Effects of Tristeza Virus Inoculations In Valencia Oranges on Six Rootstocks

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Decline of many sweet orange trees on Troyer citrange rootstock has been associated with citrus tristeza virus (CTV) infection in Southern California, especially in Ventura County (Calavan *et al.*, 1968, 1972, 1974; Wallace and Snow, 1965). An 8-year study of the effect of CTV infection on nucellar Olinda Valencia trees on six rootstocks is reported here. Preliminary results have been reported (Calavan *et al.*, 1972, 1974).

MATERIALS AND METHODS

Vigorous, virus-free trees of nucellar Olinda Valencia were planted in 1967-68 at Somis in Ventura County 19 km from the coast. The planting consisted of 40 trees on CRC Troyer citrange, and 20 trees each on Texas Carrizo citrange, CRC Carrizo citrange, Yuma citrange, Rubidoux trifoliate orange, and Red rough lemon rootstocks. Sixty to 70 per cent of the trees of each combination were singly inoculated at planting time with buds of one of seven CTV-infected donor trees in Riverside or Ventura Counties. The remainder were noninoculated controls. Decline ratings, tree height and width, and trunk cross-section measurements were made periodically until trees were removed in November 1975. Fruit yield and quality were determined the last 3 years of the trial. All trees were indexed for CTV on Mexican lime in 1971 and 1974. The six inoculated trees which indexed negatively and the three controls which indexed positively were omitted. Ten Olinda Valencia trees on Troyer and Carrizo rootstocks at Riverside were inoculated by bud grafts from the Ventura County donors.

RESULTS

All CTV-infected trees on Carrizo, Troyer and Yuma citrange rootstocks declined within 2 years (table 1). However, by the time the trial was terminated, most of the trees on Carrizo and Troyer had recovered. Trees on Yuma citrange remained stunted and were slightly to severely chlorotic most of the time. Trees on Yuma citrange were more sensitive to CTV than trees on the other rootstocks. Some infected trees on Rubidoux trifoliate orange rootstock declined severely; others did not. However, throughout the trial, trees on trifoliate were stunted and chlorotic due to the high lime content of the soil. Trees on Red rough lemon rootstock continued to grow nearly as fast as noninoculated controls, and never declined (fig. 1). The virus from some severely declined trees spread into three healthy, noninoculated control trees on citrange rootstock by December 1971, and these trees began to decline by May 1972. Two additional trees on citrange became naturally infected by June 1974. Seasonal variation in the severity of symptoms occurred in all sensitive infected trees with maximal decline following major stress periods, particularly hot windy days in the late winter, spring, and fall.

The most virulent virus isolates used caused no visible decline of young Valencia trees on Carrizo and Troyer citrange rootstocks within 5 years at Riverside, 80 km from the coast. However, the Ventura D isolate from two trees in this plot caused noticeable stunting without decline after 9 years in Valencia trees on Troyer at Riverside. It appears that environmental factors

TABLE 1
COMPARATIVE EFFECTS OF SEVEN ISOLATES OF CITRUS TRISTEZA VIRUS FROM RIVERSIDE AND VENTURA COUNTIES ON DECLINE OF NUCELLAR OLINDA VALENCIA ORANGE TREES ON VARIOUS ROOTSTOCKS AT SOMIS, CALIFORNIA

Rootstock	Average decline ratings* and source of inocula							
	Noninoculated control	Riv. 1	Riv.† 2	Riv. 3	Riv. 4	Riv. 5	Ven. 1	Ven. 2
Carrizo citrange (CRC)	1.8	2.2	2.5		1.8		2.6	2.6
Carrizo citrange (Texas)	2.0	1.7		2.3		1.5	3.0	2.3
Troyer citrange (CRC)	1.5	1.5		2.6		2.3	2.3	2.9
Yuma citrange	2.0	3.2	3.5		3.8		3.5	4.3
Rubidoux trifoliate orange	1.8	1.8				1.7	1.8	2.2
Red rough lemon	1.3	1.7		1.3		1.5	1.7	1.5

*Rated in November 1975; 1 = mild to 5 = severe.
†Riv. 2 was obtained in Riverside from a seedling infected by vector-transmitted CTV; other sources of inocula were field trees.

Fig. 1. Aerial view of test area in November 1975. Left to right, first 2 rows are Valencia on CRC Carrizo citrange rootstock, next 2 rows on Yuma citrange, 2 rows on Red rough lemon, 2 rows on Rubidoux trifoliate orange, 2 rows on Texas Carrizo, and finally 4 rows on Troyer citrange.

influence the tristeza tolerance of sweet orange trees on Carrizo and Troyer citrange rootstocks.

The tallest trees, those on Red rough lemon, averaged 3.3 m in height. Trees on Troyer and on Texas Carrizo averaged 3.2 m high; on CRC citrange, 2.8 m; on trifoliate, 2.5 m; and on Yuma citrange, 2.1 m.

Trunk circumferences, measured 2.5 cm above and below the bud union were, respectively: on Troyer, 41.2/48.5 cm; on Texas Carrizo, 39.9/47.5 cm; on CRC citrange, 39.7/47.1 cm; on Red rough lemon, 42.3/46.2; on trifoliate orange, 30.7/37.4 cm; and on Yuma citrange, 25.8/34.7 cm.

In total fruit counts in November 1973, trees on Red rough lemon rootstock averaged 440 fruit per tree, on Texas Carrizo, 283; on trifoliate orange, 212; on Troyer citrange, 126; on CRC Carrizo citrange, 103; and on Yuma citrange, 78.

In 1974 and 1975, Valencia trees on Red rough lemon rootstock produced fruit with a low sugar/acid ratio (table 2).

CONCLUSIONS

Valencia orange trees on Carrizo, Troyer and Yuma citrange and on Rubidoux trifoliate orange rootstocks were severely affected by various isolates of CTV in the coastal climate of Ventura County, but were usually affected only slightly, if at all, in interior locations such as Riverside. In Ventura County, mild, moist winters followed by hot, dry winds in the spring may contribute to the tristeza problem by placing the tree under sudden and prolonged stress after it has been weakened by CTV infection. Under these conditions, the three citrange rootstocks and certain individual Rubidoux trifoliate rootstocks can be

regarded as moderately susceptible to tristeza. Conversely, Red rough lemon under the same conditions showed only a slight depression in growth when infected by CTV. Although trees on Red rough lemon rootstocks produce large crops, the quality is below average. It is apparent that each variety of rootstock must be adequately tested in each area to determine its susceptibility to CTV.

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TABLE 2
VALENCIA ORANGE FRUIT QUALITY IN TREES ON SIX ROOTSTOCKS

Rootstock	Sugar/Acid Ratio* June 1974	July 1975
Carrizo citrange (CRC)	10.5	12.1
Carrizo citrange (TEXAS)	10.2	12.0
Troyer citrange (CRC)	10.6	12.3
Yuma citrange	9.7	12.9
Rubidoux trifoliate orange	9.2	12.2
Red rough lemon	9.8	10.6

*20 fruit per sample (one fruit from each tree); except Troyer, which is average of two samples.

LITERATURE CITED

CALAVAN, E. C., R. L. BLUE, R. M. BURNS, and B. W. LEE
1974. Experimentally induced, long-term effects of tristeza virus on trees of Valencia orange on citrange, Red rough lemon and trifoliate orange rootstocks near the California coast. p. 94-96. *In* Proc. 6th Conf. IOCV. Univ. California, Div. Agr. Sci., Richmond.

CALAVAN, E. C., R. M. PRATT, B. W. LEE, and J. P. HILL
1968. Tristeza related to decline of orange trees on citrange rootstock. Calif. Citrog. 53: 75, 84-88, 90.

CALAVAN, E. C., R. M. PRATT, B. W. LEE, J. P. HILL, and R. L. BLUE
1972. Tristeza susceptibility of sweet orange on Troyer citrange rootstock, p. 146-53. *In* Proc. 5th Conf. IOCV. Univ. Florida Press, Gainesville.

WALLACE, J. M., and G. F. SNOW
1965. Report on decline of orange trees on Troyer citrange rootstock. Calif. Citrog. 50:369, 378-80, 382-83.