

Verticillium Wilt of Avocado

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During the past 15 to 25 years occasional reports have appeared of a sudden wilting and collapse of isolated avocado trees in otherwise healthy groves. This trouble was believed to be connected with a lack of oxygen in the soil brought about by a sudden saturation of the soil with water; it was variously termed collapse, asphyxiation, and apoplexy (1,3). Investigations during the winter 1947-48 showed that this disease is caused by the fungus **Verticillium albo atrum** Reink. and Berth. This paper reports work on this disease.

Symptoms

The symptoms of the disease are similar to those of Verticillium wilts on other woody hosts including maple, elm, apricot and peach. There is usually a sudden wilting of the leaves on one branch, on one side of a tree, or on an entire tree, followed quickly by death of the leaves. (Fig. 1). The leaves turn brown and remain on the tree for several months.

At the time of the initial wilting and "collapse" dark-brown streaks are readily seen in the most recently formed xylem tissue, on peeling the bark from affected branches or from the trunk. Streaks may be very abundant, covering most of the circumference of the branch (Fig. 2), or may be few in number.

Varying degrees of dieback occur; occasionally an entire tree will be killed. More commonly dieback of one-third to two-thirds of the top occurs, then, a month or more after the initial wilting and death of leaves new shoots appear from adventitious buds along the larger branches and the trunk, and vigorous new growth rapidly regenerates a new top. This renewal of growth coincides with or closely follows formation of new xylem tissue replacing that invaded by the fungus.

Following the initial disease appearance trees often completely recover and do not wilt again. Other cases have been observed, however, where trees wilted for several years in succession. The disease has been observed in December, January, June and July.

Causal Fungus

Verticillium albo-atrum was first isolated from avocado trees in Vista, San Diego County, California in December, 1947. This isolate and subsequent isolates from a number of other diseased trees, were typical of **V. albo-atrum** as described by Reinke and Berthold and as clarified by Rudolph (4)¹.

Wilhelm (5) has stated that the conidial constituent of **V. albo-atrum** forms abundant black microsclerotia at temperatures from 10° to 22° C., while from 25° to 31° C. the colonies are creamy-white with few microsclerotia. He further stated that the stable white mycelial variants are unaffected by temperature. The isolates from avocado showed the same response to temperature as those noted by Wilhelm.

Varieties Affected and Localities

Under natural conditions Verticillium wilt has been found on Guatemalan seedling trees (**Persea americana**), on Guatemalan varieties (Anaheim and Queen) budded on Guatemalan rootstocks, and on the hybrid Fuerte variety budded on Guatemalan and on Mexican (**P.americana v. drymifolia**) rootstocks.

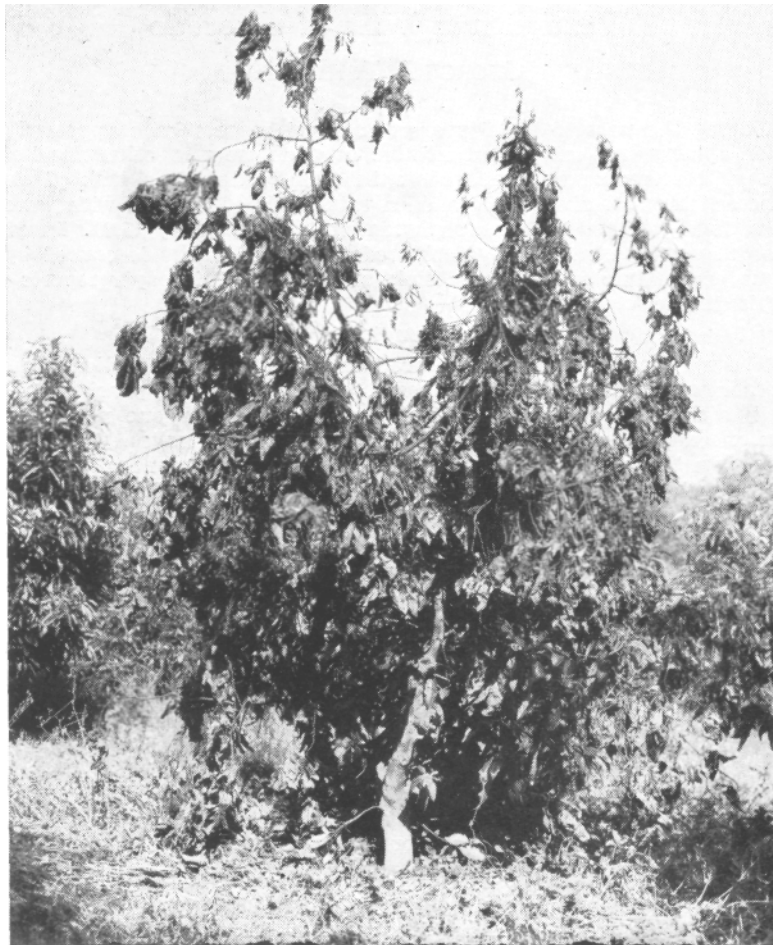


Fig. 1. Fuerte Avocado tree affected with verticillium wilt. The entire top wilted suddenly and the leaves died and turned brown. A few shoots are coming out from the trunk.

The type of rootstock was determined by the method developed by Halma (2). Various Mexican varieties comprise the majority of the rootstock sources for commercial avocado trees in California, although some Guatemalan seed has been used. The

Fuerte is the principal variety under commercial production in California.

The disease has been found in all of the commercial avocado districts in California, including sections of San Diego, Orange, Los Angeles, Ventura and Santa Barbara counties. Trees found affected under conditions of natural infection have varied from two and one-half to 20 years old. The disease usually occurs on only one or two isolated trees in a grove; thus it is not at present of economic importance.

Inoculations

Avocado seedlings were inoculated in the greenhouse by two main methods: By dipping roots in a suspension of spores and mycelium, and by injecting spores into the vascular system of the stem.

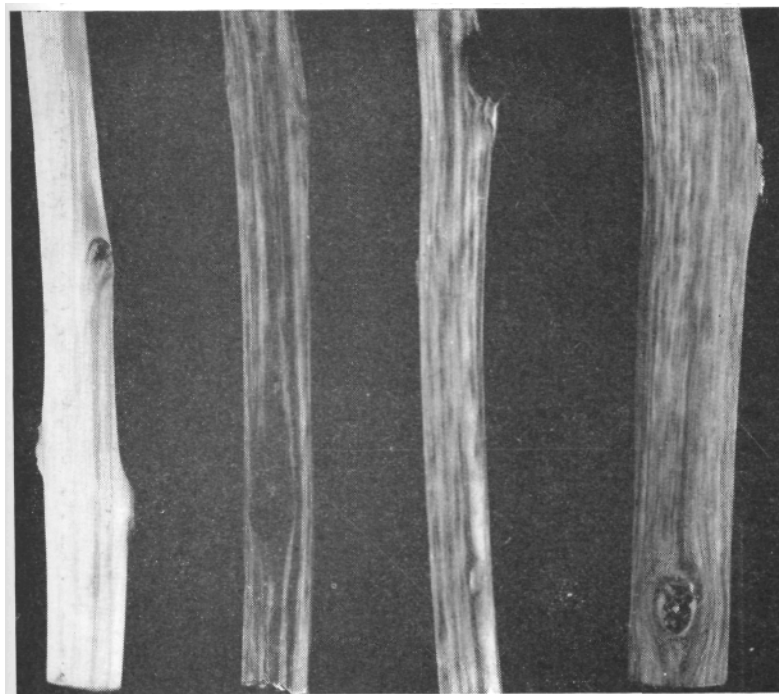


Fig. 2. Vascular discoloration (brown) caused by *v. albo-atrum* in avocado branches. Healthy branch section at left.

For the first method two 14-day-old petri dish cultures of **V. albo-atruna** isolated from avocado trees and growing on potato dextrose agar were homogenized with water in a Waring blender. The roots of young (10-month-old) Mexican (Topa Topa) and Guatemalan (Anaheim) seedlings were dipped in the spore-mycelium suspension, and the seedlings were planted in cans of sterilized greenhouse soil and the cans placed in temperature tanks in August 1948 (Fig. 3). Tomato plants (improved Pearson) were also inoculated by dipping the roots in the suspension and were planted in cans placed in the temperature tanks. Soil temperatures were maintained at 15, 20, 25, 30 and 35° C.

Twelve days after inoculation the first symptoms of Verticillium wilt appeared. The

Anaheim variety in the 20°, 25° and 30° C. tanks wilted suddenly, and the leaves died within another week. Vascular discoloration was present in leaf petioles, and the fungus was recovered from the petioles. All three varieties eventually wilted at all five soil temperatures. Disease symptoms were considerably delayed at 35° C., however, and the disease was not as severe at this temperature as at the four lower temperatures. Following the death and abscission of some of the leaves new shoots appeared, as under conditions of natural infection, in the seedlings grown at 20°, 25° and 30° C.

Inasmuch as a rather resistant variety of tomato was used, symptoms were not obvious on tomato, but some one-sided yellowing of leaves did occur, and *V. albo-atrum* was re-isolated from the faintly discolored portions of the petioles and stem.



Fig. 3. Guatemalan (left) and Mexican avocado seedlings inoculated by dipping roots in spore and mycelium suspension of *V. albo-atrum*. Photo taken 4 weeks after inoculation.

Two Anaheim and two Topa Topa seedlings were also inoculated by a method used successfully with the Dutch elm disease and other vascular diseases (6). This method

involved placing the stem of the avocado seedling in a horizontal position, pipetting a drop of concentrated spore suspension on the stem and cutting through the drop with a scalpel, penetrating into the xylem. The spore suspension is readily taken up by the vessels in this method. Ten days later several leaves in the top of both Anaheim and one Topa-Topa seedling showed a one-sided yellowing and a drying-out of tissue. Vascular stain was heavy and the fungus was readily re-isolated from leaf petioles in the top of the 18-inch seedlings.

Preventive Measures

Obvious measures to reduce the possibility of disease occurrence include not planting avocado trees on land that has been recently cropped to tomatoes or other plants highly susceptible to *Verticillium*. Several groves where the disease has appeared were planted to tomatoes the year before the avocado trees were set out. Using land that has been in some other crop susceptible to *Verticillium* should be particularly avoided in the case of nursery planting. Interplanting young groves with susceptible crops should also be avoided.

While there is as yet no definite proof that *Verticillium* wilt can be transmitted by budding, grafting, or through the seed, these means of transmission are entirely possible. Hence trees that have any history of the disease are not safe sources of budwood, graftwood or seed.

Many trees apparently recover completely. Where the disease recurs several times on the same tree, however, the tree should be removed and the soil fumigated if the area is to be replanted to avocado. Chloropicrin is the only soil fumigant definitely known to be effective against *Verticillium*. The unpleasantness of the gas plus its extreme volatility, making a water seal essential, are drawbacks to its use in the field.

Summary

A disease of avocado trees in California involving sudden wilting and collapse of the leaves, has been identified as caused by ***Verticillium albo-atrum*** Reink and Berth. Trees are usually not killed entirely and often make excellent recovery.

Trees on both Mexican and Guatemalan rootstocks are affected; the disease is present in all of the commercially producing avocado districts in southern California. Seedlings showed disease symptoms in twelve days at soil temperatures of 20°, 25° and 30° C. following dipping the roots in a suspension of spores and mycelium.

¹The isolate from avocado was submitted to Drs. B. A. Rudolph and S. Wilhelm of the University of California at San Jose and Berkeley, for examination, and was identified as ***V. albo-atrum***.

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