

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

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ABSTRACT. Citrus tristeza virus tolerant rootstocks grafted with Valencia oranges were compared in three different climatic areas. Yield results for 5 yr are presented. Other variables considered were: canopy volume, efficiency, percent juice, total soluble solids (TSS), acid, and TSS/acid ratio. From the preliminary results, the most promising rootstocks are Cleopatra mandarin, Carrizo and Toyer citranges, Volkamer lemon, Swingle citrumelo and *Citrus amblycarpa*. The selection of a single rootstock is not feasible due to the different climatic and soil conditions in the three main production areas of the country.

Index words. canopy, efficiency, disease.

In Venezuela, citrus is the third most important fruit crop after bananas and plantains. There are about 40,000 ha grown and most were budded on sour orange rootstock. The brown citrus aphid, *Toxoptera citricidus*, was first noted in 1976 (4) and the presence of citrus tristeza virus (CTV) had been known in Venezuela since 1960 (5). In 1980 the first severe outbreak of the disease occurred and now more than 4 million trees have been replanted with an estimated cost of \$ US 25 million (1, 2, 3, 4, 6, 7, 8).

One of the alternatives which has given good results in other countries is the use of tristeza-tolerant or resistant rootstocks. Several rootstocks have been evaluated in the different citrus-producing areas of the country to establish their adaptability, yield, fruit quality and stock-scion compatibility. Preliminary results of these experiments are presented.

MATERIALS AND METHODS

Rootstock trials for Valencia oranges with a clone free from exocortis, cachexia and psorosis were carried out in three different areas (located approximately 10° 20' N lat. and 68° 30' W long.): At Yumare, Yaracuy State, at 70 m elevation with an average rainfall and temperature of 1,512 mm and 25 C, respectively. The soil is a silty clay loam with a pH of 7.3 and an organic matter content of

1.48%. In a second trial in the same area, the soil texture is sandy with a pH of 5.6 and an organic matter content of 0.14%. No irrigation is used. Tree spacing is 8 x 8 m. The second location is in Güigüe, Carabobo State, at 468 m elevation with an average rainfall of 969 mm and average daily temperature of 25 C. The soil type is a clay loam with a pH of 7.4 and an organic matter content of 3.83%. Tree spacing is 7 x 7 m. The third location is at Montalbán, Carabobo State, at 690 m elevation, with an average rainfall and daily temperature of 969 mm and 22 C, respectively. The soil is clay with an organic matter content of 3.01% and a pH of 5.8. Tree spacing is 8 x 8 m.

The age of the plants is 8 yr old. Weekly irrigation is used in locations 2 and 3 from January through April. A randomized complete block design was used in all experiments mentioned in this paper. There were 6 replications.

RESULTS AND DISCUSSION

The fruit yield of the 1986 crop at the three different locations is summarized in table 1. Volkamer lemon, Carrizo and Troyer citranges and *C. amblycarpa* showed the highest fruit production over several years (tables 1 and 2). Trees grafted on rough lemon, Swingle citrumelo, Cleopatra mandarin and *C. taiwanica* had lower

TABLE 1
1986 FRUIT YIELD OF VALENCIA ORANGES GRAFTED TO TRISTEZA-TOLERANT ROOTSTOCKS AT SEVERAL LOCATIONS IN VENEZUELA

Rootstocks	Location									
	Yumare No. 1		Yumare No. 2		Güigüe		Montalbán		Avg.	
	kg	No. ^z	kg	No.	kg	No.	kg	No.	kg	No.
<i>Citrus amblycarpa</i>	339.1	1,193	238.0	712	473.7	1,667	51.5	276	275.6	962
Volkamer lemon	456.6	1,914	251.5	689	251.4	774	68.0	402	256.9	945
Troyer citrange	263.3	1,025	214.4	643	293.9	906	74.0	410	211.4	746
Carrizo citrange	322.4	1,343	250.3	791	208.8	894	60.2	335	210.4	841
Rough lemon	—	—	244.9	657	269.1	830	55.4	291	189.8	598
Cleopatra mandarin	186.1	745	135.4	356	390.9	1,472	25.1	121	184.4	673
Swingle citrumelo	299.4	1,012	127.3	442	242.9	866	46.7	263	179.1	646
<i>Citrus taiwanica</i>	232.2	973	53.5	165	249.5	813	50.5	253	146.4	551

^zNumber of fruit per tree.

TABLE 2
AVERAGE YIELD FROM 1982-86 OF VALENCIA ORANGES GRAFTED TO TRISTEZA-TOLERANT ROOTSTOCKS AT DIFFERENT LOCATIONS IN VENEZUELA

Rootstocks	Fruit yield (kg/plant)			Avg.
	Yumare (1983-86)	Güigüe (1982-86)	Montalbán (1983-86)	
Volkamer lemon	172.0	227.4	40.0	146.5
Carrizo citrange	117.8	230.5	38.2	128.8
<i>Citrus amblycarpa</i>	108.8	220.0	23.1	117.3
Troyer citrange	91.8	214.2	40.4	115.5
Swingle citrumelo	111.4	155.9	30.3	99.2
Rough lemon	—	161.5	30.4	95.9
<i>Citrus taiwanica</i>	79.3	168.6	23.7	90.5
Cleopatra mandarin	58.1	157.5	18.0	77.9

yields. The trial at Montalbán had drainage problems and the yields were influenced by lack of irrigation.

Canopy volume was largest for plants budded on Volkamer lemon, rough lemon and *C. amblycarpa*. The rootstocks with the least tree growth were Swingle citrumelo, *C. taiwanica* and Cleopatra mandarin (table 3). However, the most efficient (kg fruit/m³ of foliage) combinations were Valencia on Swingle citrumelo, Carrizo and Troyer citranges, and *C. amblycarpa* (table 3).

The best fruit quality was exhibited by Valencia oranges budded on Cleopatra mandarin, Carrizo and Troyer citranges, Swingle citrumelo and *C. amblycarpa*. Trees grafted on Volkamer lemon, rough lemon and *C. taiwanica* had the lowest fruit quality (table 4).

We can say that in Venezuela it is possible to replace sour orange with CTV-tolerant rootstocks. From our preliminary trials the most promising rootstocks for the different production areas would be Yumare: *C. amblycarpa*, Swingle citrumelo, Carrizo and Troyer citranges; Güigüe: Cleopatra mandarin, Volkamer lemon, Carrizo citrange, *C. amblycarpa*, Troyer citrange and Swingle citrumelo; Montalbán: Troyer citrange, *C. amblycarpa*, Swingle citrumelo, Volkamer lemon and Cleopatra mandarin.

Swingle citrumelo can be used in

higher density plantings than the others. The most common densities used by the farmers at Montalbán are 312 plants/ha, 8 x 4 m; at Güigüe 235 plants/ha (7 x 7 m in a triangle); and at Yumare 204 plants/ha, 7 x 7 m.

Cleopatra mandarin should be used in areas with good drainage and without excessive clay. The yield of Valencia oranges on this rootstock is lower in areas like Yumare at 70 m elevation, even though the fruit quality is good.

Volkamer lemon rootstock yields well in the different production areas, even though the fruit quality is lower at 70 m elevation at Yumare where fruit is used mostly for the fresh market.

Cleopatra mandarin and Volkamer lemon rootstocks are the most widely used by the farmers, but others like the citranges and the citrumelo will also play an important role in our future citriculture. It is recommended that growers use more than one rootstock according to the climatic conditions and types of soil in the various citrus-growing areas.

ACKNOWLEDGMENTS

We thank the Federación Nacional de Citricultores, FEDENACIT, Asociación de Industriales Procesadores de Cítricos (ASOINPROCI), and the Ministerio de Agricultura y Cría (MAC), for their financial support which made this work possible.

TABLE 3
CANOPY VOLUME AND EFFICIENCY OF VALENCIA ORANGES GRAFTED TO TRISTEZA-TOLERANT ROOTSTOCKS AT SEVERAL
LOCATIONS IN VENEZUELA²

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	73.4	6.2	40.4	6.2	61.8	4.1	16.9	4.0
Rough lemon	—	—	45.4	5.4	65.7	4.1	13.6	4.1
<i>Citrus amblycarpa</i>	71.7	4.7	31.2	7.6	72.2	6.6	18.5	2.8
Carrizo citrange	57.2	5.6	26.5	9.4	50.9	5.5	16.3	3.7
Swingle citrumelo	48.7	6.1	20.7	6.1	29.7	8.2	12.1	3.9
Troyer citrange	43.5	6.1	24.6	8.7	48.1	6.1	18.9	3.9
Cleopatra mandarin	40.0	4.7	22.4	6.0	47.4	8.3	12.9	2.0
<i>Citrus taiwanica</i>	35.0	6.6	21.3	2.5	53.4	4.7	12.8	4.0

²Ratings made in 1986 on 8-yr-old trees.

TABLE 4
FRUIT QUALITY EVALUATION OF VALENCIA ORANGES GRAFTED TO TRISTEZA-TOLERANT ROOTSTOCKS AT SEVERAL LOCATIONS IN FEBRUARY 1986

Rootstocks	Yumare			Güigüe			Montalbán		
	TSS ^a	Acid (%)	Juice (%)	TSS	Acid (%)	Juice (%)	TSS	Acid (%)	Juice (%)
Cleopatra mandarin	9.0	0.93	46.5	8.0	1.00	51.1	10	1.25	47.4
Carrizo citrange	8.0	0.77	49.9	9.0	1.01	51.8	10	1.29	46.9
Troyer citrange	9.0	0.84	45.2	8.0	0.94	49.0	10	1.32	54.6
Swingle citrumelo	8.0	0.84	48.9	8.0	1.05	52.7	11	1.58	49.7
<i>Citrus amblycarpa</i>	9.0	0.90	49.8	7.5	0.98	46.3	11	1.50	55.6
Volkamer lemon	7.0	0.74	47.5	8.0	0.98	51.8	10	1.48	49.6
Rough lemon	6.0	0.75	43.6	7.0	1.02	50.0	9	1.44	47.6
<i>Citrus taiwanica</i>	7.5	1.06	43.4	7.5	0.93	51.4	10	1.49	50.4

^aTSS = total soluble solids (%).

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