Abnormal Bud Unions of Triumph Grapefruit and Related Varieties on Rough Lemon Rootstock

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Grapefruits, such as Marsh seedless and Ruby, usually make normal unions with Rough lemon. This is the case in all trees so far examined by the writer. Limited observations by Grimm *et al.* (*1*) of Rough lemon rootstocks with grapefruit scions agree with this observation. In South Africa, the Triumph grapefruit (probably a grapefruit × sweet orange hybrid) is an exception. Limited observations in small commercial orchards in the Eastern Transvaal showed that all Triumph trees on Rough lemon had an abnormal union. The same applied to Jackson grapefruit, a seedless sport of the Triumph, and to a seedling of Jackson (grown at Pretoria University by Professor Oberholzer).

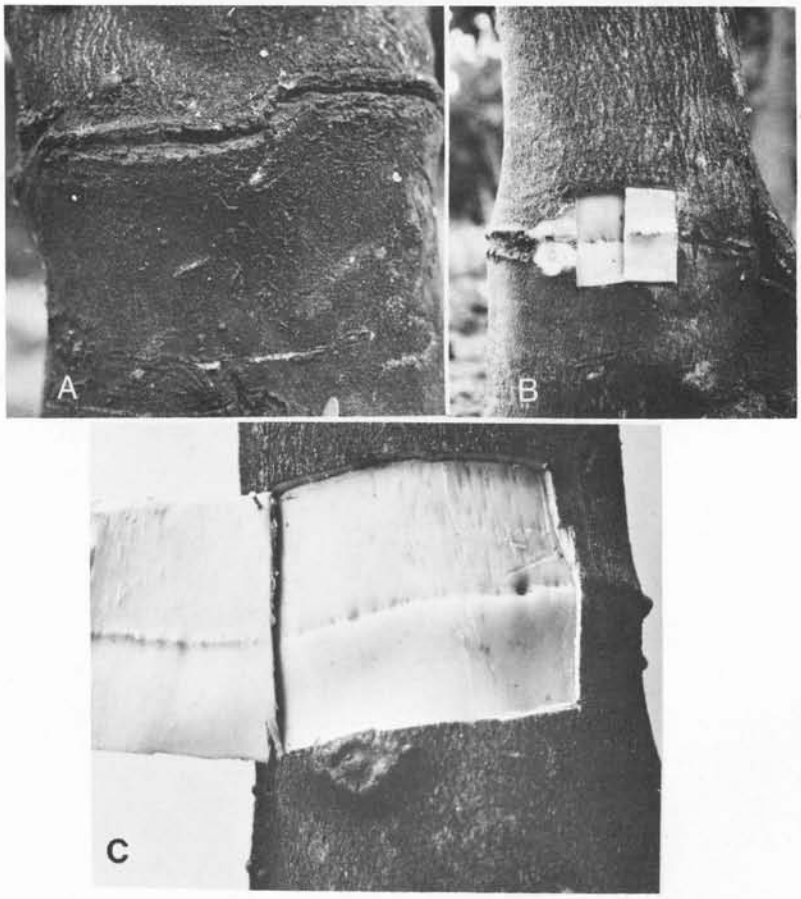

Fig. 1. Abnormal unions of Triumph grapefruit scions on Rough lemon. *A*, Jackson seedling scion (untreated) with external fissure at union; *B*, Triumph seedling scion (inoculated) with external fissure and internal symptoms; *C*, Triumph seedling scion (untreated) with internal symptoms.

Symptoms at the union of affected trees are virtually the same as those that occur between some sweet oranges and Rough lemon (fig. 1) (*2*). In severe cases an external collar of cracked and eruptive bark forms around the trunk. Trees of Triumph on Rough lemon tend to be somewhat stunted and to decline prematurely. This may be partly due to their sensitivity to stem-pitting disease, which is present in all trees.

The object of this paper is to record the bud-union trouble between Triumph grapefruit and Rough lemon rootstock, and record some experimental evidence suggesting that the trouble may be a genetic incompatibility.

EXPERIMENTS AND RESULTS

Trees of old-line Triumph, a seedling line of Triumph, and a seedling line of Jackson grapefruit were propagated on Rough lemon and planted at Buffelspoort. After 10 years, all the trees showed internal symptoms at the unions, and most of them, an external collar of eruptive bark around the trunks (table 1). Some trees of the old-line Triumph and the Jackson seedling were propagated on Rangpur lime. These trees, after 10 years, have normal unions.

Table 1 also records the type of union formed between the scions of 11 seedlings of de Wilt grapefruit and Rough lemon stocks. De Wilt grapefruit closely resembles Triumph. Nine of the trees, after eight years, had normal unions, and two showed internal projections from the inner face of the bark and a shallow pitted ring in the wood (fig. 2). Most trees, whether the union was normal or abnormal, showed extensive pitting in the wood of the grapefruit scion, probably due to tristeza virus.

Additional information on the behavior of grapefruit scions on Rough lemon became available from a field experiment at Buffelspoort designed to test the reaction of three varieties of grapefruit to different sources of tristeza virus. Test trees were seedlings of three grapefruit varieties (Marsh, Ruby, and Triumph) on their own roots, plus a series of composite trees made by topworking a propagative tissue of each seedling to Rough lemon stock. Test

TABLE 1
BUD UNIONS OF TRIUMPH AND TRIUMPH-LIKE GRAPEFRUIT VARIETIES ON ROUGH LEMON STOCKS

Scion*	Number of trees	Condition of bud unions
Old-line Triumph	4	abnormal
Seedling of old-line Triumph	1	abnormal
Seedling of Jackson grapefruit	5	abnormal
de Wilt grapefruit (11 seedlings)	11	9 normal 2 abnormal

* Parent trees of the old-line Triumph and the Jackson seedling scion were on Rough lemon stocks and had abnormal unions. Parent of the de Wilt grapefruit was probably on Rough lemon, but no record was kept of condition of its union.

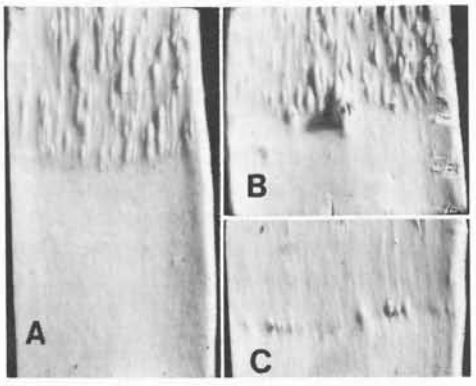

Fig. 2. Sections of bark, across union of three seedling scions of de Wilt grapefruit on Rough lemon (untreated). *A*, normal union showing extensive tristeza lesions in scion; *B*, some pegs at union of type associated with an abnormal union plus tristeza lesions in scion; *C*, pegs along union.

TABLE 2
CONDITION OF BUD UNIONS OF GRAPEFRUIT SEEDLING SCIONS ON ROUGH LEMON STOCK 13 TO 15 YEARS AFTER INOCULATION FROM VARIOUS ORCHARD TREES

Inoculum sources	Seedling scions	Number of trees	Bud unions	
			Normal	Abnormal
Sweet orange—abnormal union on Rough lemon	Ruby	9	6	3*
	Marsh	12	12	0
	Triumph	4	0	4†
Sweet oranges, grapefruits, and a lemon apparently free of transmissible factor causing abnormal union	Ruby	9	9	0
	Marsh	17	16	1‡
	Triumph	9	3	6
Untreated controls	Ruby	2	2	0
	Marsh	2	2	0
	Triumph	2	0	2

* Very mild internal symptoms.
† One of these trees that was inoculated from an old-line Verna orange developed pronounced internal and external symptoms at the union. Seeds from this tree were used to raise the seedlings of the trees that were propagated for the experiment recorded in table 3.
‡ The scion of this tree was a sexual variant.

trees were prepared and inoculated in a glasshouse. The condition of the bud unions of the trees after growing in the open for 15 years is given in table 2. Results are grouped according to whether the trees were untreated controls, or whether or not the inoculum sources contained the factor capable of inducing an abnormal union between sweet orange and Rough lemon (*2*).

Trees with Triumph scions had the highest number of abnormal unions. Positives included all the untreated controls and all but three of the inoculated trees. In the case of inoculated trees, there was no evidence that the result was influenced to any significant extent by the inoculum source.

Trees of the other grapefruits mostly produced normal unions with Rough lemon stock. But three Ruby scions on Rough lemon developed very mild internal symptoms following inoculation with tissue from a tree of sweet orange on Rough lemon that had an abnormal union.

Of the Marsh seedling scions, all but one inoculated tree made good unions. The exception was a sexual variant.

One of the Triumphs that developed conspicuous internal and external symptoms (fig. 1B) was used to start a new experiment. Seedlings raised from it were top-worked to Rough lemon, and the composite trees were then planted in the open. Some trees were inoculated and some left untreated. One inoculum source was a tree of sweet orange on Rough lemon, with a faulty union. The other inoculum source was apparently free of any transmissible factor that would cause an abnormal union between sweet orange and Rough lemon. The condition of the unions after eight years is given in table 3. There was no evidence that an abnormal union depended on the introduction of a transmissible factor. Four trees developed normal unions, but the remainder, including three controls (fig. 1C) and seven of the inoculated trees, developed internal symptoms at the unions. The two inoculated from the sweet orange showed some external cracking of the

TABLE 3
CONDITION OF BUD UNIONS OF TRIUMPH SEEDLING SCIONS ON ROUGH LEMON STOCKS 8 YEARS AFTER INOCULATION*

Inoculum source	Number of trees	Bud unions	
		Normal	Abnormal
Sweet orange—abnormal union on Rough lemon	2	0	2
Sources (sour orange seedling trees and grapefruits) free of transmissible factor causing abnormal union	8	3	5
Untreated controls	4	1	3

* Different Triumph seedling was used as the scion for each tree.

bark. Trees that developed normal unions had thinner bark than that of trees with abnormal unions.

All trees in both experiments showed symptoms of stem-pitting in their trucks, whether normal or abnormal.

DISCUSSION AND CONCLUSIONS

The faulty union between Triumph and related grapefruit varieties and Rough lemon indicates a tissue incompatibility between these two kinds of citrus. Evidence seems to indicate that this may be genetic although there is no definite evidence to exclude there being a seed-borne pathogen. Tristeza and xyloporosis were not involved. All experimental trees became infected with tristeza virus, but not all trees developed abnormal unions. On indexing to Orlando tangelo, the old-line Triumph was found to be infected with xyloporosis, but not the seedling line of Jackson grapefruit.

Marsh and Ruby types of grapefruit seem to be compatible with Rough lemon. Three Ruby seedling scions on Rough lemon developed mild symptoms at their unions following inoculation with buds from trees of sweet orange on Rough lemon with a faulty union. This suggests that some seedling lines of Ruby on Rough lemon may react to the same transmissible agent that causes abnormal union between some sweet oranges and Rough lemon.

LITERATURE CITED

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