

Differences in Transmission Efficiency of Citrus Tristeza Virus by *Aphis gossypii* Using Sweet Orange, Mandarin or Lemon Trees as Donor or Receptor Hosts Plants

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ABSTRACT. The transmission of T-300, an isolate of citrus tristeza virus (CTV) widespread in Spain, was tested using *Aphis gossypii* (Homoptera, Aphididae). The tests were performed with the three most commonly cultivated citrus species: sweet orange, mandarin and lemon trees, as donor and as receptor hosts. Colonies of 200 aphids were used for each plant in the transmission experiments. The lowest transmission efficiency ratios were obtained when using lemon as donor or as receptor hosts, whereas the highest efficiency was found from sweet orange to sweet orange plants.

In previous work (4) the transmissibility of two Spanish isolates of the citrus tristeza virus (CTV) was assayed using the major citrus aphid species of Spain. Only *Aphis gossypii*, *Aphis citricola* and *Toxoptera aurantii* were capable of transmitting some of the isolates tested, and the transmission efficiency of *Aphis gossypii* was significantly higher than that of the other two species.

Aphid transmissibility of CTV depends on many factors including the citrus species used as donor (1, 6, 7) or receptor (3, 7) plants.

The most widespread citrus species in Spain are: sweet orange (54.88% of total citrus area), mandarin (24.62%) and lemon (20.20%) (5). The other species represent only 0.29% of the total area.

We report here the results of experiments conducted to determine whether the transmission efficiency of CTV by *A. gossypii*, the main vector of tristeza in Spain, varied when sweet orange, mandarin and lemon were used as CTV donor or receptor hosts.

MATERIALS AND METHODS

The T-300 isolate of CTV was employed for *A. gossypii* transmission tests. It was obtained by C. Fuertes in the Valencian Country by exposing healthy Mexican lime seedlings to

natural infection in the field. This isolate induced mild symptoms on Mexican lime and is representative of the most common type of CTV in Spain.

Donor and receptor hosts were 2-yr-old Washington navel sweet orange, Clementino Fino mandarin and Verna lemon plants, budded on sour orange. Donor plants were graft-inoculated with the T-300 isolate of CTV. These donor plants were pruned periodically to produce young shoots for aphid feeding. From 40 to 50 receptor plants were employed for each of the nine combinations of sweet orange, mandarin and lemon as donor and receptor hosts.

Aphids used in the experiments were reared on cotton in a greenhouse with temperatures ranging from 18 C to 25 C. There were about 200 *A. gossypii* (adults, and nymphs of different ages) on each receptor plant. Transmission cages were employed as described earlier (4).

Transmission experiments were conducted under greenhouse conditions described above. Acquisition time varied from 24 to 48 h, whereas inoculation time was always 48 h. After inoculation, receptor plants were transferred to another greenhouse with the same temperature conditions and observed for at least 6 months. Then, they were tested for CTV by enzyme-linked immunosorbent assay (ELISA).

RESULTS AND DISCUSSION

Results of the experiments are shown in table 1. *A. gossypii* transmitted isolate T-300 of CTV to the combined receptor plants more efficiently from sweet orange (13.8%) than from mandarin (7.5%); and from mandarin more efficiently than from lemon (0.8%). Similarly, transmission efficiency was higher from the combined donor plants to sweet orange (13.4%) than to mandarin (8.5%), and was higher to mandarin than to lemon (1.4%).

When considering each species separately it appears that lemon, both as donor and as receptor, always gave the lowest rates of transmission efficiency. Conversely, when comparing sweet orange and mandarin as donor host plants, transmissive efficiency was sometimes higher with sweet orange than with mandarin, and sometimes the reverse was true depending on the receptor species used. The same variation in transmission efficiency was observed when comparing sweet orange and mandarin as receptor host plants.

The highest rate of transmission observed in this experiment was found when transmitting T-300 from sweet orange on sour stock, to sweet orange on sour stock. This efficiency rate, however, was significantly lower than that obtained in previous work (4) with the same CTV isolate and aphid from sweet orange donors to seedling Mexican lime receptors. This difference may be due to the receptor species used, or because the

donor plants were budded in one test and not in the other. It could also have been due to differences in the chamber or greenhouse conditions used in the two experiments.

A. gossypii transmitted a severe isolate of CTV to Key lime efficiently (83.3%) in Florida (6) using sweet orange as a donor, whereas no transmission was achieved from Cleopatra mandarin. In contrast, *A. gossypii* transmitted seedling yellows-tristeza (CTV-SY) to Mexican lime in a similar way in Israel from sweet orange (45.4%) or mandarin (42.3%) donors (1). On the other hand, *A. gossypii* transmitted several isolates of CTV and CTV-SY to different receptor species in California (7) with lower efficiency where lemon was the donor host (from 0 to 17%) than when using sweet orange as a donor (from 14 to 100%). These results agree with the low transmissibility observed from lemon, and in the variability of transmission efficiency when employing sweet orange and mandarin as virus donor hosts.

Low transmissibility of CTV when using lemon as donor plant could be caused by the irregular distribution of the virus in this species (2, 7). Moreover, Roistacher *et al.* (8) in California observed that *A. gossypii* did not feed preferentially on lemon leaves. As these authors indicated, field natural infection of CTV will be lower in lemon than in other citrus species. Field surveys carried out in Spain (Moreno, personal communication), confirm that CTV-infected lemon trees are rare in the field, and

TABLE 1
CTV TRANSMISSION BY *APHIS GOSSYPYII* WHEN USING THREE CITRUS SPECIES AS DONOR OR RECEPTOR PLANTS

Donor plants	Receptor plants							
	Sweet orange		Mandarin		Lemon		Combination	
	Transmission ^z	%	Transmission ^z	%	Transmission ^z	%	Transmission ^z	%
Sweet orange	15/46	32.6	5/49	10.2	0/50	0.0	20/145	13.8
Mandarin	3/47	6.4	6/50	12.0	2/50	4.0	11/147	7.5
Lemon	0/41	0.0	1/43	2.3	0/43	0.0	1/127	0.8
Combination	18/134	13.4	12/142	8.5	2/143	1.4	—	—

^zNo. of infected plants/no. of inoculated plants.

that the rate of tristeza spread to orange trees is lower in areas where lemon trees are predominant.

We conclude that lemon is a poorer donor and receptor of tristeza than sweet orange and mandarin. There was no clear difference, between sweet orange and mandarin as donor or receptor host plants. Their transmissive efficiency depends on

the citrus species employed, either in receiving or transmitting the virus.

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LITERATURE CITED

1. Bar-Joseph, M., B. Raccach, and G. Loebenstein
1977. Evaluation of the main variables that affect citrus tristeza transmission by aphids. 1977 Proc. Int. Soc. Citriculture 3: 958-961.
2. Cambra, M., J. F. Ballester, J. A. Pina, and A. Laviña
1984. Translocación del virus de la tristeza de los cítricos en diferentes huéspedes y sus combinaciones, p. 75. In Resúm. 3er Congr. Nac. Soc. Esp. Fitopatología. ICIA, Tenerife.
3. Costa, A. S., T. J. Grant, and S. Moreira
1949. Investigações sobre a tristeza dos citros. II. Conceitos dados sobre a reação das plantas cítricas a tristeza. *Bragantia* 9: 50-80.
4. Hermoso de Mendoza, A., J. F. Ballester-Olmos, and J. A. Pina
1984. Transmission of citrus tristeza virus by aphids (Homoptera, Aphididae) in Spain, p. 23-27. In Proc. 9th Conf. IOCV. IOCV, Riverside.
5. Ministerio de Agricultura
1983. Anuario de estadística agraria: 279.
6. Norman, P. A. and T. J. Grant
1959. Transmission of T₃ severe strain of tristeza virus of citrus by melon aphid. *J. Econ. Ent.* 52: 632-643.
7. Roistacher, C. N. and M. Bar-Joseph
1984. Transmission of tristeza and seedling yellows tristeza virus by *Aphis gossypii* from sweet orange, grapefruit and lemon to mexican lime, grapefruit and lemon, p. 9-18. In Proc. 9th Conf. IOCV. IOCV, Riverside.
8. Roistacher, C. N., M. Bar-Joseph, and T. Carson
1984. Preferential feeding by *Aphis gossypii* on young leaves of sweet orange, grapefruit and lemon, p. 19-22. In Proc. 9th Conf. IOCV. IOCV, Riverside.