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### Authors

Wallace, James M.  
Drake, R. J.

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# CITRUS VEIN ENATION<sup>1</sup>

J. M. Wallace and R. J. Drake<sup>2</sup>

University of California Citrus Experiment Station,  
Riverside, California

## INTRODUCTION

Citrus vein enation was first described in 1953 by Wallace and Drake,<sup>3</sup> who demonstrated that this disorder was caused by a graft-transmissible virus. Early in 1954, McClean,<sup>4</sup> in South Africa, described the same symptoms on citrus, and demonstrated that the vein-enation virus is also transmitted by *Toxoptera citricidus* (Kirk.). In both California and South Africa, preliminary studies have indicated that the virus of vein enation is rather commonly present in orchard trees of miscellaneous citrus varieties. Swelling and/or formation of small papillae or slight projections at scattered locations on leaf veins are the only symptoms found to be associated with infection by this virus.

In California, the vein-enation virus is being given further study to determine whether it has any injurious effect on citrus. The virus appears to cause no injury to infected seedlings. In fact, its presence has so little effect on the plants that it is perhaps incorrect to describe vein enation as a disease of citrus. However, further study may demonstrate that the veinal effects are symptoms of one of the known viruses of citrus, or that they are symptoms of a presently unknown virus which may be the cause of one of the viruslike disorders of citrus, such as bud-union crease or one of the other bud-union disorders. At any rate, it is advisable to include in these Proceedings a brief account of this virus as a reference for those engaged in the study of citrus virus diseases.

## SYMPTOMATOLOGY

Symptoms vary in degree on different citrus varieties. On leaves of sour orange, *Citrus aurantium* Linn., and Mexican lime, *C. aurantifolia* (Christm.) Swing., many of the veins on the underside of the leaf are slightly swollen. The individual projections, few or many, are scattered over the leaf surface and commonly arise on the main lateral veins. After the projections on the under surface of the leaf have become conspicuous (fig. 1, left), the upper surface of the leaf shows corresponding indentations (fig. 1, right). On inoculated lime seedlings, symptoms sometimes appear within four weeks, but commonly they are not easily detected until two or more months after inoculation.

## HOST RANGE AND DISTRIBUTION

No extensive studies have been made of the *Citrus* species and varieties which are susceptible to and show symptoms of vein enation. Indications are that nearly all *Citrus* species are susceptible to infection, even though some may not express symptoms. The authors have observed symptoms on Mexican lime; Florida Rough lemon,

<sup>1</sup> Paper No. 1108, University of California Citrus Experiment Station, Riverside, California.

<sup>2</sup> Plant Pathologist and Principal Laboratory Technician, respectively, Citrus Experiment Station, Riverside.

<sup>3</sup> Wallace, J. M., and R. J. Drake. A virus-induced vein enation in citrus. *Citrus Leaves* 33(2): 22, 24. 1953.

<sup>4</sup> McClean, A. P. D. Citrus vein-enation virus. *S. African Jour. Sci.* 50: 147-151. 1954.

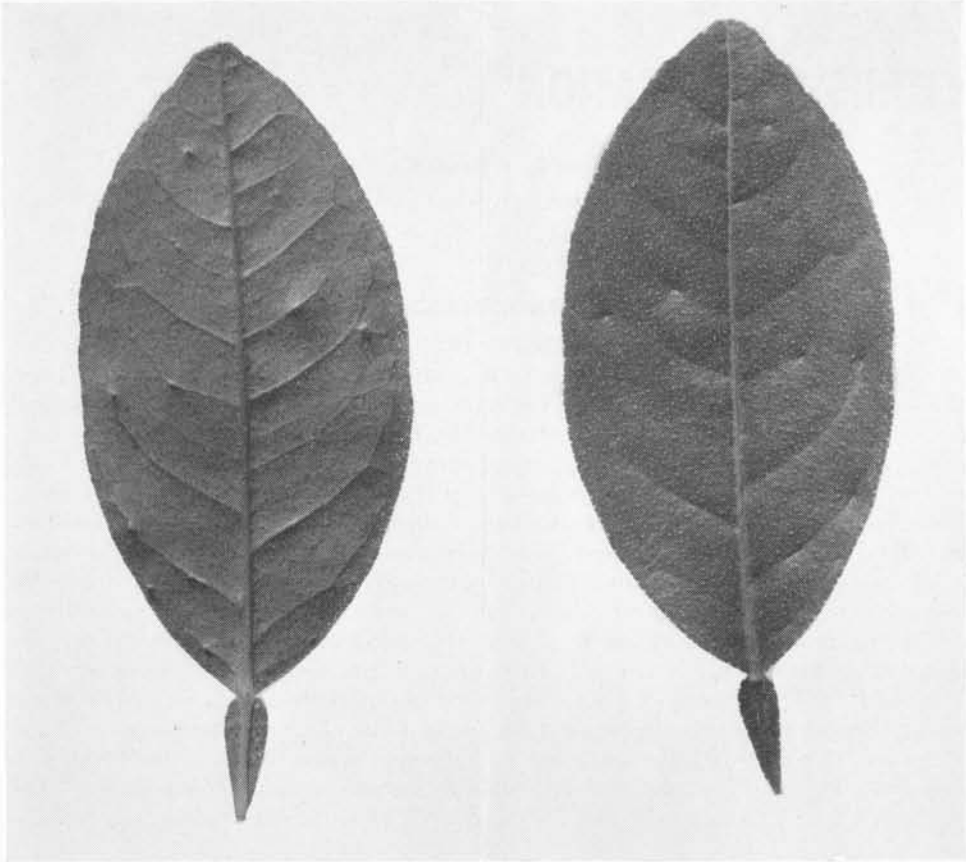


Fig. 1. Symptoms of vein-enation disease on leaves of Mexican lime: (Left) Vein swellings and enations on under surface of leaf. (Right) Same leaf showing corresponding indentations on upper surface.

*C. jambhiri* Lushington; Palestine sweet lime, *C. limettioides* Tanaka; varieties of sweet orange, *C. sinensis* (Linn.) Osbeck; sour orange; mandarin, *C. reticulata* Blanco; kumquat, *Fortunella* sp. Swingle; and a few other miscellaneous *Citrus* species and hybrids.

Tests of field trees, largely in tristeza and psorosis studies, have disclosed infected trees of lemon, *Citrus limon* (Linn.) Burm.; grapefruit, *C. paradisi* Macf.; Rangpur lime, *C. limonia* Osbeck; mandarin, and sweet orange. In some areas relatively high percentages of orchard trees of lemon are infected. From the incidental data that have accumulated, it appears that in some locations citrus trees are quite generally infected, whereas in other places they are not.

#### INSECT TRANSMISSION OF VEIN-ENATION VIRUS

McClellan<sup>4</sup> demonstrated that the vein-enation virus in citrus in South Africa is transmitted by *Toxoptera citricidus*, the principal vector of tristeza virus in South Africa, South America, and some other countries. In California, seedlings of sour orange growing in lathhouses were sometimes found to show vein-enation symptoms. It seemed evident that the virus was being spread by insects. Numerous transmission experiments were therefore carried out with *Aphis gossypii* Glover, the vector of tristeza virus in California, to determine whether this species could also transmit the vein-enation virus.

No infections resulted in the trials with this aphid. Limited tests were then made with other *Aphis* species, including *A. spiraeicola* Patch, *Macrosiphum solanifolii* (Ashmead), and *Myzus persicae* (Sulz.). The aphids were first fed on vein-enation-infected sweet orange or Mexican lime seedlings and transferred to healthy young seedlings of Mexican lime. No infections resulted in the tests with *A. spiraeicola* and *Macrosiphum solanifolii*, but 7 out of 63 lime plants exposed to groups of *Myzus persicae* became infected. Thus it appears that one more virus can be added to the long list already established as being transmitted by the green peach aphid, *Myzus persicae*.

#### POSSIBLE RELATION TO OTHER VIRUS DISEASES OR VIRUSLIKE DISORDERS

Studies on the possibility that the vein-enation virus may be the same as that causing one of the known citrus virus diseases, such as exocortis, stubborn disease, or others for which no characteristic leaf symptom is known, are now being initiated. Further studies of vein enation will also consider whether the causal virus is associated with lemon decline, bud-union crease, or other bud-union disorders of unknown causes.

The vein-enation virus has often been found in orchard trees infected also with the viruses of either tristeza or psorosis, but it frequently occurs separately from these. Its absence from one tree of navel orange on Palestine sweet lime which had severe xyloporosis symptoms on the rootstock, at Riverside, suggests that vein enation has no relation to xyloporosis.

Until further investigations are made and additional information is obtained, no conclusions can be drawn regarding the possible relationship or association of vein enation with other known injurious diseases or disorders of citrus.

#### SUMMARY AND CONCLUSIONS

The virus that causes vein-enation symptoms on leaves of certain species of *Citrus* has a wide host range within the citrus family. It can be present in some species or varieties without causing symptoms.

In South Africa, it is transmitted by *Toxoptera citricidus*, the aphid species that transmits the tristeza virus there and in some other countries. In limited tests in California, the vector of tristeza, *Aphis gossypii*, did not transmit vein-enation virus, but some transmissions were made experimentally with the green peach aphid, *Myzus persicae*.

It has not yet been determined whether vein-enation virus causes injury to infected citrus. Unless it proves to have a causal relationship with other known virus diseases of citrus or with some of the viruslike disorders of unknown cause, it will be accepted as of no economic importance and will not require further consideration in citrus virus research programs or in citrus budwood certification schemes.