

The Dying Back of Avocado Trees in Southern California

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During the last few years a decline or dying back of avocado trees has become prominent in some parts of Southern California. It has been conservatively computed that some 500 acres of avocados are thus affected. The condition usually occurs in fairly old trees of 10 or more years in age. They appear to lose vitality, become sparsely foliated, do not produce a crop; and branches begin to die back.

The decline is particularly common in heavy clay soil and often on steeply sloping hillsides. In many instances also, it has been found that an impervious subsoil occurs some 2 feet or so below the surface.

Affected trees examined during the winter were found to be in excessively wet soil. In one instance, a hole 3 feet deep was dug in an orchard about 10 days after a continuous period of fairly heavy rain. After 15 minutes, water began to ooze out of the sides of the hole about 2 feet from the surface and trickle to the bottom.

Roots of affected trees were found to be blackened and dead, especially the fibrous ones and those up to 1/8" thick. Larger roots were also sometimes soft, brown and rotten and had a disagreeable odor. When the thin bark is scraped on some of the large roots, brown lesions 1/8" to 3/4" in diameter are often seen. These are usually at the junction of a small root which is dead. When the bark of healthy roots is scraped off, the tissue below is white and crisp, while in affected ones it is brown and soft.

An examination of large numbers of infected roots from trees exhibiting die-back symptoms in various parts of Southern California revealed the fact that a fungus, **Phytophthora cinnamomi**, was commonly present, not only in the smaller blackened roots, but also in the lesions on the larger ones. This fungus had previously been found on avocado roots in Puerto Rico by Dr. C. M. Tucker and also by the writer in South Africa. It was associated with dying back in both cases. In addition to occurrence on avocado, the fungus has also been found in various countries on the roots of numerous plants which are usually killed by it, such as chestnut, yew, spruce, pine, walnut, oak, rhododendron, heaths, pineapples, and on citrus associated with gummosis in Brazil and has occurred in Europe, Australia, East Indies, and the United States.



Fig. 1.—No fungus was added to the soil. The 3 pots on the left were submerged for 3 days, the other for 9 days. None of the plants subsequently showed any ill effects.



Fig. 2.—*Phytophthora cinnamomi* was added to the soil of each pot. A month later the 3 avocado plants on the left were submerged for 2 days, the other 3 for 3 days. The photograph was taken a week later when the plants had wilted and died.

Previous experiments on avocados in Puerto Rico had shown that the fungus was

unable to attack plants which were grown and watered in a normal manner.

The fact that the dying back seemed to be associated with excessive wetness of the soil led the writer to make the following experiments. Avocado plants about 3 feet high growing in pots had the fungus added to the soil Without injuring the roots. This was done by taking cultures of the fungus which had been previously grown in the laboratory and adding them to the soil and digging the material into the soil with a stick. A month later the pots in which the trees were growing were submerged in large containers of water for various periods of time. They were then drained rapidly and subsequently watered only when necessary. Other avocado plants were treated in the same manner except that no fungus was added.

The results were striking. When no fungus was present, the plants could be submerged for 3 days, for 6 days, and even as long as 9 consecutive days without subsequently showing any injury. (See fig. 1.) When the fungus was present, however, plants that were submerged for 2 days or for 3 days began to wilt a few days later and were mostly dead within a week. (See fig. 2.) Even one day's submerging produced wilting, but some of the wilted plants died and others subsequently recovered. Those plants to which the fungus had been added but which were watered only when necessary continued to grow and thrive, and during the next six months showed no effects of the presence of the fungus. (See fig. 3.)

This *Phytophthora* fungus grew well at temperatures ranging from 60° to 90° F, doing best at 75° to 80° F. Other workers have shown that it is able to attack plants growing in soils varying from pH 4.0 to 7.3 and that avocados grow best in acid soils of approximately pH 5.0.

It seems probable then that this fungus occurs extensively in the soil in numerous parts of the avocado-growing districts of Southern California. After heavy or continuous rains, or in orchards in which the trees have been over-irrigated, many of the roots may be killed off by the fungus. During the dry weather of the succeeding summer months, the depleted stock of roots may not be able to supply enough nourishment to the tree, and dying back appears. At such time, the cause of the decline might be baffling, for no signs of the very wet conditions would be then evident. The combination of fungus and wet conditions might also account for the sudden collapse and death of avocado trees, instances of which have been encountered occasionally. On one tree about 25 years old with a trunk nearly 18" in diameter all the leaves withered and died suddenly during September following a particularly hot period.



Fig. 3.—*Phytophthora cinnamomi* was added to the 4 pots on the left, controls on right. Soil watered when necessary. After 6 months all were still healthy.

When the fungus is not present, avocado trees can withstand submerging for as long as 9 continuous days without any harmful effect. This wet condition, however, enables the fungus, when present, to make an entrance into the roots and kill them.

In poorly drained, heavy soils, then, there seems to be a definite menace to the health of the tree when too much water is present. This may be due to heavy rains, too-frequent irrigation, seepage from a neighboring grove on steeply sloping hillsides, or from a leaky or broken water pipe. It is suggested that drainage ditches be cut or tile drains laid to take care of excess water. It is also suggested that a soil tube should be used before every irrigation to regulate the amount of water applied and to know to what depth it penetrates. Whether badly affected trees will recover when treated in this way is a question, no answer to which is known at the moment, but it seems most probable that decline might be prevented in healthy trees situated in orchards where this condition is prevalent.

A more detailed report on this investigation is being published in *Hilgardia*.