

Stem Pitting of Grapefruit: Field Protection by the Use of Mild Strains, An Evaluation of Trials in Two Climatic Districts

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Trials with grapefruit to assess the protective value of mild strains of stem-pitting virus against natural infection by severe strains have been in progress in New South Wales (N.S.W.) for up to 21 years.

A progress report (Fraser *et al.*, 1968) outlined results to 1965. No breakdown in protection was then apparent in any trials. This paper reports further results in four trials in two climatic districts.

TRIAL PLANTINGS

Three trials are located at the Gosford Horticultural Research Station (Somersby and Narara sections), on the central coast of N.S.W. They comprise:

Somersby trial 1. Direct propagations of Marsh grapefruit selected from indexed field trees, four carrying mild stem pitting and two carrying strains of medium severity in terms of fruit quality (a total of 117 trees). These are interplanted with 24 trees carrying a severe strain, planted at Somersby in 1954.

Somersby trial 2. Nucellar Marsh grapefruit, originally virus free, tissue inoculated with nine mild strains of stem pitting from field trees which showed no symptoms (a total of 65 trees). These were interplanted with 11 uninoculated trees planted at Somersby in 1956; direct propagations of the same symptom-free, mild-strain sources were included in the trial (30 trees).

Narara, trial 3. Direct propagations of 58 Marsh grapefruit selections carrying mild strains of stem pitting were used in a

trial to determine whether any would provide protection against severe strains introduced by tissue inoculation. Six severe strains were selected, purified by passage through *Toxoptera citricidus*, and used for inoculation of mild-strain trees. These trees were propagated in 1965, planted at Narara in 1966, and inoculated in 1968 (700 trees).

One trial, planted in 1959, is located at Dareton Horticultural Research Station in southwest N.S.W. This planting included a virus-free selection of Marsh grapefruit inoculated with three mild-strain, stem-pitting selections, 12 trees of each, 12 uninoculated trees of a second virus-free budline, and 12 trees each of Ruby and Thompson grapefruit selections naturally infected with mild strains. Six trees carrying the severe strain, used also in Somersby trial 1, are distributed within the block. Buffer rows of Marsh grapefruit, originally virus-free, inoculated with a mild strain at the age of three years, surround the planting.

EFFECT OF CLIMATE ON SYMPTOM EXPRESSION

The climate at Gosford is warm temperate; the annual rainfall is 120 cm and this is supplemented with irrigation. At Dareton the climate is semiarid, average annual rainfall is 32 cm, and irrigation is

necessary throughout the year. The average minimum and maximum temperatures at the two stations are shown in table 1.

At Somersby and Narara all mild-strain

selections show some evidence of stem-pitting infection as a percentage of slightly flattened or lopsided fruit and a few mild pits in the trunks of some trees. Average fruit size is smaller than at Dareton. Trees carrying the severe strain produce no marketable fruit and are severely stunted and strongly pitted.

At Dareton, virus symptom severity is greatly reduced, fruit of trees carrying mild strains show no malformation and trunk pitting is mild and rare. The fruit of severe-strain infected trees is smaller than normal on the average but most is commercially acceptable, yields and tree size being about one third less than

BREAKDOWN OF PROTECTION

Up to 1965 no evidence of breakdown in protection was seen in trials 1 and 2 at Somersby; each budline or protective strain maintained, with minor seasonal variations, the fruit and tree characteristics of the parent line. No evidence of breakdown in protection was seen at Dareton where fruit size was better than at Somersby (Fraser *et al.*, 1968).

Early indications of deterioration were shown by some of the originally virus-free Somersby trees in 1966 and 1967; some of the mild-strain propagations were also showing a tendency towards small fruit.

TABLE 1
AVERAGE TEMPERATURES IN °C

	Minimum		Maximum	
	July	January	July	January
Gosford	3.5	16.2	17.0	27.8
Dareton	4.8	17.6	16.1	32.5

mild-strain protected trees. Pitting is usually present, but is not severe. The difference in severity of symptoms between Dareton and Gosford suggests that symptom expression is modified by higher temperatures at Dareton.

At the last assessment, in 1975, the position was as follows:

Somersby, trial 1. Six trees out of 117 mild-strain propagations have shown marked deterioration of fruit size and quality and four are showing similar trends but to a lesser degree (table 2). There is a low incidence of mild stem pitting, not correlated with deterioration of fruit quality.

Somersby, trial 2. Six of eleven originally virus-free trees have shown marked deterioration of fruit size and quality and two are developing similar symptoms (table 2).

TABLE 2
AVERAGE FRUIT WEIGHT (g) OF REPRESENTATIVE TREES IN TRIALS 1 AND 2, SOMERSBY

Year	Severe strain propagation	Initially virus-free now deteriorated	Mild strain propagation	
			Deteriorated	Satisfactory
1959	119	260	252	242
1965	114	187	247	243
1970	65	108	70	355
1972	65	115	82	249

Though operating with success for the first 12 years of the trial, protection by mild strains against aphid-borne infection by severe strains has proved to be incomplete as trees approach maturity under the conditions of high aphid activity prevailing at Somersby. However, when compared with the higher percentage of deterioration in originally virus-free trees

a considerable degree of protection is evident.

Narara, trial 3. All 58 mild-strain selections have shown early and marked deterioration of fruit quality following tissue inoculation with three of the six severe strains. A proportion of trees inoculated with the other three strains are showing similar trends (table 3).

TABLE 3
PERCENTAGE OF MILD-STRAIN TREES DETERIORATED AFTER TISSUE INOCULATION
IN 1968 WITH SEVERE STRAINS OF STEM PITTING (PLANTING 3, NARARA)

Year	Control	Severe strain selection					
		4124	4125	4126	4127	4128	4292
1970	0	2	55	43	1	6	25
1972	0	6	92	71	2	20	72
1975	1	6	93	72	2	25	86

Of the trees at Somersby carrying severe stem pitting, a few over the years have produced vigorous branches, which showed the presence of somewhat milder strains when indexed on West Indian lime. Those branches in all cases subsequently lost vigor and showed the pitting and small fruit characteristic of the severe strain.

It is apparent that once a severe strain becomes established, either by vector feeding or tissue inoculation, in a tree in which a strain of a milder type is present, it will progress throughout the tree suppressing the manifestation of milder strains. None of 58 mild strains under trial show promise of protection against tissue-transmitted severe strains.

At Dareton there has been no clear evidence of deterioration in mild-strain protected trees. The continuing satisfactory performance of the trees could be due in part to lower aphid activity that reduced the likelihood of introduction and establishment of severe strains.

Of the 12 originally virus-free trees in the trial, three have, in the last three years, shown a low proportion of smaller or malformed fruit and two have shown a slight reduction in yield and reduction in annual increment of butt diameter, which may indicate that a severer strain is becoming established. However, at Dareton, the masking effect of temperature and the marked alternate cropping habit make it difficult to assess early indications of a change in virus content from yields or tree appearance. Symptoms pro-

duced by inoculation to West Indian lime indicator seedlings differ in intensity according to source. It is not, however, possible to correlate these with slight differences in fruit and tree symptoms, though extremes of mildness and severity are clearly different.

Before the trials were established, preliminary glasshouse transmission experiments had shown that larger numbers of infective aphids were required to establish the virus in grapefruit seedlings than in orange seedlings and that to establish a severe strain in grapefruit seedlings already carrying strains of lesser severity required still larger numbers (Fraser *et al.*, 1968). Aphid transmission trials from various mixtures and at a range of temperatures may go some way towards clarifying the operation of protection in the field. The possibility cannot be ruled out that a strain of differing severity could arise as a mutation. It would, however, not be possible to prove that a change in disease severity in an open field trial was due to this cause.

Commercial grapefruit growing in N.S.W. is limited to semiarid, warm to hot climatic zones and under these conditions results obtained at Dareton are expected to apply. However, the partial failure of protection shown at Somersby in maturing trees suggests that, with increasing age, the protective effect may operate with less efficiency. Continued observations will therefore be necessary at both Somersby and Dareton.

LITERATURE CITED

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