Ten-Year Evaluation of Citrus Tristeza Virus Tolerant Rootstocks Grafted with Valencia Orange in Venezuela

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ABSTRACT. Citrus tristeza virus tolerant rootstocks were compared in three different climatic areas. Yield results for 10 yr are presented. Other variables were considered like: canopy volume, efficiency, percent juice, total soluble solids (TSS) and acidity. Based on preliminary results, Volkamer lemon and *Citrus amblycarpa* have been the highest yielding rootstocks. Swingle citrumelo could be a promising rootstock if planted at a greater density. It is necessary to use more than one rootstock adapted to each climatic and soil condition.
Index words. CTV, yield, canopy, efficiency.

Our citrus culture has to improve the field techniques to satisfy the requirements of the new rootstocks being evaluated. These citrus tristeza virus (CTV)-resistant rootstocks require different treatment than sour orange rootstock which was traditionally used before the tristeza outbreak. There are many unknown aspects about the adaptability of these rootstocks to different climatic and soil conditions. We have tried to answer these questions over the past 10 yr, with several rootstock trials in different locations. This has permitted us to identify the best choice in each region. Preliminary results of these experiments have been presented (1, 2, 3, 4, 5, 6, 7).

MATERIALS AND METHODS

Characteristics of these experiments have been described previously (6).

The plants were 10 yr old in 1989. Weekly irrigation was used in locations two and three from January through April. A randomized complete block design was used in all experiments. There were six replications, except at Yumare 1, which had four replications.

RESULTS AND DISCUSSION

As shown in Table 1, Volkamer and Rough lemons, *Citrus amblycarpa*, Carrizo and Troyer citranges had the highest fruit produc-

TABLE 1
AVERAGE ANNUAL YIELDS FROM 1982-88 OF VALENCIA ORANGES GRAFTED TO TRISTEZA-TOLERANT ROOTSTOCKS AT DIFFERENT LOCATIONS IN VENEZUELA

	Fruit yield (kg/plant)			
	Yumare (1983-1988)		Güigüe	Montalbán
Rootstocks	(1)	(2)	(1982-88)	(1984-88)
Volkamer lemon	145.0	167.4	233.8	60.5
Carrizo citrange	121.9	111.3	216.6	68.7
Rough lemon	119.2	—	196.8	57.5
Citrus amblycarpa	103.1	120.5	216.5	55.3
Troyer citrange	113.5	90.5	216.2	65.4
Swingle citrumelo	77.9	113.7	155.4	50.5
Taiwanica orange	44.6	95.0	186.9	45.3
Cleopatra mandarin	62.1	58.7	161.5	45.4

TABLE 2
CANOPY, VOLUME AND EFFICIENCY OF VALENCIA ORANGES GRAFTED TO TRISTEZA-TOLERANT ROOTSTOCKS AT SEVERAL LOCATIONS IN VENEZUELA[z]

Rootstocks	Yumare No. 1		Yumare No. 2		Güigüe		Montalbán	
	Canopy volume (m^3)	Efficiency (kg fruit/m^3)	Canopy volume (m^3)	Efficiency (kg fruit/m^3)	Canopy volume (m^3)	Efficiency (kg fruit/m^3)	Canopy volume (m^3)	Efficiency (kg fruit/m^3)
Volkamer lemon	61.6 ab[y]	3.5 ab	60. a	3.96 b	68.6 b	1.3 b	20.1 ab	4.8 c
Citrus amblycarpa	53.9 b	2.3 bc	44.2 b	5.35 ab	80.6 a	1.1 b	24.2 a	5.2 b
Carrizo citrange	39.6 c	4.5 a	41.8 b	3.86 b	54.0 bc	1.7 b	19.9 ab	6.0 ab
Troyer citrange	39.1 c	4.4 a	34.0 c	4.16 b	50.9 c	1.9 b	22.1 ab	5.3 bc
Rough lemon	68.0 a	2.2 bc	—	—	80.8 a	1.5 b	17.3 bc	7.2 a
Swingle citrumelo	35.2 c	3.7 a	31.5 cd	5.84 a	35.4 d	3.1 a	15.6 c	5.6 ab
Cleopatra mandarin	33.6 c	1.8 c	34.2 c	3.27 c	67.2 b	3.1 a	15.6 c	6.3 ab
Taiwanica orange	35.7 c	2.2 bc	28.8 d	6.97 b	62.4 b	2.1 ab	19.9 ab	5.1 c

[z]Ratings made in 1988 on 10-yr-old trees.
[y]Values with the same letters are not statistically different.

TABLE 3
FRUIT QUALITY EVALUATION OF VALENCIA ORANGES GRAFTED TO TRISTEZA-TOLERANT ROOTSTOCKS AT SEVERAL LOCATIONS IN VENEZUELA, 1988

Rootstocks	Yumare			Güigüe			Montalbán		
	TSS[z]	Acid (%)	Juice (%)	TSS	Acid (%)	Juice (%)	TSS	Acid (%)	Juice (%)
Volkamer lemon	10.2 ab	1.0 a	43.0 a	10.0 a	1.1 a	51.8 bc	10.1 a	1.4 a	46.6 c
Citrus amblycarpa	9.4 b	1.1 a	44.0 a	9.0 b	1.1 a	55.5 a	10.3 a	1.4 a	50.1 b
Carrizo citrange	10.5 a	1.0 a	41.0 b	10.0 a	1.2 a	55.4 a	10.3 a	1.3 a	53.2 b
Troyer citrange	10.1 ab	0.9 a	46.6 a	10.0 a	1.0 a	49.1 c	10.1 a	1.3 a	49.3 b
Rough lemon	9.7 b	1.2 a	42.6 a	8.0 c	1.1 a	51.8 bc	9.5 b	1.3 a	50.5 b
Swingle citrumelo	9.8 b	1.0 a	44.6 a	10.0 a	1.1 a	53.6 a	9.7 ab	1.3 a	51.8 b
Cleopatra mandarin	9.4 bc	0.9 a	44.3 a	9.0 b	0.8 a	53.6 a	9.9 ab	1.4 a	50.2 b
Taiwanica orange	9.0 cd	0.8 a	42.1 ab	8.0 c	0.8 a	53.4 a	9.8 ab	1.4 a	59.8 a

[z]TSS = Total soluble solids (%)

tion. For the past 4 yr they have maintained a productive tendency at the different locations (Table 1, 2). Volkamer lemon has always been first and Swingle citrumelo, Cleopatra mandarin and Taiwanica orange the last. This relationship has not been too accentuated in Montalbán, because there were some irrigation problems at the beginning of the experiment. The range in numbers of fruit/plant varied for Volkamer lemon between 400 and 1,000. The other rootstocks showed lower values.

Canopy volume was greatest for plants budded on Volkamer and Rough lemons and *Citrus amblycarpa* (Table 2). However, the efficiency of these plants, was lower than for Carrizo and Troyer citranges in all locations (Table 2).

Valencia orange grafted on Carrizo and Troyer citranges and Swingle citrumelo had the best fruit quality (Table 3), especially the percent of juice. In Montalbán, at the highest elevation, the total soluble solids were greater, although fruit quality was not notably different between the treatments

Due to limited canopy volume Swingle citrumelo could be planted closer to compensate for the relatively lower production per plant.

Also, *Citrus amblycarpa*, in spite of the great canopy volume, has shown a good behaviour and must be considered and option at the Yumare (1, 2) and Güigüe locations.

In general, the trifoliate hybrids especially Swingle citrumelo could be the rootstocks increasing in the coming years.

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