

Some Observations on the Spread of *Phytophthora Cinnamomi* in Diseased Avocado Groves¹

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In previous reports by the author² it has been pointed out that ***Phytophthora cinnamomi*** may be taken more abundantly from the roots of diseased avocado trees than from the roots of healthy individuals. Healthy trees, whose roots have yielded the fungus were, for the most part, in or near affected areas in declining groves.

Generally, small roots (less than one-fourth inch in diameter) were taken for study. As a rule, these were taken about six to eight feet from the tree trunk and at a depth of four to eight inches; in many instances, several root samples were taken from a questionable tree at varying distances from the trunk and at varying depths. The rootlets were cut into short pieces (about one inch long) and incised longitudinally, aseptically, after which they were placed (cut surface downward) on cornmeal agar in Petri dishes. Fungal colonies appeared usually within five to seven days. Isolations of species and records of their frequency distribution were kept. In all, about twenty-five species of fungi were tabulated in a year's study.

During the period covered by this investigation, the roots of 971 avocado trees were studied for their root-fungal populations; 487 representing diseased or "declining" trees and 484 being apparently healthy individuals. Roots of 251 (52 per cent) diseased trees yielded ***Phytophthora cinnamomi***; 91 (18 per cent) of the non-declining trees yielded the fungus in question. In its frequency, ***Phythium vexans*** was a close runner-up for second place, appearing more often in diseased groves.

By repeated examinations of selected groves, during the year, some evidence was accumulated to indicate that "decline" was spreading from tree to tree, and that such a spread was associated with excess soil moisture. Samplings of roots over ever widening areas in groves in southern counties showed ***P. cinnamomi*** to be closely associated with declining trees and wet soil. Very often a tree that had been earlier evaluated as a healthy individual and which had yielded ***P. cinnamomi*** from its roots, was later found to be declining; in such cases the value rating had to be changed from "O" to "1" or even to "2" (see evaluation scale in Plate I); in Plates I and IV, the evaluations are given for the initial samplings only. In more northerly counties, Santa Cruz and Fresno, typical decline was not observable even though trees were growing in water soaked or otherwise continuously very moist soil.

Although more than a year has elapsed since the above studies were completed, the writer deemed it worthwhile to review the work of two study plots, involving three avocado groves and contiguous portions of adjoining groves. The two plots possess certain features that are advantageous in studying the spread of decline; certain factors as slope and drainage, exposure, the juxtaposition of healthy and diseased trees, and

differences in grove management were considered in selecting these plots.

Plot 1 (Plate I) is located in San Diego County. In this plot, there is one large grove in which a broad drainage swale is more or less centrally located. The drainage area, except for one small ditch, slopes easterly; the directional slope of the excepted ditch is northerly. In the bottom of the flattened swale, marked "depressed area" (Plate I), the sandy soil was found to be wet whenever samplings were taken during the twelve-month period. In this area, there were found many dead trees (with a scale rating of "6") and many dying ones (rating, "5"), as well as tall grass and weeds. Higher, upon the gentle slopes, the soil was better drained and here the trees generally exhibited less evidence of disease; there was less grass, owing to the shade from the more dense foliage of the trees. At still higher levels, the trees were in excellent condition, bearing large and shiny leaves; there was considerable leaf mould in this portion of the grove, and the surface roots of the trees were very numerous and healthy in the adequately moist soil. Roots from these trees did not yield *P. cinnamomi*, unless the trees were near the infected ones that evidenced distress. This fact became more significant when one realized that rootlets from adjacent trees intermingle freely. In studying this plot, one may readily see the relationships between soil moisture and the diseased or healthy condition of the trees, and the degree to which the trees are subject to attack by *P. cinnamomi*. Of the diseased trees 68 per cent were infested with the fungus in question, whereas only 27 per cent of the healthy trees yielded that organism.

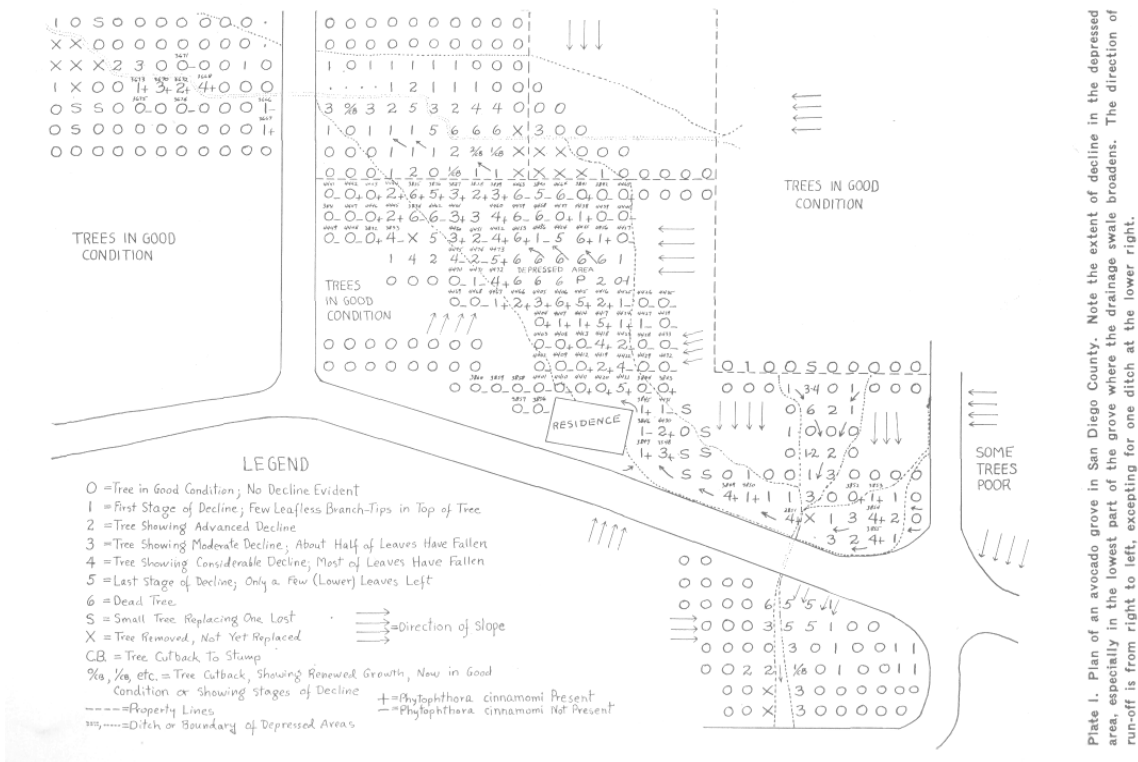
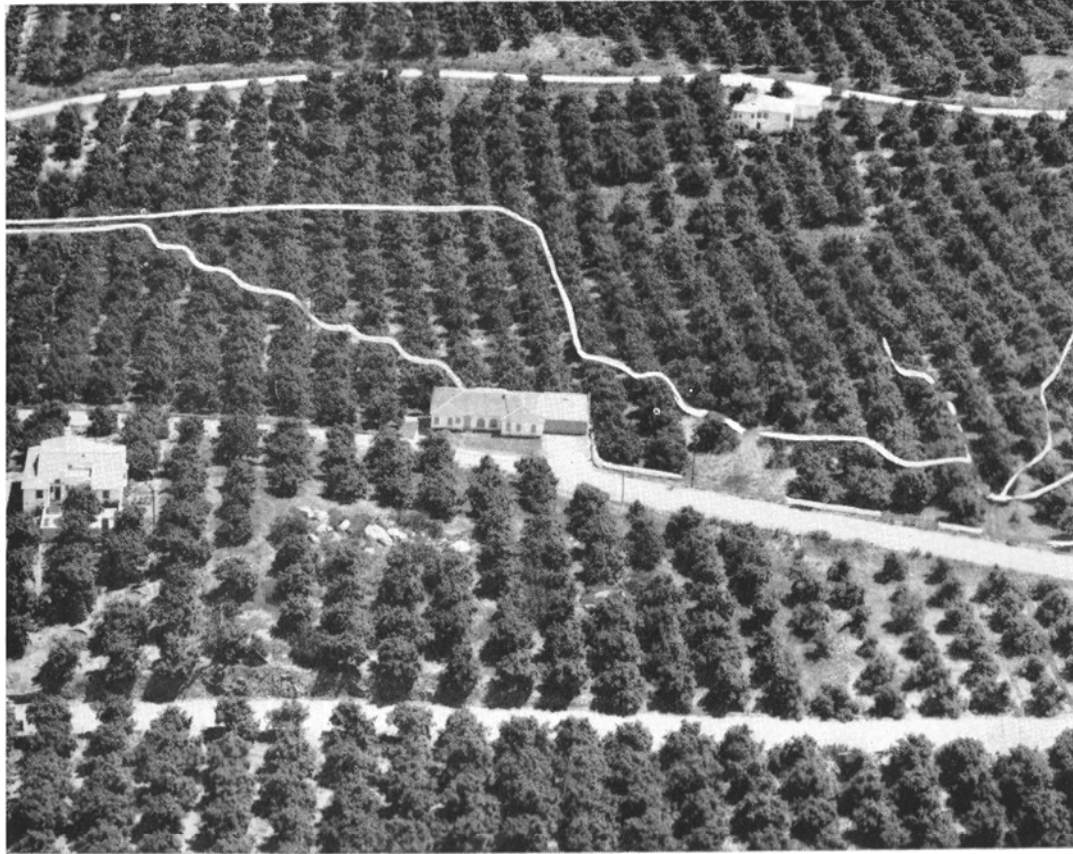


Plate II. Aerial photograph taken of avocado grove plotted in Plate I at a time when all trees were healthy. The white lines indicate the boundaries of the main drainage swale. Note the somewhat sparse growth of trees in the drainage area.



The aerial photograph (Plate II), obligingly furnished by the owner of the above grove, indicates the healthy condition of the grove before heavy rains, in 1942, made conditions incompatible with the welfare of avocado trees. Figures 1 and 2 represent healthy trees and badly declined ones in the same grove, mapped in Plate I. The affected trees in Figure 2 are located in the center of the swale that passes through the grove.

Plot 2 (Plate IV) is located in Los Angeles county. Two groves, with trees of the same age and of the same source, these having been planted on the same northerly slope and possessing almost the same soil environment, exhibited different pictures when repeatedly studied. Contiguous portions of the two groves were at one time under the same management. One grove is still under its original managership (A) and the other (B) had changed hands at least two times, within four years, by the time this study was begun.

Improper watering in grove B seems to have been the deciding factor in bringing about is down-grade history; where the irrigation run-off was very poor, next to grove A, there appeared "decline" in grove A, as well as in B in which it was more extensive. Several "O" trees in grove A yielded **P. cinnamomi** on the first visit to that portion of the plot; on succeeding visits, those trees showed a loss of vitality, in several cases having advanced to stage "1" in decline. In grove B, the trees were in a worse condition. To begin with, 75 per cent of the declining trees in grove A yielded **P. cinnamomi** whereas

only 24 per cent of the non-declining trees yielded the fungus from their roots. In grove B, ailing trees were found to be infested with *P. cinnamomi* in 52 per cent of the cases studied; 45 per cent of the non-ailing trees yielded the fungus.

The writer was not able to follow up the studies in plots 1 and 2, nor in other frequently visited groves in southern California. A repeated study of every tree sampled might be of worth in obtaining data on the spread of "decline". Such a study, which would involve remapping of groves, might well show the "advance front" of the spreading disease, especially where physical conditions permit such a spread.

Other tree plot observations and studies of isolated individuals, in southern California, have appeared to bear out the fact that excess moisture is of primary importance in the spread of decline. On the contrary, there are "spotted" plantings of avocado in central California (near Santa Cruz and near Fresno), in nearly every planting of which the soil was found to be wet, but in which plots no declining trees were found; likewise *P. cinnamomi* was not found to be present. In one very healthy grove of eighty trees, made up of twenty varieties, the writer found the most abundant young crop of fruit in the entire state for the season. This grove, located in a warm spot in the foothills of the mountains east of Fresno did not appear to suffer as a result of having a very moist soil environment.

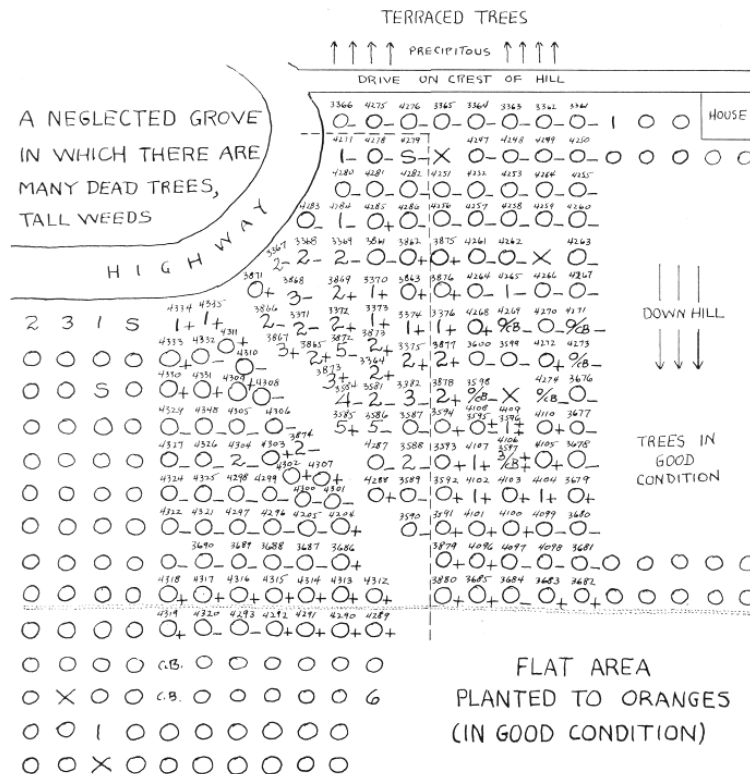


Plate IV. Portions of adjacent groves in a Los Angeles County plot. Grove A, at right, has been constantly under one ownership and management for many years. The ownership and management of the grove at the left has changed hands at least three times in four years. Decline appears to be spreading from the trees in grove B to those in grove A.

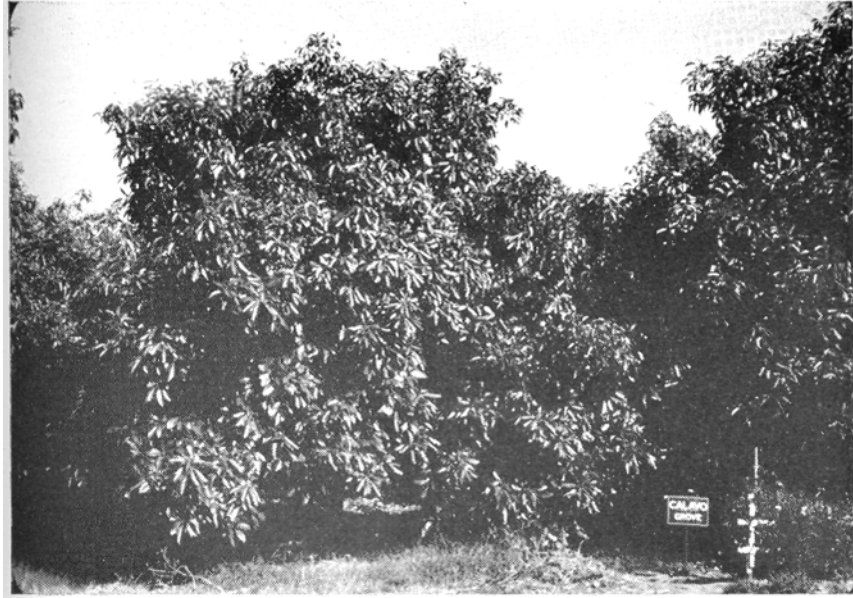


Figure 1. Healthy, non-declining, avocado trees in plot 1 (Plates I and II). Underneath these trees the soil is in good condition and is well drained.



Figure 2. Dead or dying avocado trees in a depressed portion of the grove, plot 1, in which the drainage is very poor. Note the spaces from which dead trees have been removed; also note one very resistant tree in the center of the devastated area.

SUMMARY

In a year's study of fungi associated with declining avocado trees, **Phytophthora cinnamomi** was isolated from the roots of more than one-half (52 per cent) of the diseased trees. Conversely, only 27 per cent of the healthy trees examined yielded the fungus.

The healthy trees that yielded **P. cinnamomi** from their roots were, in all cases, located

in declining groves and commonly near ailing trees. The apparently healthy trees, in several instances, later exhibited symptoms of decline.

In studies of selected plots, involving one or two groves and/or contiguous portions of adjacent groves, where very moist conditions prevailed, there was in evidence a spread of decline from declining trees to healthy individuals. **P. cinnamomi** was found consistently to be associated with the disease spread.

In well isolated groves in central California no decline was in evidence, even though moisture conditions were severe. **P. cinnamomi** was not taken from trees in those groves.

1. The data for this report were obtained while the author was working on a problem cooperatively sponsored by The United States Department of Agriculture, Emergency Plant Disease Survey Project, and The University of California, Citrus Experiment Station.

2. Harvey, James V., Fungi Associated with Decline of Avocado and Citrus (I, II, III). Plant Disease Reporter, USDA, interim reports, 1944-45.