CRISTACORTIS AND IMPIETRATURA

Evidence for the Existence of Strains of the Cristacortis Pathogen

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Cristacortis disease is widespread in Corsica and affects many Clementine trees on sour orange rootstock (Vogel and Bové, 1972). Clementine is the main commercial variety on the island. While all affected Clementine trees show symptoms of cristacortis stem pitting on the sour orange rootstocks, only certain trees also have symptoms on the Clementine scions. On certain trees stem pitting on the Clementine is restricted to the trunk; on others it extends to all parts of the top, including the young shoots. The experiments described in this paper were undertaken to determine whether the presence or absence of cristacortis stem pitting symptoms on Clementine scions could be explained in terms of strains of the cristacortis pathogen.

MATERIALS AND METHODS

Three 6-year-old Clementine trees on sour orange rootstocks were selected as source trees for bud and bark collection. Tree A was in the "Delarue" orchard and showed cristacortis stem pitting only on the sour orange rootstock; the tree is now 11 years old and has never shown symptoms on the Clementine top. Tree B was in the same orchard but also had stem pitting on the Clementine trunk. Tree C was in the "Mistral" orchard and had severe pitting all over the tree, from the rootstock to the young shoots. The three source trees had a common origin in that the "Delarue" and "Mistral" orchards were propagated with budwood from the same orchard (Semidei).

Three experiments were undertaken. In the first, buds from each source tree were propagated on eight sour orange seedlings; the budlings were planted in the field in October 1970. In the second, virus-free Clementine buds (SRA15) were propagated on sour orange and Orlando tangelo seedlings in June 1968; the plants were transferred from the greenhouse to the field in April 1970. Two months later, groups of six budlings were inoculated with bark inoculum from either tree A or B. In the third experiment, six Orlando tangelo and six sour orange seedlings were inoculated with bark inoculum from tree A and the same kinds and numbers of seedlings from tree B; the inoculated seedlings were planted in the field in October 1970.

Indexing revealed that tree B was infected with the exocortis viroid; so were all the experimental trees propagated from, or inoculated with, material from tree B. It is well known that besides stem pitting, the cristacortis syndrome includes psorosis-like young leaf symptoms (Vogel and Bové, 1974). The three source trees as well as the experimental trees have all shown these symptoms.

RESULTS AND DISCUSSION

In the first experiment buds from the three cristacortis-affected source trees were propagated on sour orange; the rate of cristacortis symptom appearance on the sour orange rootstocks and the Clementine tops was recorded from 1972 to 1975. Table 1 shows that the cristacortis symptoms appeared on the sour orange rootstock in all three groups of progeny trees but only the propagations from trees B and C also had symptoms on the Clementine tops. The rate of symptom appearance on Clementine scions was faster when buds from tree C, rather than from tree B, were used.

Thus the symptom expression of cristacortis on the progeny trees is the same as that shown by the corresponding tree. If the parent Clementine tree showed no cristacortis stem pitting on the scion (tree A), pitting was also absent on the progeny scions. Also, the more severe the symptoms in the Clementine top of the parent tree (tree C), the faster and more severe the symptoms appeared on both the scions and stocks of the progeny trees.

TABLE 1
PROPAGATION OF CRISTACORTIS-INFECTED CLEMENTINE BUDS ON SOUR ORANGE: RATE OF SYMPTOM EXPRESSION

Source of Clementine buds	Cristacortis stem pitting symptoms* On sour orange stock in 1972	1973	1974	1975	On Clementine scion in 1972	1973	1974	1975
Tree A	0/8	0/8	2/8	5/8	0/8	0/8	0/8	0/8
Tree B	2/8	5/8	7/8	7/8	0/8	0/8	1/8	3/8
Tree C	4/8	5/8	8/8	8/8	5/8	8/8	8/8	8/8

*Number of plants showing symptoms/total number of plants used.

Special attention was given to source trees A and B. The fact that the Clementine top of tree A shows no symptoms of cristacortis, while that of tree B does, could be explained in either of two ways: (1) the two trees come from an identical Clementine cultivar, but they are infected by different strains of the cristacortis pathogen; or (2) the two trees represent distinct cultivars, each reacting differently to the same strain of the cristacortis pathogen. Table 2 shows the results of an inoculation experiment to determine which of the above possibilities is correct.

Buds from virus-free Clementine cultivar SRA15 were budded onto sour orange as well as onto Orlando tangelo rootstocks. The budlings were then graft inoculated with bark from source tree A or B (bark A or B). Five years after inoculation practically all the inoculated trees (23 of 24) showed cristacortis symptoms on the sour orange or Orlando tangelo stocks (table 2). However, only those trees inoculated with bark B developed cristacortis symptoms on the Clementine top (10 of 12); none of the 12 trees inoculated with bark A developed such symptoms. Thus, symptom expression on the inoculated trees is the same as that on the respective source trees.

In this experiment the trees were from a single Clementine cultivar (SRA15), yet they reacted differently to the cristacortis pathogen; those inoculated with bark A reacted like tree A, those inoculated with bark B had symptoms like tree B. Thus it seems likely that differences in cristacortis symptom expression in Clementine are due to differences in cristacortis

TABLE 2
CLEMENTINE BUDS PROPAGATED ON SOUR ORANGE AND ON ORLANDO TANGELO STOCKS AND INOCULATED WITH TWO SOURCES OF CRISTACORTIS: RATE OF SYMPTOM EXPRESSION

Source of Clementine bark inoculum	Test plant	Cristacortis symptoms on*											
		Sour orange stock in				Orlando tangelo stock in				Clementine scion in			
		1972	1973	1974	1975	1972	1973	1974	1975	1972	1973	1974	1975
Tree A	Clementine SR15 on sour orange	0/6	0/6	2/6	6/6					0/6	0/6	0/6	0/6
Tree B	Clementine SR15 on sour orange	1/6	3/6	6/6	6/6					0/6	0/6	0/6	4/6
Tree A	Clementine SR15 on Orlando tangelo					0/6	1/6	5/6	5/6	0/6	0/6	0/6	0/6
Tree B	Clementine SR15 on Orlando tangelo					3/6	6/6	6/6	6/6	1/6	1/6	1/6	6/6

*Number of plants showing symptoms/total number inoculated.

TABLE 3
ORLANDO TANGELO AND SOUR ORANGE SEEDLINGS INOCULATED WITH DIFFERENT SOURCES OF CRISTACORTIS: RATE OF SYMPTOM EXPRESSION

Source of Clementine bark inoculum	Test plant	Cristacortis symptoms in*			
		1972	1973	1974	1975
Tree A	Orlando tangelo	1/6	1/6	6/6	6/6
Tree B	Orlando tangelo	6/6	6/6	6/6	6/6
Tree A	Sour Orange	0/6	0/6	4/6	5/6
Tree B	Sour Orange	3/6	5/6	6/6	6/6

*Number of plants showing symptoms/total number inoculated.

strains rather than to differences in Clementine cultivars.

The existence of cristacortis strains also can explain the results in table 3, which shows that identical Orlando tangelo or sour orange seedlings reacted faster to the cristacortis pathogen when they were inoculated with bark from tree B rather than from tree A. We do not think that the presence of exocortis in tree B can explain the fact that inoculum from that tree induced cristacortis symptoms faster than that from exocortis-free tree A, one reason being that trees propagated from exocortis-free tree C showed cristacortis symptoms in even less time than the progeny trees from exocortis-infected tree B (table 1).

CONCLUSION

From the data reported here we conclude that different strains of the cristacortis pathogen exist. The strain present in tree A cannot induce stem pitting on Clementine while those in tree B and C can. The strain in tree C seems to be more severe than that in tree B since it induces cristacortis stem pitting not only on Clementine trunks, as does strain "B", but also on young Clementine shoots. Also, with strain "C" stem pitting appears in the shortest time. Strain "C" would thus be more severe than strain "B". The mildest strain would be "A" because it cannot induce stem pitting on Clementine. Clementine appears to be useful for distinguishing different strains of cristacortis.

LITERATURE CITED

VOGEL R., and J. M. BOVÉ
1972. Relation of cristacortis virus to other citrus viruses, p. 178-84. *In* W. C. Price, (ed.), Proc. 5th Conf. Intern. Organization Citrus Virol. Univ. Florida Press, Gainesville.

VOGEL R., and J. M. BOVÉ
1974. Studies on the cause of leaf symptoms associated with cristacortis disease of citrus, p. 131-34. *In* L. G. Weathers and M. Cohen, (eds.), Proc. 6th Conf. Intern. Organization Citrus Virol. Univ. California Div. Agr. Sci., Berkeley.