Evaluation of Citrus Tristeza Virus Tolerant Rootstocks Budded with Washington Navel Orange

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ABSTRACT. Several citrus tristeza virus tolerant rootstocks budded with Washington navel orange were evaluated in Aguirre, Carabobo State, Venezuela. Yield results of 7 yr are presented. Other parameters taken into consideration were: canopy volume, efficiency, fruit size, peel width, percent of juice, total soluble solids (TSS), percent acid and TSS/acid ratio. From the preliminary results the most promising rootstocks seem to be Volkamer lemon, *Citrus taiwanica* and Carrizo citrange. The selection of a single rootstock would not be possible nor recommended due to the different climatic and soil conditions.
Index words. yield, canopy, efficiency.

Citrus is one of the main fruit crops in Venezuela. The most common varieties are Valencia and Washington navel oranges with 80 and 10% of the crop, respectively (3). Most plantings were on sour orange, but citrus tristeza virus killed a high percentage of those plants and farmers now are using other rootstocks tolerant to tristeza. Several rootstocks have been evaluated since 1976 in the main citrus production area to establish their adaptability, yield, fruit quality and scion-rootstock compatibility. More than 400,000 trees of Washington navel on tolerant rootstocks have been replanted (1, 2, 3, 4, 5, 6).

Preliminary results of this experiment are presented because 15 or more years may be required to draw final conclusions.

MATERIALS AND METHODS

The rootstock trial for Washington navel was carried out at Aguirre, distrito Montalbán, Carabobo State, on a commercial farm located approximately 10° 20′ N lat, and 68° 38′ W log. The elevation is 690 m with an average rainfall and temperature of 969 mm and 22 C, respectively. Soil type was a light clay with a pH of 6.3 and an organic matter content of 3.3%. The age of the plants was 10 yr. A randomized complete block design was used. The tree spacing was 7 x 7 m in a triangular pattern.

RESULTS AND DISCUSSION

The average fruit yield during 1980-1986 of Washington navel trees on different rootstocks is summarized in table 1. Volkamer lemon and *C. taiwanica* showed the highest average yield per year. Trees grafted to Swingle citrumelo and Troyer citrange had lower but still acceptable yields. The trees on sour orange are already affected by citrus tristeza

TABLE 1
EVALUATION OF 10-YR-OLD WASHINGTON NAVEL ORANGES BUDDED TO TRISTEZA-TOLERANT ROOTSTOCKS

Rootstocks	Fruit yield (kg/plant)[z]	No. of fruits/plant[y]	Canopy volume (m^3)[y]	Efficiency (kg fruit/m^3)[y]
Volkamer lemon	104	290	48.3	4.0
Citrus taiwanica	80	260	48.9	3.0
Swingle citrumelo	74	242	35.4	3.0
Troyer citrange	6	230	27.2	3.7
Sour orange	6	274	32.1	1.1

[z]Average 1980-86.
[y]Measured 1986.

TABLE 2
FRUIT QUALITY EVALUATION OF WASHINGTON NAVEL ORANGES GRAFTED TO TRISTEZA-TOLERANT ROOTSTOCKS

Rootstocks	Juice (%)[z]	TSS (%)[y z]	Acid (%)[z]	TSS[y]/Acid ratio
Volkamer lemon	45.1	9.0	0.79	11.4
Sour orange	47.2	10.8	0.97	11.1
Swingle citrumelo	47.7	10.0	0.92	10.9
Citrus taiwanica	47.0	8.8	0.84	10.4
Troyer citrange	44.5	9.0	0.97	9.3

[z]Average of two samples taken 4 July and 26 September 1986.
[y]Total soluble solids.

virus. Canopy volume was largest for plants budded on Volkamer lemon and *C. taiwanica*.

The rootstocks with the least tree growth were Swingle citrumelo and Troyer citrange. The most efficient combinations (kg fruit/m^3 of foliage) were Washington navel on Volkamer lemon and Troyer citrange rootstocks.

The best internal fruit quality was shown by Washington navel oranges budded on Swingle citrumelo (table 1). Trees grafted on Volkamer lemon, *C. taiwanica*, and Troyer citrange had a lower, but still commercially acceptable fruit quality. Fruit on Volkamer lemon had the greatest, and on Swingle citrumelo the lowest peel thickness (table 3).

The yields per plant of the 1986 crop are presented in table 4. An estimated yield of fruit and value per hectare are also shown.

In conclusion, there are alternatives for sour orange which are citrus tristeza virus tolerant. From the preliminary results, the most promising rootstocks for our main producing area would be Volkamer lemon, Swingle citrumelo and Troyer citrange. Under our tropical conditions,

TABLE 3
FRUIT QUALITY EVALUATION OF WASHINGTON NAVEL ORANGES GRAFTED TO TRISTEZA-TOLERANT ROOTSTOCKS

Rootstocks	Fruit weight (g)[z]	Fruit diameter (cm)[z]	Peel thickness (cm)[z]
Volkamer lemon	360	8.7	0.37
Swingle citrumelo	308	8.3	0.26
Citrus taiwanica	309	8.2	0.38
Troyer citrange	295	8.1	0.34
Sour orange	229	7.4	0.37

[z]Average of two samples taken 4 July and 26 September 1986.

TABLE 4
YIELD PER PLANT, YIELD PER HECTARE AND VALUE IN BOLIVARS OF WASHINGTON NAVEL ORANGE ON FIVE ROOTSTOCKS

Rootstocks	Fruit yield (kg/plant)	Estimated yield (kg/ha)[z]	Value (Bs/ha/yr)[y]
Volkamer lemon	194	45,590	63,319
Citrus taiwanica	146	34,310	55,608
Swingle citrumelo	106	24,910	40,465
Troyer citrange	99	23,265	39,459
Sour orange	36	8,460	18,512

[z]235 plants/ha.
[y]Assuming a price/fruit of 0.5 bolivares (Bs).

Washington navel oranges need to be grown over 400 m elevation to avoid dry fruits which have no commercial value.

It is recommended that growers use more than one rootstock according to the climatic conditions and types of soils.

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