Control of Tristeza Decline of Grapefruit on Sour Orange Rootstock by Preinduced Immunity

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Cross-protection studies by the second author on the relationship between yellowing and nonyellowing forms of tristeza virus have been described (Stubbs, 1964). In these, isolates from Lisbon and Meyer lemons, and from Marsh grapefruit, were challenged with a seedling-yellows type isolate from Ellendale tangor. Trees infected with the Lisbon lemon isolate did not react visibly to the challenge inoculant for three years. Thereafter they deteriorated, but less severely than trees inoculated with other avirulent isolates. Unprotected trees and control trees infected by naturally spread tristeza virus died.

MATERIALS AND METHODS

A vigorous 30-year-old Marsh grapefruit tree from an orchard at Merbein (near Mildura), Victoria, where adjacent trees were declining through stem pitting (Stubbs, 1964), was selected as a source of budwood for propagation. This tree indexed negatively for tristeza on lime. Sour orange seedlings grown in containers under glass were budded, and the resultant combinations selected for uniformity. Two months prior to transplanting, 35 trees were inoculated with the Lisbon isolate of tristeza virus by leaf implantation, and 25 were left as healthy controls.

Sour orange was chosen as the rootstock for two reasons. One was to reduce the time interval between infection and expression of symptoms, as grapefruit deterioration through stem pitting is seldom apparent on trees less than 15 years old (Stubbs, 1964). The other was to impose a more severe test on the value of preimmunization as a potential control measure.

Although all isolates were obtained through aphid, *Toxoptera citricidus* (Kirk.), transference, both protective and challenge inoculations of trees of a Homosassa sweet orange nucellar clone on sour orange rootstock were performed by implantation of leaf tissue beneath the bark. As grafting is a more severe test than inoculation by a vector, it was decided to test the protective value of the Lisbon isolate in a field situation where trees would be exposed to natural spread. Grapefruit, because it deteriorates in Australia on all rootstocks as a result of tristeza infection, was chosen as the test species.

In September 1961, the trees were planted 3.8 m apart in rows 7.3 m apart in two adjacent blocks at the Mildura Horticultural Research Station. A statistical design was not used because it was considered that trees propagated on sour orange would not survive sufficiently long to warrant the expense of a planting designed for long-term collection of analysable data.

The experimental area is surrounded by a variety of *Citrus* spp., all trees of which are infected with strains of the tristeza virus. The area is tile drained and irrigated by an overhead sprinkler system. Tree herbicides were applied in 1964, and in 1969 a complete herbicide (no cultivation) program was commenced. A complete NPK fertilizer was applied annually with a minimum application rate of 2.7 kg per tree.

The vector *T. citricidus* occurs at Mildura but is less prevalent there than in coastal citrus growing areas of Australia (Stubbs, 1964).

RESULTS

In the early years of the experiment, control trees made more vigorous growth than the preimmunized trees, although the latter were without disease symptoms. By 1975, however, the growth differential had disappeared and the mean surface areas (π x d x h) of control and preimmunized trees were 59.8 and 59.6 m^2, respectively.

Since 1965, fruit produced on the preimmunized trees has been smaller than fruit from the control trees but of a more acceptable size commercially. The numbers of fruit per kg for each treatment are depicted graphically in fig. 1. Calculations have been made at 2-year intervals to smooth out biennial bearing fluctuations. The mean cumulative number and weight of fruit per tree beginning in 1966 are as follows: on preimmunized trees 3,179 fruits weighing 1119 kg and on control trees 3,146 fruits weighing 1180 kg.

The mean annual yields of fruit from control and preimmunized trees are compared in fig. 2. In every year except 1973 preimmunized trees have yielded slightly less than control trees. The reversal that occurred in that year appears to have eliminated the biennial bearing effect in control trees in 1974. This is due to the effect of tristeza-induced decline in the control block, which was first observed in 1971.

Trees declining, apparently as a result of infection with severe strains of tristeza, were recorded on April 29, 1975. In the control block 20 of 25 trees were obviously affected. Six were almost dead, 10 were in an advanced stage of decline, four were in an early stage of decline, five appeared healthy. In the preimmunized block one tree was almost dead, two showed early signs of infection and 32 were without obvious symptoms. It is certain, therefore, that the yield of fruit from trees in the control block will decrease dramatically in the future.

Curiously none of the affected trees has yet developed stem pitting which characterizes the decline of grapefruit on other rootstocks in Australia.

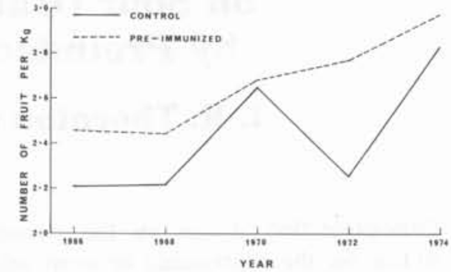

Fig. 1. Numbers of grapefruit per kg on preimmunized and control trees for each biennium, 1966-1974.

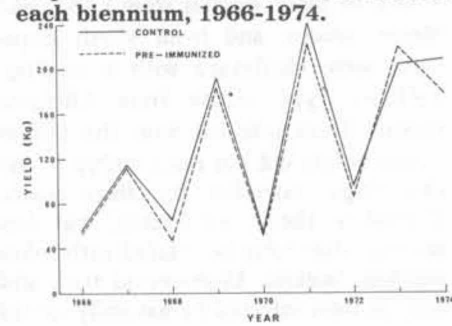

Fig. 2. Mean annual yields of preimmunized and control grapefruit trees, 1966-1974.

DISCUSSION

The above results indicate that is is possible to select a strain of tristeza virus that will at least delay the onset of tristeza-induced decline of a susceptible stionic combination when exposed to natural infection. It is premature at this stage to predict that the protective strain will continue to prevent invasion by a more virulent strain, particularly as three trees appear to be affected in the preimmunized block.

On the other hand, new forms of the tristeza virus appear to be increasing in several areas (North America, South America, and perhaps Australia). Such variants from the normal strains are already infecting rootstocks hitherto believed to be immune or tolerant, such as trifoliate orange, Troyer citrange, and sweet orange.

Further research on the possible use of avirulent strains of the virus as a control measure would, therefore, seem essential in countries where the virus is endemic. The question as to whether protective isolates should be sought in the species it is desired to protect, or from species which tolerate the tristeza disease, even when combined with intolerant rootstocks, can only be resolved by field experimentation.

LITERATURE CITED

STUBBS, L. L.
1964. Transmission and protective inoculation studies with viruses of the citrus tristeza complex. Australian J. Agr. Res. 15:752-70.