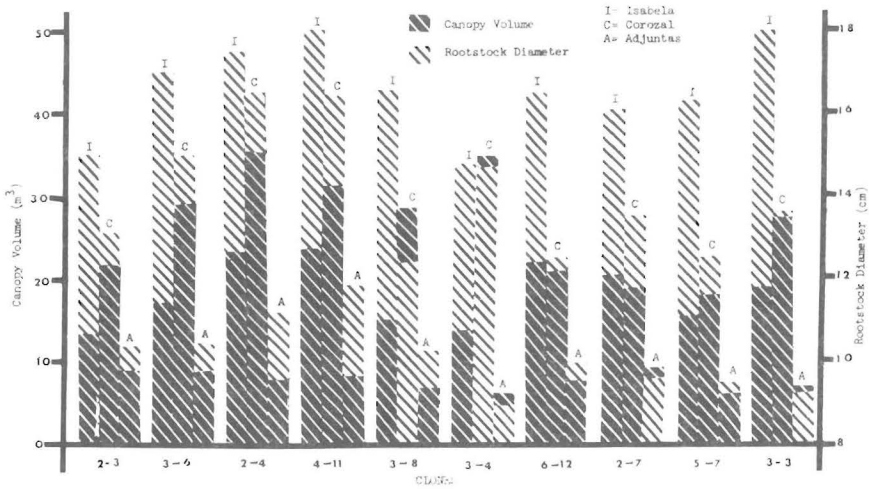


FIG. 1.—Mean canopy volume and rootstock diameter of the 10 chironja clones at the Isabela, Corozal and Adjuntas Substations.

TABLE 1.—Rootstock and scion diameter and the S/R ratio of chironja trees at the Isabela, Corozal and Adjuntas Substations during years 1971 and 1976

Year	Substations			Mean
	Isabela	Corozal	Adjuntas	
	<i>Cm</i>	<i>Cm</i>	<i>Cm</i>	<i>Cm</i>
	<i>Rootstock</i>			
1971	14.4	13.3	8.9	12.2a ¹
1976	18.7	14.7	11.3	14.9b
Mean	16.5c	14.0b	10.1a	13.6
	<i>Scion</i>			
1971	14.9	13.9	10.4	13.1a
1976	19.5	17.0	13.5	16.7b
Mean	17.2c	15.5b	12.0a	14.0
	<i>Scion/rootstock ratio</i>			
1971	1.03	1.05	1.17	1.07a
1976	1.04	1.16	1.19	1.12b
Mean	1.04a	1.11b	1.18c	1.09

¹ Means within rows and columns followed by one or more letters in common do not significantly differ at the 0.01 level.

Table 2 also shows that the Isabela trees bore fruits of equal size as those of Corozal and significantly larger than those of Adjuntas. The production, expressed in number and weight per tree was significantly higher in Isabela, intermediate in Corozal and lowest in Adjuntas.

Table 3 shows the weights in kg per tree and g per fruit of the ten

TABLE 2.—*Number of fruits per tree, weight (g) per fruit and weight of fruit per (kg) tree of the chironja clones during the years 1970, 1971 and 1972 at the Isabela, Corozal and Adjuntas Substations*

Year	Substation			Mean
	Isabela	Corozal	Adjuntas	
<i>Number of fruits/tree</i>				
1970	113	78	71	87c
1971	335	354	165	284b
1972	491	386	359	409a
Mean	313a	273b	198c	261
<i>Weight in g/fruit</i>				
1970	463	522	493	493c
1971	441	432	410	428b
1972	436	386	327	383a
Mean	447a	447b	410c	434
<i>Weight in kg/tree</i>				
1970	53	42	36	44c
1971	151	162	69	127b
1972	219	153	121	164a
Mean	141a	119b	75c	112

¹ See footnote, Table 1.

TABLE 3.—*Weight (kg) per tree and size (g) per fruit on the 10 chironja clones. Mean of 3 years.*

Clone	Weight per tree	Weight per fruit
	Kg	G
2-3	105a ¹	398a
3-6	123b	431b
2-4	133c	473d
4-11	125b	435b
3-8	121b	440c
3-4	104a	441c
6-12	106a	446c
2-7	103a	439c
5-7	84a	414b
3-3	112a	432b
Mean	112	434

¹ Means within columns followed by the same letter do not differ significantly at the 0.05 level.

chironja clones. Clone 2-4 had significantly the highest yield and the heaviest weight per fruit, characters that are promising for the multiplication of this clone.

RESUMEN

Tres experimentos se establecieron para estudiar el comportamiento de diez clones de chironja en las subestaciones experimentales agrícolas de Isabela, Corozal y Adjuntas.

Los resultados de este estudio demostraron lo siguiente:

El injerto de chironjo en naranjo agrio es incompatible. Esta incompatibilidad fue significativamente mayor en la altura (Adjuntas) que en Isabela y Corozal.

Los troncos de los chironjos en Adjuntas fueron significativamente más delgados (patrón e injerto) y la copa más pequeña, por lo cual eran más pequeños y menos productivos que los de Isabela y Corozal.

En Isabela los troncos fueron significativamente más gruesos (patrón e injerto) y la copa más pequeña.

El número y peso de las frutas por árbol aumentó con la edad, de 1970 a 1972, pero al mismo tiempo el tamaño de las frutas disminuyó en las tres Subestaciones.

El clon 2-4 fue el que produjo significativamente el mayor peso de frutas por árbol y las frutas más grandes, lo cual sugiere que su multiplicación debe recomendarse.

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