# A Decline of Citrus on Trifoliate Orange Rootstock Associated with Tristeza Virus

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THIS PAPER is concerned with the symptomatology and possible cause of a serious decline of citrus that has occurred in a zone consisting of about 6,000 hectares on the left bank of the Paraná River in Misiones Province. First noticed in 1959 near the river in the Puerto Rico area, the decline has spread to more than 50,000 trees, putting them out of production. The principal variety in the zone is the Calderón orange—a local selection of a late sweet orange—but Washington Navel and Valencia sweet orange, Marsh grapefruit, lemon, and some mandarin trees are also grown there. About 80 per cent of the trees are on trifoliate orange rootstock; the remainder are on sweet orange, rough lemon, and Cleopatra mandarin. Only those trees on trifoliate orange seem to be severely affected. The strong deficiency symptoms and the reduction in fruit size, together with the poor vegetative growth of affected trees, was originally attributed to poor culture—primarily lack of fertilizer—and to drought. However, when optimal conditions were provided, affected trees failed to recover and, moreover, additional trees developed the same symptoms.

## *Symptoms*

Affected trees develop a variety of strong deficiency symptoms—especially those of zinc deficiency—and become defoliated, although undersized leaves at the ends of twigs are often retained. Fruit are small, often 3 cm or less in diameter, and tend to drop before harvest time. Twigs and branches up to 1–3 cm in diameter tend to die back. In advanced stages, even the main branches are affected. Rootlets and large roots die back from the tips. The disease may affect a single branch or the entire canopy of the tree. A characteristic feature is the tendency of affected trees to flower profusely, often out of season, either on a single branch or throughout the tree. Another common and striking feature is the vigorous growth of shoots from the trifoliate orange stocks of affected trees with dead scions.

## *Reaction of Varieties and Rootstocks*

The symptoms described above have been observed on Calderón sweet orange and in a few plantings of Washington Navel and Valencia sweet orange trees on trifoliate orange rootstock. Marsh grapefruit on

this rootstock also showed strong deficiency symptoms—small leaves, flattened tops, and some dieback—whereas neighboring grapefruit trees on sweet orange or rough lemon rootstock developed normally, except for mild to severe stem pitting. The grapefruit crop had been harvested prior to our inspection, but it was reported by the owner to be normal on the normal trees.

Six of 300 4-year-old trees of Genoa lemon/trifoliate orange obtained from the Concordia Experiment Station had declined. The affected scions had honeycombing, and their rootstocks showed mild stem pitting. Before declining, the trees made excellent growth.

The sweet orange scions on sweet orange or rough lemon rootstock were essentially normal as compared with those on trifoliate orange, but they did have some dieback and yielded mostly smaller than normal fruit.

Neither vegetative growth nor fruit of Calderón or Valencia sweet orange on Cleopatra mandarin rootstock showed symptoms even when growing next to affected trees on trifoliate orange rootstock. Nursery trees of Calderón sweet orange on Cleopatra mandarin grew vigorously whereas adjacent trees on trifoliate orange were only half the size, had deficiency symptoms, and lacked vigor.

### *Transmission Experiments*

Seedlings of various species were inoculated in the greenhouse with material from Calderón sweet orange trees. In the case of those varieties in which the inoculated seedlings developed seedling-yellows-like symptoms, the same symptoms were found on the Calderón sweet orange scions. Inoculated trifoliate orange seedlings showed no definite symptoms nor were symptoms found in the Calderón scions on this rootstock in the greenhouse. The only effect noticed so far was a slight growth depression of the Calderón scions, but it is too early for definite conclusions.

Inoculation of trifoliate orange seedlings with fungi isolated from decaying trifoliate orange roots of diseased trees failed to induce symptoms.

### *Bark Fluorescence Test*

Declining trees show deficiency symptoms similar to those of greening-affected trees. For this reason, it was suggested by Pujol (2) that the disorder might be caused by a greening- or stubbornlike pathogen. The bark fluorescence test developed by Schwarz (3) permits the detection of a phenolic marker substance (gentisoyl glucoside) produced in sweet orange trees infected with the greening pathogen. The test was applied to the bark of affected Calderón sweet orange trees on trifoliate orange rootstock—with negative results.

### *Discussion and Conclusions*

The following observations lead to the conclusion that the decline is caused by a pathogen: the recovery of the rootstock after the death of the

scion; the sudden decline of 20–25-year-old trees that had been producing normal vegetative growth and crops of fruit; orchard spread of the disease in a pattern suggesting the presence of vectors; and the development of symptoms in young sweet orange trees on trifoliate orange rootstock within 2 years after being planted near affected trees.

The absence of exocortis virus in affected Calderón orchard trees was indicated by the absence of bark scaling on the trifoliate orange rootstock and by the negative results of indexing at the Concordia Experiment Station. Psorosis virus also appeared to be absent in the affected trees because foliar symptoms and bark scaling were not observed.

The preliminary negative results with the bark fluorescence test indicates that the greening pathogen, suspected by Pujol (2) as a possible cause of the disorder, is not related to the problem. In seedlings of various species grafted with material from affected plants, only seedling-yellows symptoms were found. The symptoms on the inoculated sweet lime seedlings were typical for seedling yellows. However, Giacometti (1) has shown that sweet lime does not show seedling-yellows symptoms in Brazil even when inoculated with certain tristeza virus strains that induce seedling yellows in other species.

We conclude from these observations that Misiones decline may be caused by a new atypical strain of seedling-yellows virus to which trifoliate orange, when used as a rootstock for certain scion cultivars, is especially susceptible, and that this strain also induces seedling yellows in sweet lime.

It also appears probable that the disease is spread by a vector, probably *Toxoptera citricidus* (Kirk.), which is an efficient vector of tristeza virus and very common in Argentina.

Several scion/stock combinations have been planted in affected areas to test their tolerance to the decline pathogen. Under sweet orange, Cleopatra mandarin appears to be the only rootstock not affected by the disorder.

## *Literature Cited*

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