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Seed Transmission of Exocortis Virus

THE VIRUS of exocortis is reported not to be seed-transmitted (3, 7), although rare instances of transmission of psorosis and xyloporosis viruses through seed of citrus have been reported (5, 9). Fraser and Levitt (1) found no exocortis in trifoliate orange [*Poncirus trifoliata* (L.) Raf.] seedlings grown from seed of trees infected with exocortis virus and concluded that this virus is not seed-transmitted to a significant extent. This paper reports some studies conducted at the Limeira Citrus Experiment Station on seed transmission of exocortis virus.

Tests of Nucellar Lines

Several trees of nucellar lines of 20 varieties and species of citrus were tested for exocortis virus by using the quick test of Moreira (4). The old-line parent trees of nine of these varieties, the Baianinha (a small Washington Navel), Hamlin and Valencia orange [*Citrus sinensis* (L.) Osbeck], Marsh seedless grapefruit (*C. paradisi* Macf.), Umbigo sweet lime (*C. limettioides* Tanaka), Cristal acid lime [*C. aurantifolia* (Christm.) Swing.], and Eureka, Amber, and Armstrong lemon [*C. limon* (L.) Burm. f.], were known to be infected with exocortis virus. All trees tested were first generation by vegetative propagation from nucellar seedlings. The indicator plants were inoculated in November, 1959. Eight months later, the indicator plants used in testing two of the 18 nucellar Baianinha Navel orange trees had symptoms indicative of a mild strain of exocortis virus.

All nucellar Baianinha orange trees at the Limeira Citrus Experiment Station were then tested for exocortis virus. They were derived

from 112 different nucellar seedlings no longer in existence. Twenty-four 18-year-old trees, representing 24 different nucellar lines, were on Rangpur lime (*C. limonia* Osbeck) rootstock exhibiting no visible exocortis symptoms. All the other trees were 12 years old on Caipira sweet orange rootstock. Inoculations of indicator plants were made in October, 1960. One year later, symptoms on the test plants indicated that six of the 24 Baianinha orange trees on Rangpur lime and seven of the 88 trees on Caipira sweet orange rootstock were infected with exocortis virus. The test plants displayed in all cases mild symptoms that required 8-10 months to appear, indicative of mild strains of the virus. One hundred control test plants developed no symptoms. Buds from these diseased test plants transmitted the virus to other Rangpur lime seedlings in subsequent experiments. In all these tests, many inoculating buds were used to inoculate each indicator plant.

In another test, buds from an infected nucellar Baianinha orange tree on Caipira sweet orange rootstock were used to inoculate 20 Rangpur lime seedlings, one bud for each seedling. Inoculations were made in December, 1961. Twelve buds transmitted the mild strain of exocortis virus. Three other seedlings showed only a slight yellowing in the bark, normally not considered to be symptoms of exocortis. Five seedlings failed to exhibit symptoms and subsequent transmission tests gave negative results.

Young trees of Baianinha orange on Rangpur lime, daughter plants of seven healthy and one diseased nucellar tree, were planted at the Limeira Station in 1959. The daughter plants from the trees were smaller than those from the healthy ones in 1963. Seven-year-old trees of some infected nucellar lines, also on Rangpur lime rootstock, did not show typical scaling of the rootstock. A small amount of bark cracking could be seen in the rootstock; this cracking was attributed to presence of a mild strain of exocortis virus.

In testing for exocortis, Rossetti (7) used as control plants, daughter trees of one of the infected nucellar Baianinha orange trees. This would account for some of her unexpected positive results.

Transmission Through Seed of Rangpur Lime

Two 5-year-old Hamlin orange trees on Caipira sweet orange rootstock were topworked with Rangpur lime by Moreira (3). The Rangpur lime sprouts developed typical exocortis symptoms, but in spite of the disease they made vigorous growth and produced many fruit. Seeds

from these two Rangpur lime trees were sowed in May, 1958, and the 400 seedlings obtained were transplanted to a nursery. They included a small percentage of seedlings of non-nucellar origin. Periodical inspections up to the fourth year in the nursery revealed no symptom of exocortis in any Rangpur lime seedling. During this period the seedlings were cut back twice.

Discussion and Conclusions

Root grafts, an insect vector, unseen bud inoculation, and seed transmission were suggested as possible explanations for detection of mild strains of exocortis virus in apparently non-inoculated nucellar Baianinha orange trees. Root grafts are uncommon and would not explain the fairly high percentage of infected trees encountered. There are no indications of insect vectors of exocortis in Brazil. If one should exist, it would be difficult to explain why it transmitted the virus only to Baianinha orange trees. The possibility of unseen bud inoculation in the nursery has also been considered. Infected trees have, however, come from nurseries that were established many years apart. It would be difficult to explain why on both occasions only buds carrying mild strains were used and why the trees from other varieties in the same nursery escaped inoculation. For all these reasons, the authors have considered that there is a strong reason to believe in seed transmission of the exocortis virus. All old-line Baianinha orange trees are infected with exocortis virus since this variety originated from a bud mutation. Only the exocortis virus was found in the infected nucellar Baianinha orange trees. All infected trees were found to be carrying only a mild strain of the virus, while more commonly the diseased old-lines were carrying severe strains (8). The Baianinha orange is a seedless small Navel variety, being necessarily cross-pollinated to produce seeds. Its flowers are abnormal and this fact may account for seed transmission of exocortis virus in it.

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