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*A Disorder of Rangpur Lime and Citron  
on Sweet Orange*

**I**N 1958 attention was called to a disorder of Rangpur lime (*Citrus limonia*) on sweet orange (*C. sinensis*) rootstock which preliminary investigations had suggested was caused by a bud-transmissible virus (1). It is the purpose of this paper to report further work on this disorder, the results of which confirm the initial conclusion and indicate that the citron (*C. medica*) is also affected.

Citron was included because of the disorder observed in Diamante citron on sweet orange in a rootstock planting made in 1955, which involved 5 other rootstocks. The other 5 rootstock combinations grew normally.

*Symptomatology*

The symptoms previously reported—pronounced dwarfing accompanied by chlorotic and sparse foliage and early and heavy blossoming—have been confirmed for both fruits. To these can now be added an earlier and more specific symptom, namely, a marked repression of stem thickening of the rootstock in comparison with the scion (Fig. 1). Anatomical studies remain to be made. This symptom is more highly developed in the nursery or lathhouse, where mean temperatures are lower than in the glasshouse.

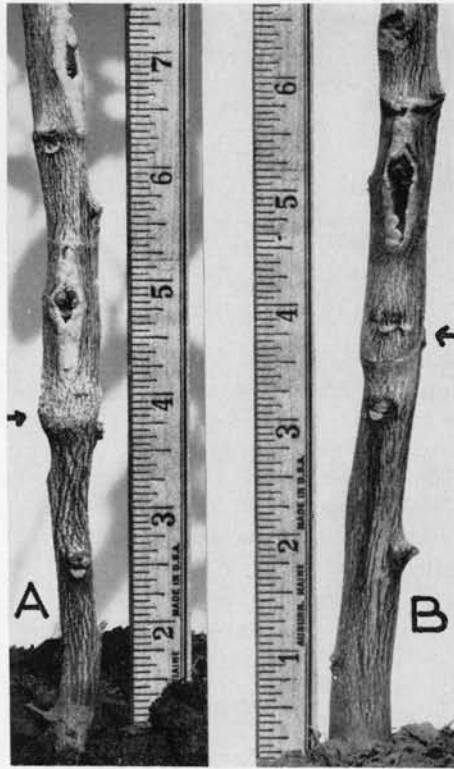


FIGURE 1. Rangpur D 4-24 on sweet orange 9 months after inoculation. A. Inoculated with C 26-1. B. Inoculated with D 4-24. Arrow points to graft union.

### *Methods and Materials*

The plants employed in the experiments herein reported were all propagated in the glasshouse by the rooted-cutting-graft method described by Halma (2). After rooting, the cuttings were transferred to gallon cans of soil and grown in the glasshouse for about 6 months before planting in permanent locations in the field where all readings were taken.

In all cases, the original inoculation was effected by means of a twig graft made at the time of propagation. The inoculation graft was re-

moved by pruning after the plant had become well established in the field, and the new top was grown from a single shoot from the inoculated scion. Where a secondary inoculation was required it was accomplished by inserting 3 shield buds into the established scion.

The clones employed were the following:

AS ROOTSTOCK

The Blackman sweet orange (also known as Brown). The parent tree is from a seedling tree on the L. V. W. Brown Estate properties at Riverside, California.

AS SCIONS

1. Old Rangpur lime clone C 26-1. The parent clone was received from W. T. Swingle of the U.S. Department of Agriculture many years ago under the label *Citrus limonia*, India.
2. Presumably virus-free young Rangpur lime clone C 26-1 seedlings derived by nucellar embryony in 1955.
3. Old Rangpur lime clone D 4-24. The parent clone was received from W. T. Swingle under CPB number 10537.
4. Diamante citron. The parent clone came from the U.S. Department of Agriculture under P. I. number 102895.
5. Fawcett citron. The parent clone came from the U.S. Department of Agriculture under P. I. number 85049.

### *Experimental Results*

The experimental results to date are given below. Briefly summarized they are as follows:

RANGPUR LIME

*Experiment 1—1958 planting*

- a. Eight plants of old clone C 26-1 on sweet orange; all declined.
- b. Control: 14 plants of young clone C 26-1 seedling on sweet orange; 12 normal, 2 declined. This behavior necessitated the substitution of old Rangpur clone D 4-24 for the control in the 1959 experiments.
- c. Ten plants of young clone C 26-1 seedling on sweet orange with twig-graft inoculation from old clone C 26-1; 6 declined, 4 normal. Following reinoculation, the latter all declined.
- d. Eight plants of sweet orange on virus-infected old clone C 26-1 and an equal number on virus-free old clone D 4-24. All have grown normally with no detectable difference between the two lots.



FIGURE 2. A. Rangpur C 26-1 on sweet orange. B. Rangpur D 4-24 on sweet orange. C. Rangpur D 4-24 on sweet orange with Rangpur C 26-1 inoculum. All 2 years old.

*Experiment 2—1959 planting (Fig. 2)*

- a. Nineteen plants of old clone C 26-1 on sweet orange (identical with Experiment 1a) ; 18 declined, 1 normal. The latter declined when reinoculated.
- b. Nine plants of old clone D 4-24 on sweet orange. All normal.
- c. Ten plants of virus-free D 4-24 on sweet orange with twig-graft inoculation from old clone C 26-1 (similar to Experiment 1c) ; 8 declined, 2 normal. Both of the latter declined following reinoculation.

*Experiment 5—1960 planting*

Thirty plants (2 each of 15 seedlings) of young clone C 26-1 seedling on sweet orange; 26 normal, 4 now showing the early symptoms of reduced rootstock stem thickening.

*Citron*

*Experiment 3—1958 planting*

- a. Seven plants of Diamante citron on sweet orange; 2 declined, 5 normal.
- b. Seven plants of Fawcett citron on sweet orange; 6 declined, 1 normal.
- c. Six plants of young clone C 26-1 seedling on sweet orange with twig-graft inoculation from Diamante citron; 4 declined, 2 normal. Following reinoculation these latter two declined.
- d. Fourteen plants of young clone C 26-1 on sweet orange, not inoculated; 2 declined, 12 normal.

*Experiment 4—1959 planting*

- a. Nine old clone D 4-24 on sweet orange, not inoculated; all normal.
- b. Six plants of virus-free D 4-24 on sweet orange with twig-graft inoculation from Diamante. All 6 normal. On reinoculation 3 declined and 3 remained normal.

*Experiment 6—1960 planting*

- a. Eight rooted cuttings from the best normal Diamante tree in Experiment 4 and 10 from the worst declined tree in that experiment. All normal and no detectible difference between the two lots.
- b. Ten plants of the best normal Diamante (Experiment 3a) on sweet orange. All normal to date.
- c. Ten plants of the worst declined Diamante (Experiment 3a) on sweet orange. Four already exhibit the early symptom of reduced rootstock stem thickening. Six appear normal thus far.

*Discussion*

It will be noted that there is evidence of infection in the presumably virus-free young Rangpur lime clone C 26-1 seedlings, derived by nucellar embryony (14 per cent in Experiment 1b and 13 per cent in Experiment 5). This suggests the possibility of seed transmission from its virus-infected parent clone. For this reason, the experiment was repeated, substituting Rangpur lime clone D 4-24, which had made normal growth on sweet orange for 25 years.

Failure to transmit from virus-infected clones occurred in many of these experiments (3 with Rangpur lime and 5 with citron) and in one

(Experiment 4) transmission was not accomplished even on reinoculation. It will be noted, however, that the percentage of transmission was higher in Rangpur lime (60 to 95 per cent) than in the citron (29 to 86 per cent) and much lower in Diamante (29 to 67 per cent) than in Fawcett (86 per cent in only one experiment).

By way of comment on these findings, attention is directed to the fact that the twig-grafts employed for initial inoculation were taken from terminal shoots, which were younger and of smaller diameter than the scions used for secondary inoculations.

It will also be noted (Experiments 1d and 6a) that this disorder is similar in some respects to tristeza in that it becomes effective only in combination with a susceptible rootstock. Rangpur lime clone C 26-1 grows normally on sour orange rootstock and as rooted cuttings (1). Sweet orange scions on infected C 26-1 rootstocks grow normally, as do also infected sweet orange cuttings.

Additional work is in progress to check further the possibility of seed transmission in the apparently infected C 26-1 seedlings. There is, of course, always the possibility of other means of natural spread although no evidence of insect transmission has been observed in the plantings at Los Angeles.

### *Summary and Conclusions*

A series of experiments conducted during the past three growing seasons (1958-60) has confirmed a preliminary report (1) and supports the following conclusions:

1. The existence of an apparently new virus disease of Rangpur lime (*C. limonia*) and citron (*C. medica*) on sweet orange is established.
2. The effects of this virus require the presence of an infected scion of either Rangpur lime or citron on sweet orange rootstock.
3. The reciprocal combinations are not affected.
4. The virus affects neither Rangpur lime nor sweet orange alone.
5. It apparently transmits more readily from Rangpur lime than from citron.

### *Literature Cited*

1. FROLICH, E. F. 1958. A disorder of Rangpur lime on sweet orange rootstock. *Plant Disease Repr.* 42: 500-501.
2. HALMA, F. F. 1931. The propagation of citrus by cuttings. *Hilgardia* 6: 131-157.