10

Other Subjects

Possible Value of Close-Planted, Virus-Dwarfed Orange Trees

J. K. LONG, L. R. FRASER, and J. E. COX

FRASER AND LEVITT (2) reported dwarfness in citrus trees on trifoliate orange rootstock; it was not associated with the bark scaling due to exocortis virus but was reproduced in progeny trees. The factor causing dwarfness was, moreover, transmitted in budwood of affected Marsh grapefruit and Washington Navel orange to a vigorous nucellar Navel orange tree on trifoliate orange rootstock (3). The present paper reports some results obtained from trials of plantings in which dwarfness was induced by the transmissible factor.

Dwarf trees have obvious advantages, including greater production per hectare, especially in the early years following establishment: reduced harvesting costs, because little or no ladder work is necessary; better pest and disease control through more efficient spraying; and lower spraying costs, because less expensive equipment can be used (1, 4). Plantings of dwarf trees might be a desirable alternative to plantings of vigorous trees that require annual hedging (4).

Transmission of a dwarfing factor to an acceptable, proven scion/rootstock combination without any other effects would be preferable to propagating a scion carrying the dwarfing factor. Several trials were commenced in New South Wales in recent years to examine various aspects of producing dwarf trees by this method.

The studies were prompted by two earlier exploratory plantings, one under completely irrigated conditions at Griffith in the Murrumbidgee Irrigation Area (MIA), and one under supplementary irrigation at Somersby on the central coast. Although the plantings were not experimentally designed, the results prompted more detailed trials on dwarf trees.

Exploratory Plantings

In the trial at Somersby, nucellar Navel orange trees on trifoliate orange stock were inoculated in the nursery in 1955 with budwood from dwarfed Washington Navel orange, Valencia orange, and Marsh seedless grapefruit trees; they were planted 450 per hectare. There have been no obvious effects on fruit size or internal quality; tree health is satisfactory; foliage is dense and of good color; and there are no obvious signs of disease in any tree. There were relatively small differences in yield per hectare for the various treatments (Table 1). The possible planting density and the calculated yields (Table 1) were based on the assumption of no reduction due to closer planting so that at their present size the foliage of adjacent trees touched in the row, and a clear space of 1.83 m was left between rows. The results suggest that the possible commercial use of dwarfed trees is worthy of close study. Each of the dwarfing isolates is free from psorosis and xyloporosis viruses.

In the trial at Griffith, Washington Navel orange trees on trifoliate orange rootstock were planted in 1947

TABLE 1. SIZE AND CUMULATIVE YIELD OF DWARF NAVEL ORANGE TREES AT SOMERSBY AFTER 10 YEARS CROPPING

Inoculation selection[a]	Mean tree size (m)		Mean cumulative yield per tree (kg)	Possible planting density (trees/ha)	Theoretical cumulative yield if planted at possible planting density (metric tons/ha)
	Height	Spread			
Nil	3.05	3.44	599	544	326
C	2.07	2.87	378	741	280
B	2.04	2.83	392	766	300
E	1.77	2.53	309	914	282
D	1.80	2.38	288	988	285

a. The 4 isolates of the dwarfing factor that induced the greatest amount of dwarfness.

TABLE 2. NAVAL ORANGE TREES ON TRIFOLIATE ORANGE STOCK INOCULATED WITH VARIOUS DWARFING ISOLATES PLANTED AT YANCO, 1963

Scion	Virus used for inoculation	Planting rate (trees/ha)	Butt circumference (cm)		Average yield for 1968 and 1969 (kg)		Ratio of average yield to mean butt circumference for 1968 and 1969 (kg/cm)
			1968	1969	Per tree	Per ha	
Nucellar	None (control)	225	16.8	20.3	34.2	7695	1.84
	Severe exocortis	225	13.4	15.2	17.9	4028	1.25
Nucellar and old line[a]	Severe exocortis	900	12.7	14.3	18.0	16200	1.33
	Dwarfing isolates[b]						
	B	900	14.1	16.6	26.7	24030	1.74
	C	900	13.9	16.1	25.4	22860	1.69
	D	900	14.3	16.8	27.0	24300	1.74
	E	900	13.9	16.3	24.6	22140	1.63

a. Mean figures—no difference between scions at this stage.
b. Same selections as those referred to in Table 1.

as a demonstration to show the importance of bud selection to avoid exocortis. Originally planted very densely, the trees were thinned in 1955 to 600 per hectare. Alternate rows contained trees infected with a severe strain of exocortis virus. As expected, the infected trees developed scaling and were dwarfed. The exocortis-free trees averaged 3.38 m tall and 3.54 m wide in 1962 and 3.66 m tall and 4.33 m wide in 1966; the infected trees averaged 1.89 m tall and 2.13 m wide in 1962 and 1.98 m tall and 2.56 m wide in 1966.

Both the large and small trees have settled into fairly even production since 1962, averaging about 140 and 36 kg of fruit per year, respectively (Fig. 1). The infected trees were slower growing and at present are pale in color and less dense than the exocortis-free trees. This is considered to be due mainly to presence of the severe strain of exocortis virus, rather than to shading by the larger trees. Figure 1 shows that for each healthy tree, about 3.4 infected trees would have been nec-

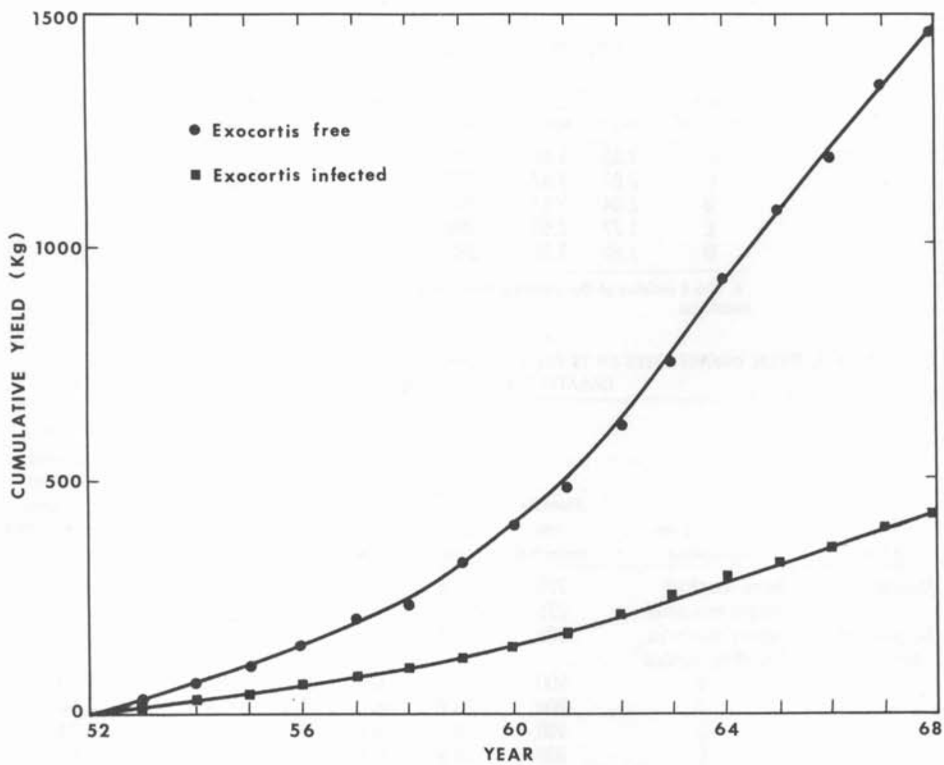

FIGURE 1. *Mean cumulative yield of fruit per tree from Navel orange trees infected with exocortis virus compared with trees free from exocortis virus.*

essary to produce the same cumulative yield per hectare by 1968, assuming no reduction in yield due to hedgerowing. Indexing of these 2 scions for psorosis and xyloporosis is not complete.

Plantings for Detailed Study

COMPARISON OF DWARFING SELECTIONS.—In 1963, a planting to compare 5 dwarfing isolates of virus was made at Yanco on the MIA. Four of

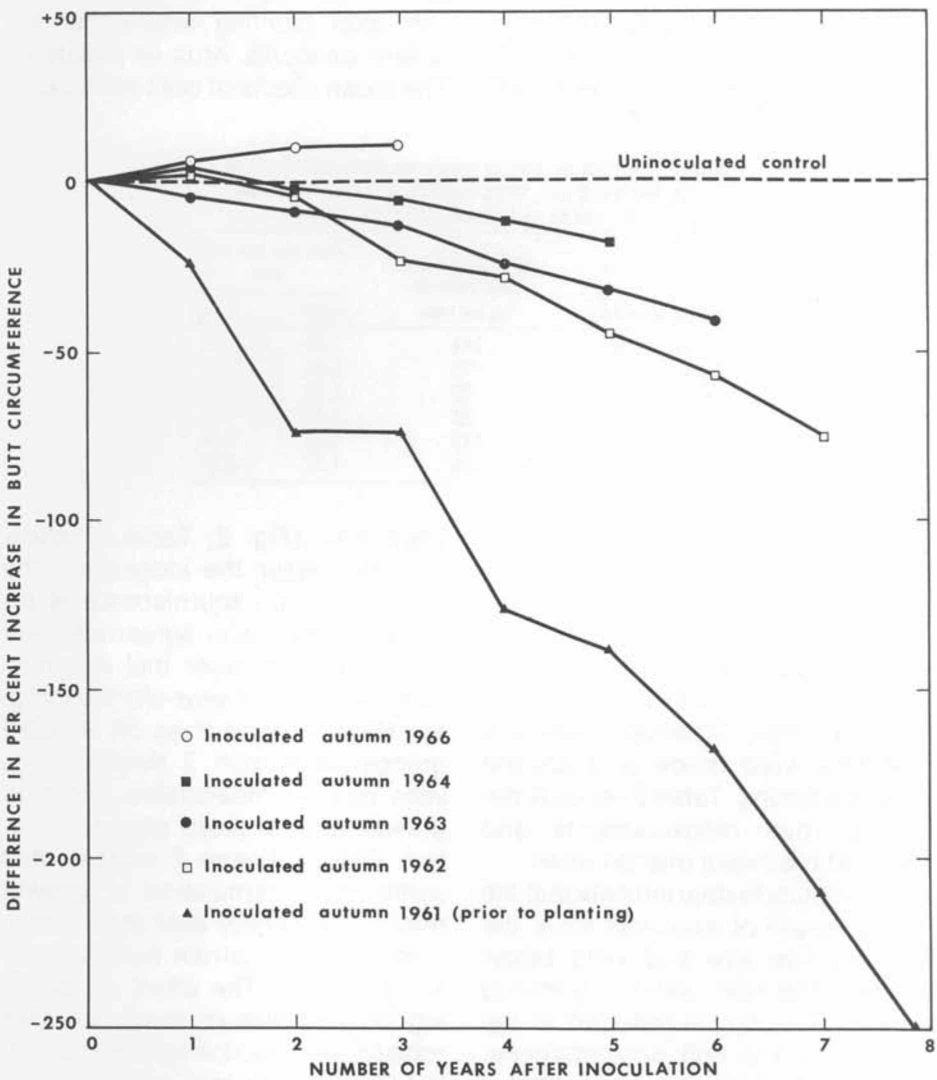

FIGURE 2. *Difference in mean percentage increase of butt circumference of sweet orange trees on trifoliate orange rootstock at various years after inoculation with severe exocortis virus, or dwarfing isolate D, as compared with noninoculated controls.*

the dwarfing isolates were those at Somersby previously mentioned; the fifth was the severe exocortis isolate mentioned above. Each isolate was inoculated into both old-line Washington and nucellar Navel orange trees on trifoliate orange rootstock in the nursery. The trees were planted at a distance of 5.2 m × 2.2 m, giving approximately 900 trees per hectare. Similar trees of the nucellar Navel, both noninoculated and inoculated with the severe exocortis isolates, were planted immediately adjacent, at a distance of 6.7 m × 6.7 m, 225 trees per hectare. In 1964, 2 similar adjacent plantings were made of 2 old-line Valencia scions. Table 2 records details of butt measurements and yields of the Navel orange trees.

The results to date indicate that the severe strain of exocortis virus depressed tree size and yield below those of the trees with the dwarfing isolates. This fact is reflected in the ratio of yield to butt circumference.

EFFECT OF TIME OF INOCULATION.—Time of inoculation, which is of importance in any commercial production of virus-induced dwarf citrus trees, was in the nursery row in autumn, prior to spring planting. In a trial at Yanco in 1961, nucellar Navel orange trees on trifoliate orange stock were inoculated either before planting or at various intervals after planting with either the severe exocortis virus or isolate D. The mean effects of both inoculation treatments (Fig. 2, Table 3) show that the earlier the inoculation the more the butt circumference is restricted, which is in agreement with results from another trial in which inoculation of 14-year-old Washington Navel orange trees on trifoliate orange stock with 2 dwarfing isolates had no measurable effect on growth until 6 years after inoculation. Data in Figure 2 suggest that some initial stimulation in growth may occur shortly after inoculation.

TABLE 3. EFFECT OF TIME OF DWARFING INOCULATION ON TREE SIZE AND YIELD (ALL TREES PLANTED AT YANCO IN SPRING, 1961—MEAN OF 2 INOCULATION TREATMENTS)

Time of inoculation	Mean cumulative yield 1966–69 (kg per tree)	Mean tree size 1969 (m)	
		Height	Spread
Noninoculated	124	1.89	2.04
Autumn 1961	75	1.31	1.58
Autumn 1962	80	1.40	1.75
Autumn 1963	92	1.46	1.77
Autumn 1964	133	1.52	1.86
Autumn 1966	126	1.52	2.04

ROOTSTOCKS OTHER THAN TRIFOLIATE ORANGE.—The effect of dwarfing virus isolates on trees on other rootstocks is also being investigated, but results are not yet available. The rootstocks include Carrizo and Troyer citrange, Cleopatra mandarin, Rangpur lime, sweet orange, and rough lemon.

ACKNOWLEDGMENT.—These studies are being conducted under the aegis of the Citrus Improvement Committee of the New South Wales Department of Agriculture. Special acknowledgment is due to the committee's former chairman, Mr. E. C. Levitt.

Literature Cited

1. ANONYMOUS. 1966. Dwarf orange trees. Agr. Gaz. N. S. Wales 77: 561-62.
2. FRASER, L. R., and LEVITT, E. C. 1959. Recent advances in the study of exocortis (scaly butt) in Australia, p. 129-33. *In* J. M. Wallace (ed.), Citrus Virus Diseases. Univ. Calif. Div. Agr. Sci., Berkeley.
3. FRASER, L. R., LEVITT, E. C., and COX, J. 1961. Relationship between exocortis and stunting of citrus varieties on Poncirus trifoliata rootstock, p. 34-39. *In* W. C. Price (ed.), Proc. 2nd Conf. Intern. Organization Citrus Virol. Univ. Florida Press, Gainesville.
4. PHILLIPS, R. L. 1969. Dwarfing rootstocks for citrus, p. 401-6. *In* H. D. Chapman (ed.), Proc. 1st Intern. Citrus Symp. Univ. Calif., Riverside.