Studies on the Cause of Leaf Symptoms Associated with Cristacortis Disease of Citrus

R. Vogel and J. M. Bové

Psorosis young-leaf symptoms are always observed on citrus plants infected either naturally or experimentally with the cristacortis pathogen (*1, 2, 3*). It has been concluded that cristacortis sources were always infected with the concave gum pathogen and that psorosis young-leaf symptoms associated with cristacortis-affected trees resulted from the concave gum agent (*3*). Cristacortis sources were recently found which are likely free of concave gum virus but which show, or induce, young-leaf symptoms of psorosis on inoculated plants. This finding questions the specificity of psorosis young-leaf symptoms in diagnosing psorosis and certain other citrus viruses.

EXPERIMENTS AND RESULTS

Wood symptoms of concave gum and cristacortis. A cristacortis-free source of concave gum (Code 158–62, containing a mild strain of exocortis) inoculated into Washington navel sweet orange and Orlando tangelo seedlings produced concentric gum deposits in the wood typical of concave gum (fig. 1, *A*, and *B*). Gum layers often developed within two or three years, before concavities on the trunk or branches could be seen. The layers frequently appeared in shoots 1 cm in diameter. Presence of these concentric gum layers, either alone, in young shoots, or accompanied by concavities on older branches, is considered a diagnostic symptom of concave gum.

Many cristacortis sources also induce the concentric gum deposits when inoculated into Washington navel or Orlando tangelo seedlings. In addition, they induce radially oriented stem-pitting symptoms (fig. 1, *C*), which are never induced by sources of concave gum free of cristacortis. When concentric gum layers and radially oriented stem pits appeared in the same plant, both concave gum and cristacortis were concluded to be present.

Recently, cristacortis sources have been found which, upon inoculation, produce stem-pitting symptoms but no concentric gum deposits (fig. 1, *D*). Such sources were thought to be free of concave gum, and were used for further studies. All these sources of inoculum caused psorosis young-leaf flecking and oak leaf patterns.

Concave gum-free cristacortis sources. Ten 40-year-old local sweet orange trees on sour orange rootstocks were found at San Nicolao, Corsica, which showed cristacortis stem pitting in stock and scion but no external trunk or concentric gumming in the wood typical of concave gum. Inocula from two of these trees were used to infect six Orlando tangelo plants. Cristacortis symptoms were obtained within three years on all seedlings. Concave gum symptoms (trunk concavities or concentric gumming) were not observed, even after 11 years. Orlando tangelo seedlings inoculated with concave gum sources at the same time developed typical concave gum symptoms within six years.

The ten source trees plus an additional one were used to inoculate nucellar Willowleaf mandarins on sour orange rootstocks. Inoculum from each source was put into four trees. All 12 mandarin plants developed cristacortis symptoms within two years. None has yet produced concave gum symptoms after six years. Four mandarin budlings were inoculated at the same time with concave gum source 158–62, and

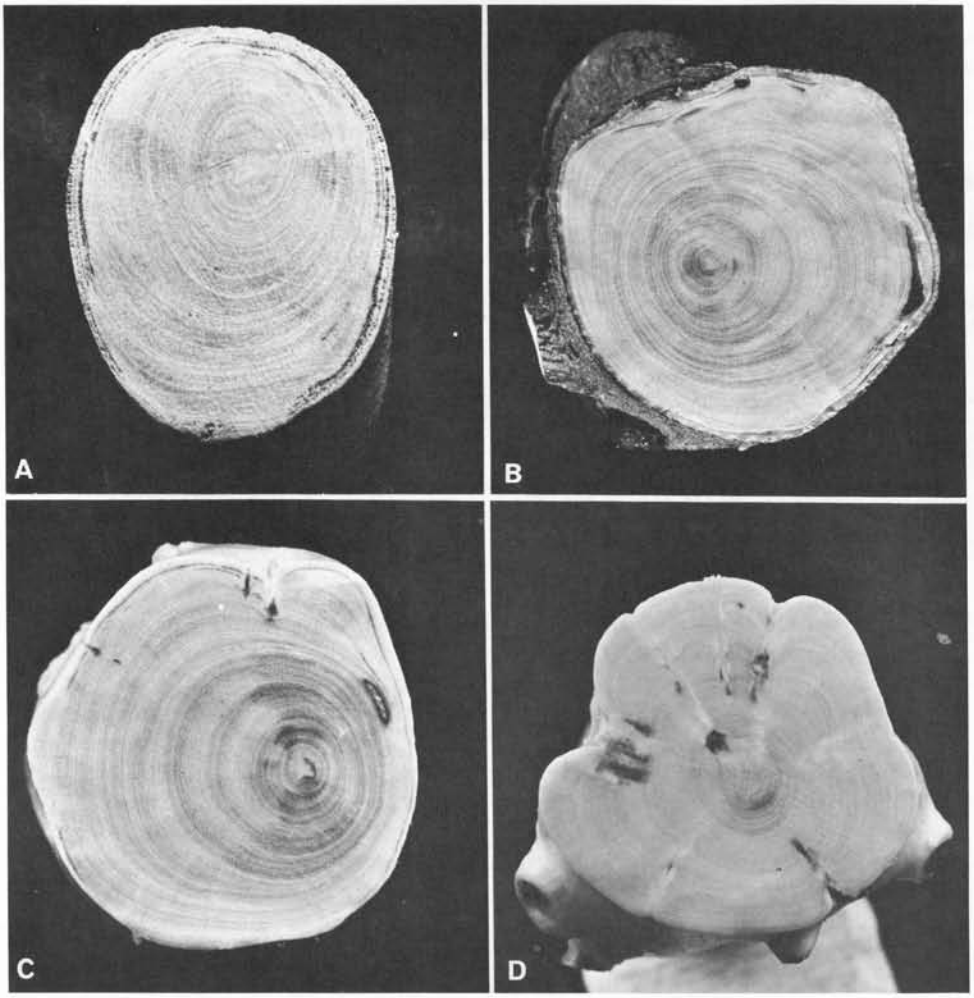

Fig. 1. Cross-sections of: *A*, Washington navel sweet orange, and *B*, Orlando tangelo seedlings, showing concentric gumming after graft-inoculation with concave gum virus. Cross-section of Orlando tangelo seedlings inoculated with: *C*, a source of cristacortis virus inducing concentric gumming and radially oriented stem pits, and *D*, a source inducing only stem pits. Average diameter of *A*=2 cm; *B*, *C*, and *D*=4 cm.

developed typical concave gum symptoms, but no cristacortis symptoms, within five years.

Psorosis young-leaf symptoms were always observed both in the presence and absence of concave gum symptoms.

Many old, local sweet orange trees in various locations in Corsica have been found to show cristacortis symptoms and psorosis young-leaf symptoms, but no concave gum symptoms. Inoculum from each of three such trees was put into each of three Orlando tangelo seedlings in 1961. Cristacortis symptoms and psorosis young-leaf symptoms were observed within three years. No concave gum symptoms were visible after 11 years. Orlando tangelo seedlings inoculated at the same time with concave gum showed trunk concavities and concentric gum deposits within five years.

In a search for a source of "pure" cristacortis, we inoculated five Tarocco sweet orange seedlings with inoculum

from a Tarocco sweet orange tree multiply affected by cristacortis, concave gum, and exocortis (*3*). Bark inoculum was removed 48 hours after inoculation. Two seedlings developed cristacortis and psorosis young-leaf symptoms within three years. No concave gum symptoms developed, even after seven years. Three of five inoculated seedlings have yet to show symptoms of any sort seven years after inoculation and removal of inoculum.

In another similar experiment, bark inoculum was removed from inoculated seedlings four, eight, and 14 days after grafting. Cristacortis, concave gum, and psorosis young-leaf symptoms developed in all the seedlings.

DISCUSSION AND CONCLUSIONS

Old trees have been found, free of concave gum, as judged by the absence of trunk concavities and concentric gum deposits, but affected by cristacortis and psorosis young-leaf symptoms. Inocula from these trees induced cristacortis and psorosis young-leaf symptoms on Orlando tangelo seedlings and mandarin plants on sour orange rootstocks, but no concave gum symptoms. Cristacortis free of concave gum was obtained from a Tarocco sweet orange source affected by both cristacortis and concave gum.

Cristacortis sources free of concave gum always induced psorosis young-leaf symptoms, thus raising the question of the cause of such symptoms.

Conceivably, even though no trunk symptoms of concave gum were seen, the causal agent could still have been present and have expressed itself as psorosis young-leaf symptoms. This does not seem likely, since in Corsica, concave gum virus induces severe symptoms in much less than 10 years. To argue that the concave gum agent was present as a separate strain producing only leaf symptoms requires the hypothesis of one strain responsible for psorosis young-leaf symptoms and another for trunk and wood symptoms. We do not favor such a hypothesis.

Other citrus diseases are known to be accompanied by psorosis young-leaf symptoms, including psorosis A, crinkly leaf, infectious variegation, and blind pocket. None of these diseases was present in cristacortis sources used in this work.

Psorosis young-leaf symptoms could be the result of cristacortis, which in that case should be considered a representative of the so-called psorosis group. There are no more reasons to include cristacortis in that group, however, than there are to include concave gum, blind pocket, crinkly leaf, and infectious variegation. At any rate, we suggest that different infectious citrus agents, such as psorosis A, concave gum, crinkly leaf, infectious variegation, cristacortis, and perhaps impietratura (Loebenstein, personal communication) produce the so-called psorosis young-leaf symptoms. We further suggest that this leaf symptom is unspecific, and although of great value in indexing work, should not be used to diagnose a specific disease.

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