Abnormal Bud Unions of Lemon and Trifoliate Orange Stock

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In 1955, Weathers *et al.* (*6*) reported a severe bud-union disorder in trees of old and nucellar lines of Eureka lemon on stocks of Troyer citrange and the trifoliate orange. Later, Nauriyal *et al.* (*2*) found that the apparent incompatibility between these scions and the trifoliate orange was more pronounced in trees top-worked to the more vigorous strains of trifoliate orange. They prevented the symptoms of incompatibility —at least for the five-year period of the experiment—by inserting a Valencia orange interstock between the Eureka scion and the trifoliate stock.

Salibe (*4, 5*) reported a similar trouble in experimental trees of both old and nucellar lines of Eureka lemons. He found that the abnormal symptoms developed at the unions regardless of which species was used as scion and which as stock.

Symptoms that appear at the union between the lemon and trifoliate or

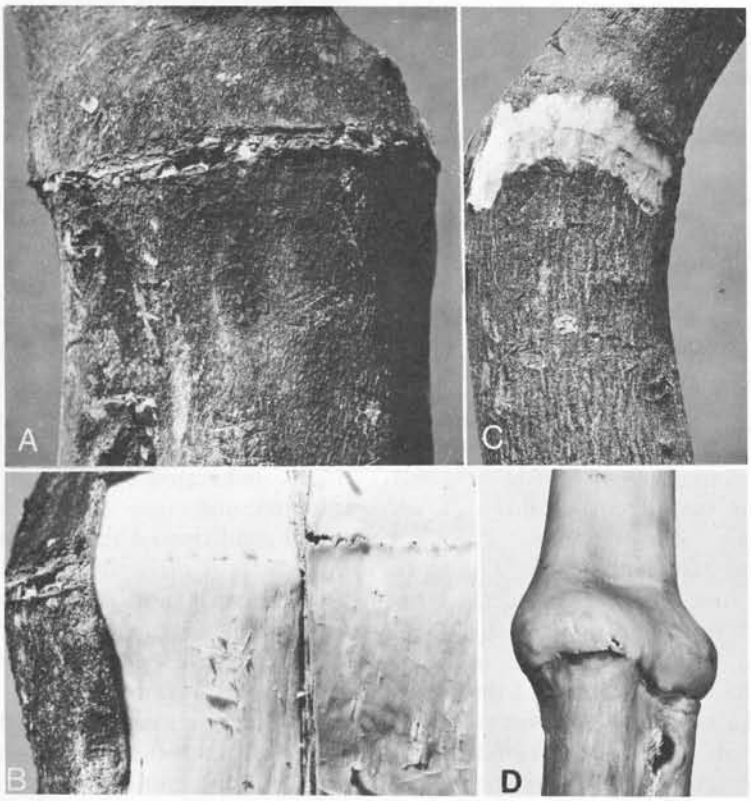

Fig. 1. Abnormal unions of lemon scions on trifoliate orange: *A*, Frost Eureka scion, with external fissure; *B*, same tree showing internal symptoms; *C*, an old-lime Eureka scion with bark pared away to show dark-colored ring at union; *D*, Eureka seedling scion showing abnormal bulge of scion and ring in wood.

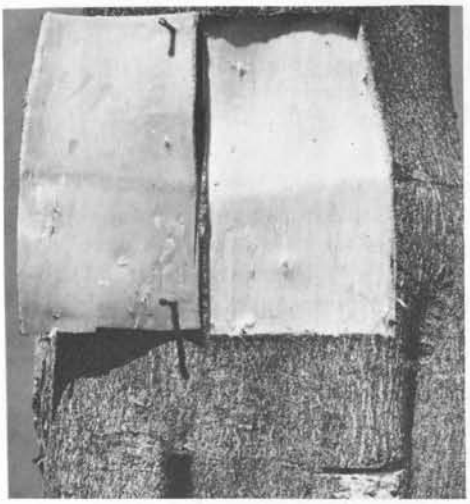

Fig. 2. Eureka seedling scion on trifoliate orange, with normal union.

citrange stock resemble closely those associated with the bud-union disorder of some sweet oranges and Rough lemon. There is the same irregular, toothed ridge projecting from the cambial face of the bark, with internal discoloration of the tissue, due probably to gum impregnation, and the corresponding pitted ring or crease running around the wood. The outer layers of the bark may also be disrupted through to the surface, causing an external ring of broken and cracked bark to develop (figs. 1 and 2). Lemon scions seem to become more swollen just above the union. Weathers *et al.* (*6*) found a starch depletion of the rootstocks of affected trees, followed by poor growth and severe decline.

The cause of the abnormality between some lemons and the trifoliate orange or Troyer citrange is probably a case of true incompatibility between their tissues. The results of earlier workers (*2, 4, 5, 6*) provide strong evidence for this explanation. There is no evidence of any direct influence by a virus. New-line lemons, apparently free of bud-transmissible viruses, are just as likely to form bad unions as are the old parent lines. Some lines, however, and particularly those of Lisbon lemon, appear to make normal unions with both trifoliate orange and Troyer citrange. This is recorded from both California and Brazil.

The purpose of this paper is to record some observations from South Africa on the behavior of lemon scions on trifoliate orange and Morton citrange rootstocks. Because practically all commercial lemons in South Africa are on Rough lemon stock, these observations were made on some experimental trees at the Buffelspoort Experiment Station.

EXPERIMENTS AND RESULTS

Experimental trees were propagated by grafting twigs from scion sources on decapitated seedlings of trifoliate orange and Morton citrange. The work was done in a glasshouse, and the trees were later transplanted into the open. After two years in the field, trees of some of the seedling lines of Lisbon and the Eureka old-line No. 3, on trifoliate and Morton citrange stocks (table 1), were inoculated by grafting into them buds of a Frost Eureka seedling that made an abnormal union with trifoliate orange. The remaining trees were left untreated. Subsequently, trees were propagated on trifoliate stock from one of the inoculated scions and from an untreated one.

The condition of the unions after 11 to 15 years is given in table 1. Results show that either all the progeny trees from a scion source developed normal unions, or all developed abnormal unions. Furthermore, in the case of those lemon scions making a normal union with the two stocks, no adverse effect on the union was produced by inoculating the scions with buds of an affected tree.

The external sign that unions were becoming faulty was usually evident within one to two years. Symptoms were

TABLE 1
BEHAVIOR OF BUD UNIONS OF LEMON SCIONS ON STOCKS OF TRIFOLIATE ORANGE AND MORTON CITRANGE

Lemon scions	Number on trifoliate orange	Number on Morton citrange	Bud unions after 11 to 15 years	
			Normal	Abnormal
Lisbon seedlings:				
1, 2 (untreated)	9	–	9	0
3 (untreated)	–	1	1	0
4 (inoculated)*	–	1	1	0
Frost Eureka:				
Old-line	4	–	0	4
4 seedlings	4	–	0	4
Additional progeny of 1 seedling	15	–	0	15
Eureka:				
Old-line No. 1	3	–	0	3
Old-line No. 2, 12 seedlings	12	–	0	12
Old-line No. 3†, 6 seedlings				
1 (untreated)	5	–	5	0
2 (inoculated)*	20	–	20	0
3, 4 (untreated)	–	2	2	0
5, 6 (inoculated)*	–	2	2	0

* Inoculated with buds from a seedling line of Frost Eureka on trifoliate stock with abnormal union.
† Parent tree from Citrus Research Institute, Nelspruit. Its identity as a true Eureka is not guaranteed.

the same as those described earlier in this paper. Overgrowth of the scions was particularly marked in some of the Eureka seedling scions that made a faulty union. Growth of most affected trees was poor, and less vigorous than that of normal trees. The scions of a few affected trees died prematurely; growth thereafter was carried on by vigorous shoots from the stocks. The most vigorous trees were those on Morton citrange.

Daughter trees of Lisbon lemon seedling No. 1 on trifoliate stocks, which are the oldest in the experiment, were planted in 1952. In the first eight years they grew satisfactorily, but then started to decline. Foliage became yellowish, and branches started to die back. Recent examination of the trunks showed excessively thick bark, numerous ray projections from the wood, especially from the scion wood, and corresponding pinholing in the cambial face of the bark. The unions, however, remain normal.

DISCUSSION AND CONCLUSIONS

These observations confirm the evidence of studies in other countries that the faulty union that develops between some varieties and seedling lines of lemon and the trifoliate orange is due to tissue incompatibility and not to a transmissible pathogen. However, some lines of Lisbon and Eureka did prove compatible with trifoliate orange and Morton citrange. This compatibility was not disturbed by inoculating trees with buds from trees with an abnormal union.

The suitability of the trifoliate

orange as a stock for lemons is doubtful, even for lines that are apparently compatible. Our experience with the one seedling line of Lisbon lemon showed that trees began to decline after eight years in spite of normal unions.

A similar disorder to the one under discussion is bud-union crease of certain citrus varieties on calamondin, that was shown to result from tissue incompatibility (*3*). McClean and Engelbrecht (*1*) recorded two examples of scions incompatible with the trifoliate orange: a sexual variant of Marsh grapefruit and a sexual variant of the Washington navel orange.

LITERATURE CITED

1. McClean, A. P. D., and A. H. P. Engelbrecht
1958. Xyloporosis, cachexia and abnormal bud-unions in South African citrus trees. S. African Jour. Agr. Sci. **1:** 389–413.
2. Nauriyal, J. P., L. M. Shannon, and E. F. Frolich
1958. Interstock effect on Eureka-trifoliate incompatibility. Calif. Citrograph **43:** 366, 386–89.
3. Olson, E. O., and E. F. Frolich
1968. Bud-union crease of calamondin—a non-infectious disorder. *In:* Proc. 4th Conf. Intern. Organ. Citrus Virol. (J. F. L. Childs, ed.) Gainesville: Univ. Florida Press, pp 341–47.
4. Salibe, A. A.
1961. Scion-rootstock incompatibilities in Brazil. *In:* Proc. 2nd Conf. Intern. Organ. Citrus Virol. (W. C. Price, ed.) Gainesville: Univ. Florida Press, pp. 172–76.
5. Salibe, A. A.
1965. Studies on bud-union crease of citrus trees. *In:* Proc. 3rd Conf. Intern. Organ. Citrus Virol. (W. C. Price, ed.) Gainesville: Univ. Florida Press, pp. 187–91.
6. Weathers, L. G., E. C. Calavan, J. M. Wallace, and D. W. Christiansen
1955. A bud-union and rootstock disorder of Troyer citrange with Eureka lemon tops. Plant Dis. Reptr. **39:** 665–69.