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IRRIGATION WATER TESTS TO ISOLATE THE AVOCADO ROOT ROT FUNGUS

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The avocado root rot disease is caused by **Phytophthora cinnamomi**, the cinnamon fungus, a soil-borne organism which invades and destroys feeder roots, and eventually kills the tree. The most important requirements for the growth and spread of this disease are a high soil moisture condition coupled with a relatively high soil temperature range. Under these conditions the fungus is readily capable of growing vegetatively, forming and releasing swimming spores and infecting feeder roots.

Specifically when excess or free water exists around trees having root rot and particularly when soil temperatures register between 77° and 82° F. the most ideal medium is present for the rapid growth and spread of the disease. It would seem then that under such conditions greater spread of root rot would take place, particularly by late summer and early fall when soil temperatures are higher. Under careful irrigation practices water can be controlled, thereby minimizing excesses in soil moisture. During periods of heavy winter rainfall, however, soil moisture often builds up until free or run-off water exists in diseased areas.

With the ability of this organism to grow vegetatively and release infectious spores it seems logical that this run-off water could serve not only to spread the disease from tree to tree, but to transport the fungus into drainage ditches, water-storage basins and canals, in turn, spreading root rot into areas irrigated by these waters.

The wet winter of 1957-58 presented an excellent opportunity to study this last-mentioned phase of the root rot problem.

Laboratory and greenhouse work indicated that infection of avocado fruit with **Phytophthora cinnamomi** could occur by suspending fruit in water containing the fungus. Avocado fruit is, in addition, readily infected by placing it in a pan of diseased soil with free water present around the fruit. Young avocado plants also are readily infected by suspending the roots in a nutrient solution containing the fungus.

With these facts at hand tests were set up in the winter of 1957-58 in an attempt to trap the root rot fungus in canals, water-storage basins, wells, and along drainage ditches.

A large-scale experiment was conducted in the Vista-Fallbrook area in an effort to trap the fungus in the waters of Soil Conservation storage ponds, wells, and other basins containing run-off water. All traps were placed in areas draining known diseased avocado groves. This experiment ran from January 31, 1958 until May 16, 1958, when the temperatures of these waters ranged from 55° F. to 72° F., and again from August

8, 1958 until September 11, 1958 with water temperatures during this latter period registering between 65° F. to 90° F. Twenty general sites were selected with 43 traps set out with a total of 629 fruit tested. Two, three, or four fruit were placed in each trap which was generally a perforated polyethylene bag, although a few wire baskets were employed to contain the fruit in the water. The fruit were changed weekly; the collected avocados being brought to the laboratory where they were left at room temperature from 24 to 48 hours to allow time for the development of rot spots. Cultures were then made from these areas.

No root rot fungus was isolated from any of these fruit from the traps in the storage ponds and reservoirs. Diseased trees were situated as close as 150 to 200 feet in two of these locations. Many of these fruit developed what appeared to be "typical" spots usually associated with fruit affected with **Phytophthora cinnamomi**. In the majority of cultures of these rot areas on the fruit a **Phytophthora** species was isolated. This appeared to be the same organism which had been isolated from fruit placed in canal traps but was nonpathogenic. Similar traps were placed in the Fallbrook area in 1956-57, with no recovery of **P. cinnamomi** resulting.

At seven of the above-mentioned locations plywood floats with two Mexicola avocado seedlings each, a variety susceptible to root rot, were staked out along the shore of these waters between April 4 and May 16, 1958. The roots were entirely immersed in the water. Root samples were placed in vials of water each week and brought to the laboratory for culturing. Many roots became rotted and some plants died from various adverse conditions but no root rot was isolated.

The work in canal water was done by placing three or four fruit in perforated polyethylene bags suspended in the water at intervals along the canal. Traps were set out in twelve canals and three reservoirs, from mid-November, 1957 to the first week in April, 1958, in the following five counties: San Bernardino, Riverside, Orange, Los Angeles, and San Diego. Water temperatures during these tests ranged from a low of 49° F. to a high of 81° F. The general range was between 50° and 70° F. Fruit was left in each trap for a 2-week period, then collected and brought to the laboratory for culturing. No **Phytophthora cinnamomi** was isolated from any of these fruit samples. A **Phytophthora** species was consistently present in these fruit but did not prove pathogenic to avocado seedlings in tests conducted in the greenhouse.

The second phase of testing involved the placing of fruit in mud along the edges of water-storage basins and drainage ditches in San Diego, Ventura, and Santa Barbara counties. This work was done during the months of February, March, April, and May, 1958 and later, in August and September of that year. Soil temperatures ranged between 50° and 68° F. in the San Diego County test areas in the earlier months, and from 64° to 81° F. during the latter period. The fruit were left usually for one week, then collected and cultured in the laboratory. Approximately 120 fruit were placed in six general locations. The root rot fungus was isolated from three of these locations, all in San Diego County. Two of these isolations were actually performed in the laboratory. Soil from a drainage ditch, bordering diseased trees, was collected and placed in pans of free water with fruit added. The other infection took place under field conditions. This was one fruit in wet soil covered with leaves and twigs approximately 40 feet from the mouth of a culvert under a highway, carrying run-off water from a diseased area. These infected fruit had the characteristic firm rot caused by the cinnamon fungus and the

fungus was isolated from the fruit in the laboratory.

Further studies were made to ascertain if reservoir waters contained the root rot fungus. Water from five of the water-storage basins in the Vista-Fallbrook area of San Diego County in which traps had been placed was brought to the Citrus Experiment Station to irrigate avocado seedlings in 6-inch pots. Temperature of these waters ranged from 68° to 72° F. when collected. Thirty Ganter plants (a susceptible variety) were transplanted from sand flats into one-half hour autoclaved greenhouse soil. Five plants in each series were irrigated daily with 200 ml. of one of these waters. The sixth group of five plants was irrigated with a like amount of domestic water. Irrigations were continued for two months but no root rot symptoms were observed.

In light of the above results, water was collected from five of the ponds previously-used in tests and brought to the laboratory to ascertain the effects on the root rot organism. The temperatures of these waters ranged from 66° to 73.5° F. A mixture of half pond water plus half soil extract was used as a medium. The medium was poured into petri plates and a disk of V-8 agar containing **Phytophthora cinnamomi** was placed in each. Two plates of each pond water with four disks of inoculum in each, plus a like number of check plates containing a mixture of tap water and soil extract, were involved. All plates were incubated at 76° F. and at intervals of 3, 5, and 7 days were observed for formation of sporangia (sac-like structures containing reproductive spores). Sporangia appeared in all plates after 3 days, but were most abundant with few exceptions on the seventh day. This experiment served to indicate there was no factor present in the pond waters to prevent fruit in traps from becoming infected if the waters were infested with the root rot organism.

These experiments are a continuing study and this report should not be regarded as conclusive evidence that the disease does not exist in the areas tested.

Why the cinnamon fungus was not isolated except in three instances, by the one method of testing, remains for the present a moot question. Even if spores were disseminated they may have been unable to live for a long enough period to travel from avocado tree roots to the avocado fruit or plants in the traps in the drainage waters. During all periods of these tests conditions were favorable for the vegetative growth of this fungus; however, pieces of roots containing the thread-like fungus or sloughed off pieces of the fungus itself were not carried to the trapping points, except in the three cases mentioned. Future tests may shed some light on these factors.

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