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THE DISTRIBUTION OF EXOCORTIS VIRUS IN CALIFORNIA CITRUS[1]

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INTRODUCTION

Exocortis appears to have been widely distributed for many years in California. As shown by Fawcett and Klotz (*6*), Benton *et al.* (*1*), Bitters *et al.* (*3*), Moreira (*9*), Olson *et al.* (*10*), Reitz and Knorr (*12*), and Calavan and Weathers (*4*), exocortis is now known to be closely associated with stunting of citrus trees on various rootstocks, but for many years the disease received very little attention. This situation was due, at least in part, to the small number of rootstocks of trifoliate orange, *Poncirus trifoliata* (Linn.) Raf., and of other indicator rootstocks used until recently in this state. Coit (*5*), in 1915, indicated that trifoliate orange was little used, that it failed more often than it succeeded, and that it was apparently most nearly successful in the Tulare area. He also remarked that for lemon trees it "has been an absolute failure in every case recorded in California." Webber (*14*), also, indicated that lemon, *Citrus limon* (Linn.) Burm., on trifoliate orange rootstock was very severely dwarfed and rarely proved satisfactory.

The exocortis virus is now known to be present in several varieties of *Citrus* in California. Despite recent evidence (*3, 13*) that exocortis is not the sole cause of stunting in citrus trees (especially lemons) grown on trifoliate orange rootstock, the virus has been shown by Bitters *et al.* (*3*) to be able to stunt inoculated indicator seedlings and rootstocks. In a separate report to this conference, Calavan and Weathers (*4*) indicate that exocortis virus or a transmissible factor closely associated with it has caused marked stunting of nucellar-line Eureka lemon trees on three presumably exocortis-tolerant rootstocks, and appears to have stunted old-line trees of sweet orange, *C. sinensis* (Linn.) Osbeck, on rootstock of sour orange, *C. aurantium* Linn.

These developments, together with the increasing use, in California, of roostocks susceptible to exocortis, have begun to indicate the magnitude of the exocortis problem here and have stimulated considerable interest in the study of long-term stionic tolerance of the virus by various experimental and commercial stions, as well as in the etiology, control, and present distribution of the disease.

GEOGRAPHIC DISTRIBUTION

Exocortis has been observed by the authors in practically all the important citrus areas in California, but no extensive survey has been undertaken to determine the frequency with which it occurs, because the virus is known to be latent in many trees. Despite the large number of trees known to be infected, there are apparently many exocortis-free trees of sweet orange, mandarin orange, *Citrus reticulata* Blanco, and grapefruit, *C. paradisi* Macf., in California. Fawcett and Klotz (*6*) estimated that

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exocortis symptoms were present in possibly 5 to 25 per cent of the citrus trees on trifoliate orange rootstock in southern California. At present, for older plantings, there appears to be no reason to alter this estimate. In Tulare County, a larger percentage of trees appear to be infected, probably because there are more old orchard trees on trifoliate orange stock in that area than in other parts of California. According to Opitz,[3] perhaps as many as 50 per cent of the sweet orange trees on trifoliate orange rootstock in Tulare County show exocortis. Inasmuch as the diseased trees have been propagated from a variety of sources, it seems logical to expect that a similar percentage of the citrus propagated on symptomless rootstocks in that area are carrying exocortis as a latent virus.

Exocortis virus is believed to be present in lemons throughout the citrus areas of the state. Except for young-line trees, the authors estimate that more than 80 per cent of all lemon trees and nearly 100 per cent of the trees of the Eureka variety are infected.

VARIETAL DISTRIBUTION

The host range of exocortis was not discussed by Fawcett and Klotz (*6*), who indicated that symptoms were present on a trifoliate orange scion with a grapefruit rootstock, and on trifoliate orange rootstocks under navel orange, Valencia orange, and grapefruit scions. Bitters (*2*) noted symptoms of exocortis on three susceptible rootstocks—trifoliate orange, Morton citrange (*Poncirus trifoliata* X *Citrus sinensis*), and Cunningham citrange—and under four scion strains and varieties—Chase Eureka lemon, CES Eureka lemon, Temple orange (*C. sinensis* X *C. reticulata*), and Valencia orange. Bitters *et al.* (*3*) transmitted exocortis to susceptible rootstocks under Frost nucellar-line Eureka tops and showed, also, that this young-line Eureka apparently does not carry exocortis. Weathers *et al.* (*13*) reported exocortis under a Messina-type lemon and indicated that exocortis virus appears to be absent in Allen nucellar-line Eurekas. Opitz (in conversation with the authors in October, 1957) stated that some Kaweah lemon selections are carrying exocortis. In Butte County, exocortis was noted by F. R. Platt (in a letter dated November 12, 1957) on trifoliate orange rootstocks under Satsuma mandarin. The authors have also observed exocortis in California on rootstocks under the following scions: old-line Marsh Seedless grapefruit, Bergamot lemon, old-line Eureka lemons (Allen, Cascade, Ross 10-1, Rubidoux, and Sawyer), old-line Lisbon lemons (Bevins, Fritz 3-2, Hales No. 2, Ledig, Monroe, Prior 5-5 and 22-1, Rock, and Wohlford), Eustis limequat, *C. aurantifolia* (Christm.) Swing. X *Fortunella japonica* (Thunb.) Swing.; Atwood early navel orange, and Hamlin sweet orange.

In addition to the known exocortis indicators (trifoliate orange and some of its hybrids) in California, there are several other varieties which as rootstocks or scions sometimes have symptoms that resemble exocortis and may be caused by the exocortis virus. Among these are the Rangpur lime, *Citrus limonia* Osbeck; Yuzu orange, *C. ichangensis* Swing. X *C. reticulata* var. *austera* Swing.; shaddock X St. Michael orange hybrid, *C. grandis* (Linn.) Osbeck X *C. sinensis;* citron, *C. medica* Linn.; Florida sour orange; Cuban shaddock (a lemon hybrid); and various lemons. Indexing trials are under way in California with these various exocortis-like disorders.

Close association and probable identity of exocortis and Rangpur lime disease have been shown by Moreira (*9*), Olson and Shull (*11*), and Reitz and Knorr (*12*). Fawcett and Klotz (*7*) briefly described a bark rot of sour orange rootstocks (unpublished data credited to Calavan and Klotz). Symptoms of this disorder, resembling those of shell bark and exocortis, were illustrated by Klotz and Fawcett (*8*).

[3] Opitz, Karl W. University of California Agricultural Extension Service, Visalia, California. In a letter dated October 22, 1957.

MEANS OF SPREAD

Available evidence indicates that exocortis has been widely distributed principally, perhaps entirely, by the use of infected propagative material and by natural root grafts. A vector, if one exists here, must be inefficient or rare, because many trees in close proximity to exocortis-infected trees have remained healthy for 25 years or more. A very few instances of exocortis development under scions from presumably healthy parents, without inoculation, have been noted, but the method of transmission has not been determined.

CONTROL

In the absence of an efficient vector, control of exocortis by propagation of exocortis-free budwood sources should be relatively simple. However, due to the lengthy period required (six years minimum) for certification of freedom from exocortis, and to the lack of any sources so certified, exocortis virus continues to be widely disseminated in nursery stock. Until the proposed program can produce certified sources, some years hence, the most desirable procedures, in the order of their effectiveness, are 1) to propagate from uncontaminated nucellar lines; 2) to propagate from symptomless trees, ten or more years of age, growing on trifoliate orange or Morton citrange rootstocks; or 3) to use rootstocks tolerant of or resistant to the exocortis virus.

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