Effect of Citrus Tristeza Stem Pitting on Fruit Size and Yield of Marsh Grapefruit in Southern Africa

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ABSTRACT. An 11-yr-old orchard of Marsh grapefruit on Rough lemon rootstock, which was propagated from budwood infected with the Nartia mild strain, was selected to determine the affect of severe stem pitting on crop yield in the Nkwaleni Valley. Ten trees with mild CTV stem pitting and ten trees with severe stem pitting were selected at random and yield and fruit size were monitored annually. After 18 years of field exposure, severe stem pitting reduced the crop by 24% with 48% of the fruit ranging in size from 87 to 73 mm. Grapefruit trees with mild stem pitting had 64% of their fruit ranging from 97 to 103 mm diameter. These results highlight the importance of mild isolate cross protection to the grapefruit industry in southern Africa.

The southern African citrus industry was established on citrus tristeza virus (CTV) tolerant rootstocks following the early discovery of CTV in the country, thus safeguarding the industry from the devastation experienced in Brazil, Argentina and Venezuela whose industries were on sour orange rootstock (2, 6, 8, 9). Severe stem pitting isolates of CTV vectored efficiently by *Toxoptera citricida* (Kirkaldy), which is endemic in orchards in southern Africa, have reduced the economic viability of Marsh grapefruit to 10-15 years. Fruit size and yield commences to decline after seven to eight years (6, 7). Commercial orchards of Ruby Red, Rio Red and Star Ruby grapefruit have been devastated by severe stem pitting isolates within four years of planting in certain areas (4). Severe stem pitting remains a continuous threat to grapefruit orchards which have not been protected by a mild isolate of CTV. Marsh grapefruit has been successfully protected from severe stem pitting since the implementation of cross protection in 1982. The isolate used is referred to as the Nartia isolate and is utilized in the cross protection of all citrus propagated from certified budwood in southern Africa (6).

MATERIALS AND METHODS

In 1985, ten trees with mild stem pitting and 10 trees infected with severe stem pitting were selected at random in an 11 year old Marsh grapefruit orchard on Rough lemon rootstock in Nkwaleni Valley, Northern Natal. The trees in this orchard were propagated from budwood cut from a parent tree at Amanzi Estates in the Eastern Cape, carrying the Nartia mild isolate used for cross protecting citrus in southern Africa (5, 7).

The trees were categorized as mild or severe by firstly examining the external pitting visible on the main trunk and scaffold branches and, secondly, by removing sections of bark 40 × 100 mm in size from the main trunks and examining the exposed wood for pitting. Trees which exhibited severe external grooving and pitting in the trunk, scaffold branches and exposed wood were designated as severe stem pitting, and those with mild to negligible stem pitting were designated as mild. Trees in the severe category which exhibited obvious signs of CTV decline (i.e. sparse, flattened crowns, die-back and small lopsided fruit) were excluded. The canopies of the selected trees were all healthy

TABLE 1
EFFECT OF STEM PITTING ON FRUIT SIZE AND YIELD OF MARSH GRAPEFRUIT TREES ON ROUGH LEMON ROOTSTOCK

Sample period Stem pitting rating	Yield[x] (kg/tree)	Fruit size (kg/tree)[x] 64 (79 mm)	56 (84 mm)	48 (87 mm)	40 (92 mm)	36 (97 mm)	32 (100 mm)	27 (103 mm)	Mean fruit diameter[x] (mm)
1985									
Mild	287.5 ns	3.3*	7.2*	33.4 ns	96.4 ns	47.8*	41.9*	57.5*	97.1*
Severe	236.3	45.9	33.6	61.9	53.6	20.0	17.9	3.4	89.2
1986									
Mild	187.1*	1.1 ns	4.5 ns	7.7 ns	26.4 ns	25.9 ns	31.1*	90.4*	102.4*
Severe	146.5	10.0	11.7	15.6	45.8	18.5	12.4	32.5	95.8
1987									
Mild	256.7*	—	1.4*	13.5*	77.6 ns	34.3 ns	44.0*	85.8*	99.3*
Severe	196.7	15.9	30.4	37.5	50.4	28.6	15.6	18.3	92.8
1988									
Mild	171.3*	—	2.4*	6.2*	31.8 ns	21.4 ns	46.9	62.6*	101.2*
Severe	129.5	15.3	15.7	25.2	33.2	18.3	9.6	12.2	93.7
1989									
Mild	250.3*	—	1.6*	6.2	58.9 ns	73.6*	43.4*	68.5*	99.2*
Severe	190.4	36.1	36.0	36.4	52.8	9.8	9.1	10.2	89.4
1990									
Mild	193.1 ns	—	11.9 ns	8.3*	33.9 ns	42.3 ns	33.7*	62.9*	98.6*
Severe	157.6	19.6	14.8	21.6	36.3	31.1	10.0	24.2	93.7
1991									
Mild	203.5 ns	8.0*	12.9*	27.5 ns	67.1 ns	33.8*	24.1*	30.0*	95.1*
Severe	189.1	45.2	44.3	31.1	44.4	11.5	9.2	3.3	88.2
Cumulative yield (1985-91)									
Mild	1,549.5*	12.4*	41.9*	102.8*	392.1*	279.1*	265.1*	457.7*	

[x]*indicates averages in a column between mild and severe stem pitting categories are significantly different ($P = 0.05$) based on Fisher's LSD comparison; ns = averages per comparison not statistically different
[y]Average of 7 yrs (1985-1991).

TABLE 1 (CONTINUED)
EFFECT OF STEM PITTING ON FRUIT SIZE AND YIELD OF MARSH GRAPEFRUIT TREES ON ROUGH LEMON ROOTSTOCK

Sample period Stem pitting rating	Yield[x] (kg/tree)	Fruit size (kg/tree)[x] 64 (79 mm)	56 (84 mm)	48 (87 mm)	40 (92 mm)	36 (97 mm)	32 (100 mm)	27 (103 mm)	Mean fruit diameter[x] (mm)
Severe	1,246.1	188.0	86.5	229.0	316.5	137.8	83.8	104.1	
Average yield per year[y]									
Mild	221.6*	2.6*	6.0*	14.7*	56.0 ns	39.9*	37.9*	65.4*	98.9*
Severe	178.0	26.9	26.6	32.8	45.2	19.7	11.9	14.9	91.8

[x]*indicates averages in a column between mild and severe stem pitting categories are significantly different ($P = 0.05$) based on Fisher's LSD comparison; ns = averages per comparison not statistically different
[y]Average of 7 yrs (1985-1991).

looking and vigorous. Individual tree yields and fruit size were recorded annually for seven years. Fruit was graded into seven size categories: 64 (79 mm diameter), 56 (84 mm diameter), 48 (87 mm diameter), 40 (92 mm diameter), 36 (97 mm diameter), 32 (100 mm diameter), 27 (103 mm diameter). Statistical significance between treatments was determined according to Fisher's LSD Comparison ($P = 0.05$).

RESULTS AND DISCUSSION

The results in Table 1 show that stem pitting had a very significant effect on yield (kg/tree) and fruit size. Similar results have been obtained in Australia (1, 3). Although there were no significant differences between yields (kg/tree) during the years 1985, 1990 and 1991, the trees with mild stem pitting produced significantly more fruit of a significantly larger size (97 to 103 mm diameter) than the trees with severe stem pitting. The mean fruit diameter of the fruit from the trees with mild stem pitting was significantly larger throughout the seven years of assessment. Trees with mild stem pitting produced 64% of their fruit in the size categories 36-27 (97-103 mm diameter) compared to 26% for trees with severe stem pitting. There was also a 20% reduction in yield (kg/tree) in severely pitted trees.

After seven years of data collection, the canopies of the trees with severe stem pitting remained vigorous. The question which arises now is, why is the incidence of severe stem pitting so high in this particular orchard bearing in mind that budwood carrying the mild protective Nartia isolate was used to propagate these trees. There are two possibilities: (1) at the time these trees were budded in the nursery, no thought had been given to protecting rootstock seedlings from infestations of *T. citricida*. Challenging isolates transmitted by *T. citricida* before budding in the nursery could break down the protection offered by the mild isolate within the bud. Nkwaleni Valley is also renowned for the presence of severe stem pitting isolates of CTV (4); (b) the Nartia mild isolate has been shown to consist of several strains, some of which cause severe stem pitting. This was discovered when indexing Nartia mild strain pre-immunized budwood at the facility in Beltsville, Maryland, and during bud inoculations at Outspan Citrus Centre, in South Africa (L. Marais unpublished data, R. Lee pers. communication). The high percentage (25%) of severe stem pitting in this trial orchard is likely as a result of prior natural infection of Rough lemon rootstock seedlings by challenging isolates transmitted by *T. citricida*. This is supported by the fact that monitoring of mother trees propagated from Nartia mild isolate pre-immunized budwood on virus-free rootstocks has shown that the incidence of severe stem pitting in these trees is not higher than 10%.

The results of this experiment show that stem pitting has a significant effect on fruit size and yield. Decline in tree health, yield and fruit size might have been greater if the trees exhibiting severe stem pitting had not been co-infected with the Nartia mild isolate. Despite the fact that overall yield was the same, the value of the crop in an orchard where a high incidence of severe stem pitting occurs will be significantly lower. A recent survey (L. Marais, unpublished data) has shown that mature grapefruit trees with mild stem pitting have a mean crop value (per tree) of R430 compared to R229 for a tree with severe stem pitting. These results emphasize the importance of cross protection to a grapefruit industry where stem pitting isolates of CTV and the vector *T. citricida* are endemic.

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