Lemon on Troyer Citrange Root

bud-union and rootstock disorder of Troyer citrange with Eureka lemon tops under study in effort to identify cause

L. G. Weathers, E. C. Calavan, J. M. Wallace, and D. W. Christiansen

A serious disorder in trees of Eureka lemon on Troyer citrange—a hybrid of the trifoliate orange and the navel orange—rootstock was discovered in 1954 when all the Eureka tops in one of the experimental plots in Ventura County turned yellow, set a heavy crop of fruit, and declined markedly.

Examination revealed a disturbance at the bud union, with retarded growth, deterioration, and gumming of the Troyer citrange. Bark and wood necrosis, accompanied by some gumming and resembling dry root rot, had developed in the rootstocks. The affected wood was firm, dry, and stained light brown, but lacked the usual odor of dry root rot.

In some trees the necrosis involved the entire rootstock, while in others it occurred as localized lesions or in longitudinal strips. The lesions did not extend into the Eureka lemon portion of the trunk. Both old-line and nucellar-line Eureka lemons on Troyer in this planting showed the disease, but the same tops on other rootstocks were not similarly affected.

A survey of other plantings of lemon on Troyer citrange in Ventura and Santa Barbara counties revealed that many of the 3- to 4-year-old trees of Frost, UCLA, Cook, and Hughes nucellar-line, and of Allen, Hughes, and Cascade old-line Eureka lemons, propagated on Troyer citrange, were declining or had died. Other cases have been observed recently in Orange County.

The bud unions of affected trees were noticeably abnormal, with the lemon scion having overgrown the stock and the bark of the Troyer often having dried and adhered to the wood. A narrow dark-brown line in the bark and on the cambial face of the wood at the bud union suggested some form of incompatibility. Treatment with iodine showed starch depletion in the Troyer rootstocks, which is indicative of girdling near the bud union of a sufficient degree to restrict severely the translocation of carbohydrates to the roots. Wood necrosis had developed in the Troyer rootstocks of only a few trees and appeared to be a secondary symptom associated with fungus invasion of tissues weakened by girdling. Some trees without extensive wood necrosis have made a partial recovery.

There was considerable variation in symptom expression on trees growing under different environmental conditions. Although there was no conclusive evidence of a causal relationship between the bud-union disorder and the necrotic lesions, it was observed that the bud-union disorder of Eureka lemon on Troyer citrange frequently occurs in the absence of rootstock lesions. With this combination no lesions were found without a conspicuous bud-union disorder.

Cook nucellar-line Eureka lemons topworked on Valencia sweet orange on Troyer citrange rootstocks in one grove in Ventura County were found declining severely three years after topworking.

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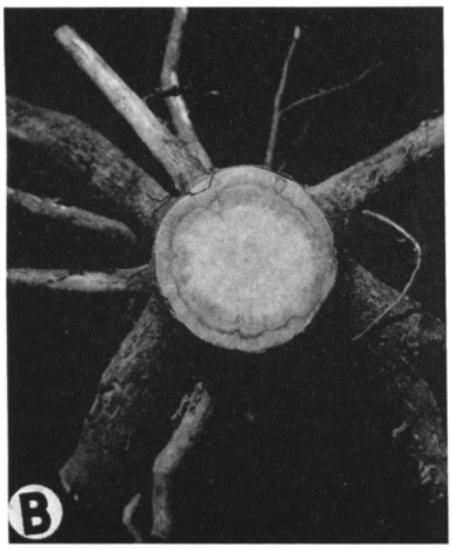

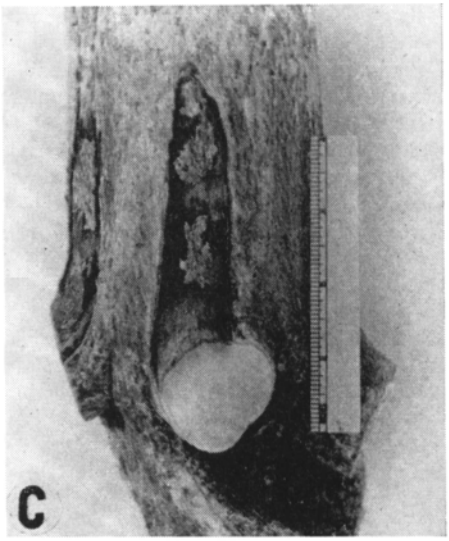

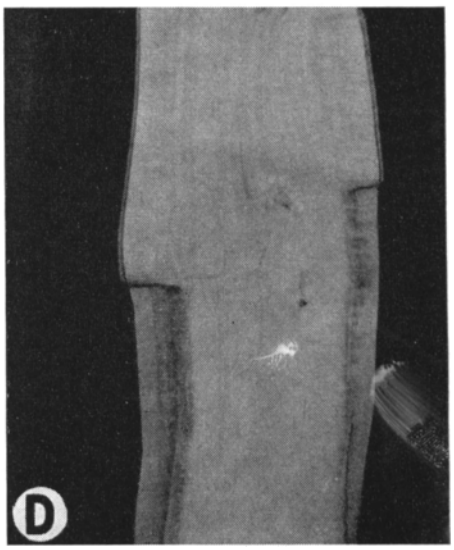

A. Disorder of Troyer citrange rootstock with Eureka lemon top, showing gumming at the bud union and retarded growth of the rootstock.

B. Cross section of Troyer citrange rootstock, showing the developing necrosis.

C. Localized lesion on Troyer citrange rootstock.

D. Longitudinal section through bud union of diseased Troyer citrange rootstock with Eureka lemon scion. Note the sharp line of demarcation at the union and the discolored wood of the rootstock.

(Photographs A, B, and D by R. G. Platt; C by K. L. Middleham.)

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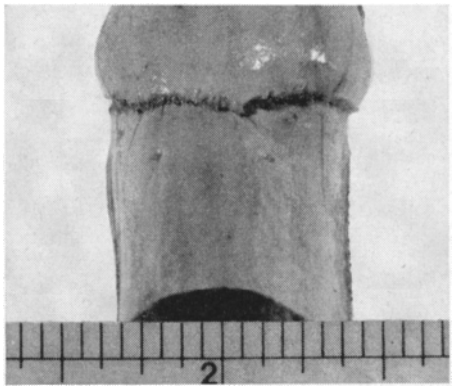
Lesions had developed in the Troyer rootstocks of some trees, but no brown line or marked overgrowth was found at either the lemon-orange or the orange-citrange unions, as was the case where Eureka lemon was propagated directly on Troyer citrange. However, the bark of the Troyer rootstock was very thin and dry and adhered very tightly to the wood. Tests with iodine indicated low starch content in the roots.

Fungi of several genera were isolated from the bark and wood of diseased Troyer citrange rootstocks from several locations in Ventura County. Fungi commonly found were *Alternaria* spp., *Fusarium* spp., *Penicillium* spp., and a fungus tentatively identified as *Gliocladium roseum* Bainier. These isolates have not yet been fully tested by inoculation into Troyer citrange, but from previous tests it is known that they are ordinarily present on citrus as saprophytes or weak parasites of weakened tissues. Attempts to isolate *Phytophthora* spp. from the diseased tissues and from the soil adjacent to the Troyer rootstocks were unsuccessful.

The cause of this disorder of Troyer citrange rootstock has not been determined. However, the following points were noted: *1*, Eureka is the only lemon variety known to be associated with this disorder. Lisbon lemon strains and oranges on Troyer citrange rootstocks have not thus far been similarly affected. *2*, Until symptoms appear two or more years after planting, the trees are very vigorous and apparently healthy. The most vigorous trees are often the first to deteriorate. *3*, Soil type, soil fumigation with DD, and irrigation practices appear to have little or no influence on the appearance of this disorder. *4*, Many trees become diseased before developing wood rot or any other evidence of fungus activity. Since the fungi thus far isolated from diseased roots appear to be secondary invaders, it is very doubtful that fungi are the primary cause. *5*, Several cases of failure of old-line and nucellar-line Eureka lemon on rootstocks of trifoliate orange, *Poncirus trifoliata* (Linn.) Raf., sometimes within a year after budding, have recently been observed. The disorder of Eureka lemon on trifoliate orange reveals a bud-union condition very similar to that observed on trees of Eureka lemon on Troyer citrange rootstocks. A young Messina-type lemon on trifoliate orange in Santa Barbara County has also developed a bud-union disturbance and exocortis. Wood necrosis has not been observed in any of the diseased trifoliate orange rootstocks.



(Photograph by K. L. Middleham)

Bud-union disorder of nucellar Eureka lemon on trifoliate orange rootstock one year after budding. Bark removed to show groove and dark line at the union. Rule is in inches.

Possible Causal Agents

The Troyer citrange rootstock disorder may be caused by a virus or by a form of incompatibility between Eureka lemon and Troyer citrange. The occurrence of rootstock lesions in trees having Valencia sweet orange interstocks disfavors direct incompatibility as the cause of this symptom, since the Valencia interstock separating the Eureka lemon from the Troyer citrange is compatible with both. This indicates that the Eureka lemon may carry a virus that seriously affects Troyer citrange. Furthermore, inasmuch as nucellar lines of Eureka on Troyer citrange react in the same way as trees of old-line Eureka on this rootstock, any virus present must be either seed-transmissible or very readily transmissible by mechanical means or by a vector.

Other studies have shown that some and possibly all old-line Eureka lemons carry a transmissible factor, possibly a virus, which retards the growth of nucellar Eureka lemons. The retardation of growth of nucellar-line Eureka lemons after graft-inoculation from old-line Eurekas does not appear to be related to the disorder of Eureka lemon on Troyer citrange. The virus or causal factor of the former is not present in nucellar-line Eureka lemons; whereas the factor responsible for the Eureka-Troyer disorder is present in all the nucellar-line Eurekas tested.

Trees of Frost and UCLA nucellar-line Eureka on some rootstocks other than Troyer citrange or trifoliate orange are retarded in growth only after being graft-inoculated from old-line Eureka sources, but the same nucellar lines when budded on Troyer citrange subsequently develop the Troyer rootstock disorder without inoculation. If a virus is involved in the latter disorder, it must be present generally in nucellar Eurekas or, as is somewhat less likely, seed-transmitted and carried latently in Troyer citrange seedlings. It is also known that trifoliate orange rootstocks having certain old-line Eureka lemon tops show symptoms of exocortis. However, exocortis is not necessarily the cause of either the bud-union trouble or the necrosis of Troyer citrange.

Experiments aimed at identifying the agent or agents responsible for the Troyer citrange rootstock disorder are now in progress.

L. G. Weathers is Assistant Plant Pathologist, University of California, Riverside.

E. C. Calavan is Associate Plant Pathologist, University of California, Riverside.

J. M. Wallace is Plant Pathologist, University of California, Riverside.

D. W. Christiansen is Senior Laboratory Technician, University of California, Riverside.

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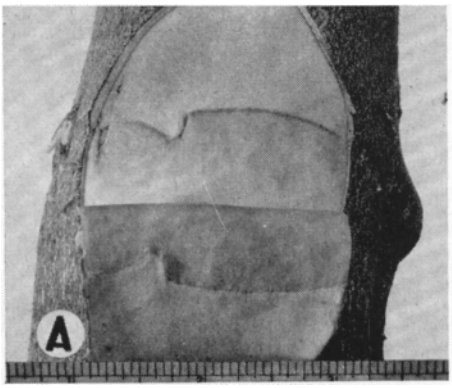
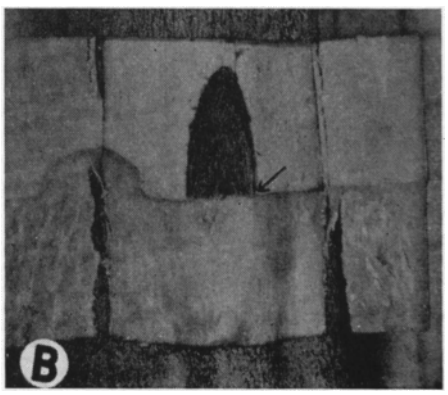
The above progress report is based on Research Project Nos. 1383 and 1544.





A. Four-year-old nucellar Eureka lemon on Troyer citrange. A flap of bark has been peeled downward across the union to show the dark line on the cambial faces of the wood and bark.

B. Four-year-old nucellar Eureka lemon on Troyer citrange. The bark across the union was cut away. A groove was chiseled across the union and the wood treated with iodine. Note color reaction for starch in the Eureka lemon wood above the union (arrow) and lack of color reaction in the Troyer citrange wood.

(Photograph A by K. L. Middleham; B by R. G. Platt.)