

Stem Pitting of Grapefruit—Field Protection by the Use of Mild Virus Strains

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STEM-PITTING VIRUS (3, 4, 5) has caused problems for growers of grapefruit (*Citrus paradisi* Macf.) in New South Wales since the disease was first observed about 1932 (1). The greatest injury occurred in the years 1940 to 1950 when many trees in the 18- to 25-year age group developed dieback and trunk pitting and bore very small, deformed fruit.

RANGE OF SYMPTOMS IN ORCHARD TREES.—The Marsh and Thompson are the varieties most susceptible to damage, and Marsh is the most commonly grown. The three main effects are on fruit (shape, size, and qual-

ity), tree vigor, and trunk and branches (pitting). These symptoms occur in various combinations and degrees of severity. For example, some trees may be relatively vigorous and mildly pitted, but the fruit badly affected; others may be quite badly pitted, but vigorous and with good fruit; still others may be pitted with poor fruit and low vigor, or there may be no apparent symptoms.

REACTION ON INDICATORS.—West Indian lime [*C. aurantifolia* (Christm.) Swing.] seedlings inoculated by budding or aphid (*Toxoptera citricida* Kirk.) feeding show symptoms of vein flecking that vary from a few mild flecks to general vein clearing with some leaf cupping, and eventual corking of veins and stunting of growth. The degree of pitting varies. However, the intensity of reaction on West Indian lime cannot be correlated satisfactorily with the symptoms shown by the grapefruit tree indexed. Almost all grapefruit trees in New South Wales which show no visible symptoms produce a mild type of flecking and pitting on index seedlings, although moderately severe symptoms are sometimes obtained. The most severe stem-pitting strains of the virus, obtained from trees showing visible symptoms, produce some vein flecking and pitting on seedlings of most citrus varieties, including citron (*C. medica* L.), Orlando tangelo (*C. reticulata* x *C. paradisi*), sweet orange [*C. sinensis* (L.) Osb.], sweet lime [*C. aurantifolia* (Christm.) Swing.], Rough lemon (*C. jambhiri* Lush.), grapefruit (*C. paradisi* Macf.), and calamondin (*C. reticulata* var. *austera* x *Fortunella* sp.), whereas mandarin (*C. reticulata* Blanco) varieties and Rangpur and Kusaie limes [*C. aurantifolia* (Christm.) Swing.] usually show no reaction. Most isolates from grapefruit do not produce typical tristeza symptoms in sweet orange on sour orange stock, but a few cause moderate to severe stunting. The relationships of this disease to the tristeza complex are discussed by Fraser (2) and McClean (4).

Materials and Methods

To obtain information on the behavior of Marsh grapefruit carrying mild or moderate strains under field conditions, trials were set out at the Horticultural Research Station at Somersby and at the Lower Murray Research Station at Dareton. The climate at Somersby is relatively mild, with rainfall about 125 cm per annum, moderate to high humidity, and temperatures ranging from 0°C to above 38°C. Dareton is semi-arid with an annual rainfall of about 30 cm, generally low to moderate humidity, and summer temperatures often in excess of 38°C. Frosts of moderate severity are experienced in winter.

Citrus aphids (*T. citricida* Kirk.) were used for transmission of the virus to test trees. After starving the aphids for a short period, an acquisition feeding period of about 20 hours and a transmission feeding period of 30 hours were used. The unit number of aphids was 10. After transmission from the virus source to sweet orange seedlings, buds from the seedlings were subsequently worked on West Indian lime for analysis of strains. Mild, moderate, or severe strains were transmitted in 50 to 75 per cent of the attempts.

Results

PRELIMINARY EXPERIMENTS.—Experiments were performed to discover whether a severe strain can be introduced into sweet orange seedlings carrying a mild strain. Seedlings of sweet orange, inoculated with buds from a grapefruit showing severe fruit symptoms, pitting, and die-back, were used for aphid acquisition feeding. It was found that this severe strain could be introduced into trees carrying mild strains provided that large numbers of aphids [50] were used. Similar results were obtained in another series of experiments with grapefruit seedlings. Larger numbers of aphids [50 to 100] were required to introduce a challenging strain into an already infected seedling than into virus-free seedlings, and the percentage of successes was low (less than 10 per cent).

In a few preliminary field trials, severely affected grapefruit trees were top-worked with buds from a mild-strain infected tree. Growth from all buds was severely affected. In a trial planted in 1959, 1-year-old grapefruit trees propagated from 6 mild-strain selections were inoculated by budding with a severe stem-pitting, fruit-distorting strain. After 1 year, pitting began to appear in the inoculated trees, and in the third and subsequent years all fruit was small and misshapen.

Field Trials

Field trials with mild strains were based on the assumption that although presence of a strain does not give immunity against reinfection by a severe strain, it increases the difficulty of establishing the challenging strain. It was hoped that under average orchard conditions, with aphids coming from different sources and carrying a variety of strains of the virus, the degree of protection afforded might be sufficient for practical purposes.

SOMERSBY TRIALS.—*Planting 1.* In 1954, a small trial comprising direct propagation of 4 mild-strain selections and 2 of medium severity

was set out and interplanted with 24 trees carrying a severe strain. *Planting 2.* Trees of virus-free nucellar Marsh grapefruit on Rough lemon and on *Poncirus trifoliata* stocks were bud inoculated with 9 mild-strain isolates. A total of 65 trees, including 11 uninoculated interplants, was set out in 1955. Direct propagations from the same 9 mild-strain sources, 2 trees of each source, were used in a parallel planting. No trees infected with a severe strain were placed within this planting, which was located several hundred yards distant from *Planting 1*, but adjacent to it were plantings of orange varieties of unknown virus potential. No attempt was made to determine the virus strains entering the area.

To date there is no evidence that the protection afforded by the presence of mild virus strains in these plantings is breaking down. The fruit produced is substantially of the type and size of the parent, but with some lines showing occasional slight distortion or flattening. Tree size also is characteristic of the parent and is uniform within selections. Some seasonal influence on fruit size has occurred throughout the block but has not affected the relative behavior of the different strains.

DARETON PLANTING.—In 1959, a small randomized planting of 120 trees was set out. The trees were direct propagations of uninoculated selections of Ruby and Thompson grapefruit obtained from virus-affected but symptomless source trees and from uninoculated virus-free nucellar Marsh. Trees of the same Marsh selection inoculated by budding with 1 severe and 3 mild strains were also planted.

In this trial also, there has been no change in strain type as yet. The highest yields and the largest fruit are produced by the uninoculated nucellar Marsh trees, but reduction in fruit size and yield in the inoculated trees has not been economically important. The trees are smallest and the yield and fruit size is poorest in trees inoculated with the severe strain. However, in this hot climate, the fruit produced to date by trees carrying the severe strain are much larger than those produced by trees affected with the same strain in the Somersby orchard, and the amount of dieback and pitting is negligible.

Discussion and Conclusions

Results to date give hope that infection with mild strains can have a protecting effect under average orchard conditions for a considerable number of years. Field observations on commercial blocks of trees of known origin support this.

Although a great extension of stem-pitting disease occurred in the 1940's, deterioration in later planted orchards has, in general, been less

marked, and many show little or no affected fruit. Much of the grapefruit budwood used for propagation by nurserymen subsequent to 1935 has been obtained from parent trees especially selected for vigor and freedom from disease and for uniform good quality fruit by the New South Wales Bud Selection Society. These trees were located in coastal orchards where it is now known that stem pitting was well established.

This suggests that the budwood obtained through the New South Wales Bud Selection Society was, in fact, infected with mild strains of the virus. Moreover, some of these parent trees have been indexed and found to be carrying mild strains of stem-pitting virus.

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