Further Studies of the Bud-Union Abnormality of Rough Lemon Rootstocks with Sweet Orange Scions

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A BUD-UNION abnormality characterized by a slight to pronounced bulge at the bud-union, by a ridge or series of pegs along the bud-union on the cambial surface of the bark, and by a corresponding narrow, intermittent to continuous depression in the wood was reported on sweet orange [*Citrus sinensis* (L.) Osb.] trees on Florida Rough lemon (*C. jambhiri* Lush.) by Grimm *et al.* (2). Discoloration of the cambial surface is generally apparent. The original report (2) suggests that a virus, possibly that of xyloporosis (cachexia), or a genetic factor, is responsible for the symptoms described.

Investigations on the cause of bud-union creasing with Florida Rough lemon rootstocks, and a possibly related bud-union problem with *Poncirus trifoliata* (L.) Raf. (1) in Brazil is reported here. The authors of the latter paper reported pegs, creasing, and yellow discoloration at the bud-union on trifoliate orange rootstocks budded with an exocortis-free Pera sweet orange which also developed creased bud-unions when budded on Florida Rough lemon rootstocks.

Methods

The Florida Citrus Budwood Registration Program has indexed over 2,000 commercial citrus trees for tristeza, psorosis, xyloporosis (cachexia), exocortis, and vein-enation viruses. From parent trees that pass index requirements, professional nurserymen propagate bud source groves that are registered with the Budwood Program (5). Ten of these groves together with virus test plants of the Budwood Program were utilized in this investigation. The progeny trees were derived from 20 sweet orange parent trees, 5 of the Pineapple variety, 6 of Hamlin, and 9 of Valencia. When examined, the progeny trees averaged 9 years from budding and all are on Florida Rough lemon rootstock. In most instances, 26 progeny trees of each parent were examined, but the progeny of 2 nucellar Hamlin trees were limited to 12 and 14 trees, respectively. From 1 old-line Hamlin selection, 52 progeny trees were examined, 26 infected only with exocortis virus and 26 infected with exocortis and

tristeza viruses. Also, 40 parent trees on Rough lemon rootstocks and 2 progeny trees of each, growing on *P. trifoliata* roostock in the virus test plots, were examined. Each tree was examined by removing a ¾ x 3 inch section of bark at the bud-union and observing the cambial surfaces of the xylem and the bark.

Results

SWEET ORANGE ON ROUGH LEMON ROOTSTOCK.—Five hundred twenty progeny trees, approximately 9 years of age from 20 parent trees, were examined (Table 1). Of these, 152 exhibited more or less abnormal bud-unions and 368 had normal unions. There were 130 progeny trees from 6 nucellar parent trees one of which was infected with tristeza virus. None of the nucellar progeny trees exhibited abnormal bud-unions.

There were 390 progeny trees from 14 old-line parent trees. Six of the progeny groups were infected with exocortis virus only. The occurrence of abnormal unions among these trees ranged from 0 in 26 to 23 in 26. Four old-line parent trees were infected with exocortis and xyloporosis (cachexia) viruses. Abnormal bud-unions among their progeny ranged from 0 in 26 to 26 in 26. Progeny groups from 2 old-line parent trees were infected with exocortis and tristeza viruses and 25 of 26 progeny trees from 1 parent exhibited abnormal unions, whereas none of the 26 trees propagated from the other parent had abnormal unions.

There were 3 old-line parent trees that were free of exocortis, xyloporosis (cachexia), tristeza, psorosis, and vein enation by our tests. The 26 progeny of one tree had normal bud-unions. Of the 26 progeny of the second tree, one had an abnormal union, and there were 4 abnormal unions among the 26 progeny of the third tree.

Mother trees of 12 of the 20 clonal lines represented in Table 1 are also on Florida Rough lemon rootstock. Nine parent trees with abnormal bud-unions all produced affected progeny. No abnormal bud-unions were found among progeny of parents with normal bud-unions.

SWEET ORANGE ON TRIFOLIATE ORANGE STOCKS.—The abnormal symptoms observed in sweet orange trees on trifoliate orange in Brazil were not found on trees propagated from any of 40 parent lines included in this test. Progeny from the 25 parents having creased bud-unions on Florida Rough lemon grew less vigorously on *P. trifoliata* rootstocks.

Discussion

All clonal selections shown in Table 1 are free of psorosis and vein-enation viruses, thus it appears that neither can cause the reported (2)

bud-union creasing of sweet orange on Florida Rough lemon rootstocks. In these examinations there was no correlation between the presence of tristeza, xyloporosis, or exocortis viruses and the presence of the bud-union abnormality (Table 1). The absence of any correlation whatever suggests that these viruses also are eliminated as possible causes of bud-union creasing.

If a genetic factor is responsible for the abnormality, the data presented suggest that only individual clones are affected and not varietal groups.

From these results it appears that a factor responsible for the abnormality was transmitted from parent to progeny. However, the total absence of the disorder among the 130 progeny trees of six nucellar clones

TABLE 1. THE RELATION OF 5 VIRUSES TO A BUD-UNION ABNORMALITY (CREASING) IN THE PROGENY OF SWEET ORANGE TREES

Parent tree variety	Root-stock	Degree of creasing	Viruses present	Progeny on Rough lemon stock	
				Number examined	Number abnormal
Nucellar					
Pineapple	Own		T	26	0
Pineapple	Own		None[a]	26	0
Hamlin	Own		None	12	0
Hamlin	Own		None	14	0
Valencia	Own		None	26	0
Valencia	Own		None	26	0
Old line					
Valencia	RL	Mod. severe	T, E	26	25
Hamlin[b]	RL	None	T, E	26	0
Hamlin[b]	RL	None	E	26	0
Hamlin	RL	Slight	E	26	5
Valencia	RL	Severe	E	26	18
Valencia	RL	Severe	E	26	23
Valencia	SO	———[c]	E	26	13
Valencia	SO	———	E	26	10
Pineapple	RL	Mod. severe	E, X	26	26
Pineapple	RL	Very severe	E, X	26	26
Valencia	RL	Slight	E, X	26	5
Hamlin	RL	None	E, X	26	0
Pineapple	RL	None	None[a]	26	0
Hamlin	RL	Very slight	None	26	1
Valencia	RL	Mod. severe	None	26	4

a. Indexed and known to be free of T, P, X, E, and VE.
b. Same clone.
c. Creasing does not occur in trees on their own rot or on sour orange.
T = tristeza; E = exocortis; X = xyloporosis; P = psorosis; VE = vein enation; RL = rough lemon; SO = sour orange.

is evidence that the factor responsible is not transmitted by insects or through seeds of Florida Rough lemon at a significant rate.

Conclusions

The bud-union abnormality of sweet orange trees on Rough lemon rootstock reported by Grimm *et al.* (2) was not correlated with the presence of exocortis, xyloporosis (cachexia), tristeza, psorosis, or vein-enation viruses in these studies. These results suggest that an unidentified virus or a genetic factor not present in all clones of Hamlin, Valencia, and Pineapple may be responsible for the disorder.

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Literature Cited

1. GRANT, T. J., MOREIRA, S., and COSTA, A. S. 1957. Observations on abnormal citrus rootstock reactions in Brazil. Plant Disease Reptr. 41: 743-748.
2. GRIMM, G. R., GRANT, T. J., and CHILDS, J. F. L. 1955. A bud-union abnormality of Rough lemon rootstock with sweet orange scions. Plant Disease Reptr. 39: 810-811.
3. MCCLEAN, A. P. D., and ENGELBRECHT, A. H. P. 1958. Xyloporosis, cachexia and abnormal bud-union in South African citrus trees. S. African J. Agr. Sci. 1 (4) : 389-413.
4. MOREIRA, S. 1965. Cachexia and xyloporosis are they caused by the same virus? p. 56-60. *In* W. C. Price [ed.], Proc. 3d Conf. Intern. Organization Citrus Virol. Univ. Florida Press, Gainesville.
5. NORMAN, G. G. 1959. Florida State Plant Board Program for virus-free budwood, p. 237-242. *In* J. M. Wallace [ed.], Citrus Virus Diseases. Univ. Calif. Div. Agr. Sci., Berkeley.
6. SALIBE, A. A. 1965. Studies on bud-union crease of citrus trees, p. 187-191. *In* W. C. Price [ed.], Proc. 3d Conf. Intern. Organization Citrus Virol. Univ. Florida Press, Gainesville.