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Tristeza in Florida

AT LEAST A FEW TREES with tristeza have been found in every important citrus-growing county in Florida, but tristeza has, nevertheless, had a relatively small economic impact on the citrus industry. This paper discusses some aspects of tristeza in Florida, including the significance of its two symptom types, the relative incidence of tristeza in different areas, evidence of current spread of the disease, and the apparently innocuous presence of tristeza virus in many trees on sour orange rootstock.

The Two Classes of Trees with Tristeza in Florida

A feature of tristeza in Florida is the widespread distribution of stunted trees carrying the virus (5). Key lime seedlings used for indexing such trees usually produce mild vein clearing and stem pitting. The stunted tree itself is not a mild effect of the virus, however, since a 25-year old tree may be no larger than a normal 5-year old tree and produces fruit in proportion to its size.

Little experimental evidence is available to explain the origin of stunted trees. In a new planting, failure of such trees to grow properly is apparent within a year or two. Thereafter the pattern is fixed; no more trees become stunted and none of the retarded trees resume normal growth. Since the stunted habit of growth is fixed so early, it is likely that such trees originated from infected buds. In the authors' experience where tristeza-infected buds were deliberately used to propagate new trees, the resultant trees were stunted. Thus, presence of stunted

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citrus trees in a grove is evidence that tristeza virus is there but not the natural spread of the virus has occurred. In most places in Florida where tristeza has been found, it has been in the form of stunted trees.

The second kind of tristeza found in Florida is that which results from natural spread; the trees involved grow normally for a number of years before showing signs of decline; when eventually affected, they are as large as their neighbors. The greatest concentration of these trees is in Orange County; they occur also, but in smaller numbers, in Lake Volusia, Marion, and Seminole counties. In 1952 and 1953, inspectors of the Florida Division of Plant Industry found hundreds of trees declining with tristeza as a result of natural spread, mainly in Orange County but also in the 4 other counties named above. These trees, however, constituted only a small proportion of all trees on sour orange rootstock in the same general area. Considering the state as a whole, fewer trees have been lost to tristeza than to any one of a number of other diseases such as spreading decline, citrus blight, and foot rot. Nowhere in Florida, however, have solid sections of groves been affected by natural spread of tristeza. A 5-acre section of a grove in Volusia County, where 50 per cent of the trees were in decline in 1954, is the area most severely affected by natural spread known to the authors.

Table 1 provides additional information on an Orange County grove in which the spread of tristeza was first described in 1956 (4). The rating

TABLE 1. NUMBER OF TREES IN MODERATE OR SEVERE DECLINE, DEAD, MISSING, OR REPLANTED IN A TEMPLE ORANGE GROVE NEAR WINTER GARDEN, ORANGE COUNTY, FLORIDA

	Total affected	Percentage of all trees in grove
July, 1952	334	8.0
July, 1953	633	15.2
August, 1954	868	20.8
August, 1955	928	22.3
July, 1956	1126	27.0
August, 1957	1131	27.1
October, 1960	1272	30.5

for December, 1958, is not given because the severe freeze of 1957-58 interfered with the diagnosis. This table shows that in Florida, as in other areas, tristeza may affect a large proportion of the trees during one period and only a few of the remaining trees during a comparable later period.

Distribution of Trees Carrying Tristeza Virus

One of the first indications that a considerable proportion of the healthy-appearing trees in Orange County were carrying tristeza virus was briefly reported in 1956 (3). In this study, half of the trees tested were immediately adjacent to trees known to have tristeza and half were 5 tree spaces away. Bark samples from the trees were examined for histological symptoms of tristeza (9) and, in addition, the trees were indexed for presence of tristeza virus by means of the Key lime test. In no case were histological symptoms of tristeza detected, but 33 trees, of which 28 were in Orange and Lake counties, were carrying tristeza virus (Table 2).

TABLE 2. INCIDENCE OF TRISTEZA VIRUS IN HEALTHY-APPEARING TREES ON SOUR ORANGE ROOTSTOCK NEAR TREES WITH TRISTEZA AS INDICATED BY RESULTS OF INDEXING ON KEY LIME SEEDLINGS IN 1953-1954

County	Number of plots	Number of trees	Trees tristeza positive
Brevard	2	14	1
Broward	1	4	0
Citrus	1	8	0
Hillsborough	1	8	1
Indian River	2	14	0
Lake	2	15	4
Manatee	1	8	0
Marion	2	13	0
Orange	5	43	24
Pasco	1	7	0
Pinellas	1	8	0
Polk	5	36	1
Putnam	1	6	1
Sarasota	1	8	1
Volusia	4	20	0
Total	30	212	33

The results of indexing trees by the Citrus Budwood Registration Program in Florida may be taken as a rough measure of the tristeza virus reservoir existing in a segment of the best citrus trees in Florida (7). Tristeza virus was found in at least a few trees of all the important varieties. In Orange County, more than 25 per cent of the trees tested were carrying tristeza virus as compared to less than 3 per cent for the rest of the state (Table 3).

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TABLE 3. INCIDENCE OF TRISTEZA VIRUS IN TREES INDEXED BY THE CITRUS BUDWOOD REGISTRATION PROGRAM, FLORIDA STATE PLANT BOARD, AS INDICATED BY RESULTS OF INDEXING ON KEY LIME SEEDLINGS, TO SEPTEMBER 19, 1960*

County	Trees negative	Trees positive
Orange	318	113
Lake	192	12
Seminole	30	2
Hillsborough	80	3
Marion	117	2
Dade	27	4
Polk	532	17
16 other counties	637	7
Total	1933	160

*Eighty-nine per cent of the trees indexed were candidate trees of the Budwood Registration Program.

Time of Infection

Much evidence exists which indicates that the virus has been spreading since the discovery of tristeza in Florida. The majority of known instances of spread occurred in Orange County. Grant (6) found that some nonbudded Key lime seedlings placed in a tristeza-affected grove developed symptoms of tristeza. In another case, 12 seedling trees of a total of 25 became infected with tristeza within a 9-month period between 1952 and 1953.

In 1960, Burnett and Boring (2) reported that some trees in Orange County tested 2 to 6½ years previously and found free of tristeza virus had subsequently become infected with this virus. Twenty of 26 trees checked from Orange County were infected but 14 trees from Polk County were still free of the virus.

Failure of Infected Trees to Decline

The number of trees declining from tristeza in Florida is extremely small in relation to the number of known infected nontolerant trees (Tables 2 and 3). Conceivably the failure of a tree to develop symptoms could be due to insufficient time of incubation of the virus in the tree (7). It is pertinent, therefore, to see how long trees have been known to be carrying tristeza virus without developing symptoms.

In the grove in Orange County to which Table 1 refers, in which so many trees have been lost, 9 trees also on sour orange rootstock are known from a small sampling to have been carrying tristeza virus for

5 to 7 years without showing signs of decline. At least 20 of the trees on sour orange that carried tristeza virus in 1953 (Table 2) were revisited in 1959-60 and were healthy in appearance. Seven trees on sour orange rootstock indexed in the Florida Division of Plant Industry Budwood Registration Program and found to be carrying tristeza virus for as long as 6 years are still healthy in appearance.

Unfortunately, there is little information published from any of the world's tristeza areas as to the interval between the time of infection of a mature tree and the time when it shows the first sign of decline. Where nursery trees have been inoculated, decline may appear in from 3 to 24 months (1, 9, and unpublished observations in Florida). One mature tree in an Orange County grove showed signs of tristeza decline within 4 years after it had been indexed and found free of tristeza virus. While the foregoing information is meager, it does not suggest that tristeza virus requires a long incubation in infected trees to produce tree decline.

A second possibility is that the strains of tristeza virus involved in the infected but symptomless trees are so mild that they do not materially injure the trees (7). Viruses from symptomless trees usually produce mild symptoms in Key lime seedlings, but viruses from many trees in decline induce in Key limes reactions less severe than those obtained with virus from symptomless trees. Thus, a strain that is mild in Key lime may not necessarily be mild in sweet orange on sour orange rootstock. It remains to evaluate on the latter combination the effect of the various strains present in infected, but symptomless, grove trees.

An additional possibility exists. Virus strain differences alone perhaps do not account for all differences seen in the condition of infected trees. The physiological condition of the tree should also be considered. Factors such as root injury or a nutrient deficiency in combination with a mild virus strain may be sufficient to cause decline in a tree which would not be injured by the virus alone.

Discussion and Conclusions

One apparent difference between tristeza in Florida and in California is the presence of stunted trees in Florida. This probably indicates only that in Florida tristeza-infected budwood carrying a mild strain of the virus was often used in propagating trees while this occurred less often in California. At the same time, because of the more severe strains of tristeza virus in California, any trees there which might have been propagated from infected budwood probably went into decline before they were large enough to move from the nursery to the field.

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The citrus regions of California and Florida are similar in that they contain areas with a high incidence of cases of natural spread of tristeza virus which are not separated by any natural barriers from other areas where the rate of natural spread is low.

Grapefruit trees on sour orange stocks with tristeza decline are found in Florida but not in California (5). In Florida, however, most of the affected grapefruit trees are of the stunted type. Few mature grapefruit trees in decline with tristeza have been reported in Florida. Insofar as decline of mature trees is concerned, the situation in Florida is not very different from that in California.

The phenomenon of tristeza-infected but symptomless trees on sour orange rootstock, however, is found only in Florida. Its apparent absence from California may only reflect the severity of virus strains there. One significant aspect of the high percentage of naturally infected trees in Florida, whether or not they eventually decline, is that they provide a demonstration that tristeza virus can infect a large number of trees in a short time. There is every reason to believe that if a strain of tristeza virus as severe as that which caused such destruction in South America appeared in Florida it could readily move into many trees there. Manifestly, the planting of new groves on sour orange rootstock in Florida still involves great risk. Prudence dictates the avoidance of this rootstock.

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