

RESEARCH ON AVOCADO ROOT ROT

G. A. Zentmyer, W. A. Thorn, S. M. Mircetich, and E. Johnson

Several aspects of the research program on avocado root rot are providing significant information in relation to control of this disease caused by the soil fungus *Phytophthora cinnamomi*. These will be summarized in this progress report.

Chemical Control

The experimental plots on the use of the chemical Dexon in the irrigation water, or applied to the soil then watered in, continue to show good results in general. As an example, the following table presents growth figures and disease condition of Hass trees in our largest plot, involving 21 trees, in Fallbrook.

TABLE 1. Effect of treatment with Dexon, in the irrigation water, on growth of trees, production, and development of root rot in Hass avocado trees in plot in Fallbrook. Trees treated once a month during irrigation season.

Treatment	No. of Trees	Ave. increase in trunk Circumference in 3 years	Ave. production per tree 1966 (pounds)	Ave. Stage 1962	Root Rot 1966*
No treatment	7	6.0	133	0.1	3.1
50 ppm Dexon	7	8.1	187	0.1	2.4
100 ppm Dexon	7	10.6	249	0.5	1.1

* Stage of root rot based on a scale where 0 = healthy, 5 = dead.

An earlier plot, with four trees treated with Dexon compared with four untreated trees, continues to show excellent results after 6 1/2 years of treatment. Figure 1 shows one of the treated trees compared with the only original untreated tree still remaining alive. When this plot was started in 1959, these two trees were very similar in appearance.

Other plots have not shown such striking results but treated trees have continued to grow faster than untreated trees and to show less severe disease symptoms. The granular form of Dexon (5% formulation) has been included in six plots established within the past year in Santa Barbara, Ventura, Orange, and San Diego counties. Early indications are that this formulation is also effective in retarding root rot. Additional data on yield and on comparative growth of treated and untreated trees will be obtained during the coming season. The granular Dexon can be spread evenly on the soil under the trees to be treated, then watered with one gallon of water per square foot; it does not require special equipment to inject it into the irrigation line. A large granular Dexon plot was established in 1966 in Fallbrook to provide more information on dosages and timing of applications. This plot involves 42 trees in early stages of root rot and should

help to provide definite answers on the effectiveness of granular Dexon and the economics of its use.

The granular formulation has not yet been approved for use on avocado trees, pending more information on its performance in comparison with the wettable powder formulation that we have been using in all earlier plots and that is approved for use.

Dexon is very unstable in the presence of sunlight, and once in solution, or once the granules are wet, must be immediately watered into the soil or it will lose its effectiveness.



Figure 1. Hass avocado tree (top) treated with Dexon for 6 years, compared with untreated tree (bottom). Both trees were diseased when treatment was started, and were in similar stage of disease.



Resistance

Research is continuing on the project of finding or developing a resistant rootstock. The cooperative work now under way in Mexico, directed by Dr. Jorge Galindo at the Graduate School, National School of Agriculture, is providing an opportunity to test many additional Mexican types of avocado and other species of *Persea* not previously

collected. This project is summarized in an article appearing elsewhere in this Yearbook.

In our nutrient solution tank tests at Riverside we are continuing the search for higher resistance in various seed trees from California, with emphasis on various sources of the Duke variety. During the past year approximately 2500 seedlings have been tested. Seedlings showing resistance in these tests are transplanted into 1-gallon cans containing soil. Those that still make good growth after several months in soil are then transplanted to beds of soil infested with the avocado root rot fungus for further testing.

Further field tests in California of compatible varieties of avocado continue to show that the Duke variety has some resistance, compared to the standard types of rootstocks such as Topa Topa. Selected seedlings and rooted cuttings of the Duke variety and cuttings of another Mexican type along with some Topa-Topa seedlings have recently been top-worked in several plots; additional data on the performance of these seedlings and cuttings when grafted to a commercial scion will be available in another year or two.

Rootstock resistance still seems to offer the best possibility for controlling a disease of this type, so the major emphasis in our research continues to be on this phase. In addition to search for a rootstock that could be used directly, this project has involved and continues to involve search for a possible interstock that could be used to break the incompatibility barrier between the commercial avocado and the highly resistant small-fruited species of *Persea* (*P. caerulea*, *P. skutchii*, *P. borborito*, etc.).

Chemotaxis

Another aspect of the root rot research that is showing interesting results is that of the chemotaxis of zoospores toward avocado roots. This is the phenomenon whereby the swimming spores of the avocado root rot fungus are attracted to some chemical exuding from the small avocado roots. We now have evidence that some of the amino acids, which occur in exudates from roots, may be involved in this chemotaxis.

Chromatographic analysis of avocado root exudates has shown that a number of common amino acids are exuded from the roots. Tests of the attraction of individual amino acids for zoospores of *Phytophthora cinnamomi* show that the swimming spores are strongly attracted to glutamic acid and aspartic acid, and not to other amino acids such as glutamine, asparagine, glycine, methionine and histidine. Figure 2 shows attraction of zoospores to glutamic acid contained in agar in a fine capillary tube.

Glutamic and aspartic acids occur in root exudates of many plants including the avocado, so they could play an important role in attraction and penetration of the root. One puzzling aspect of this situation is that zoospores of *P. cinnamomi* are not attracted to the roots of some other plants, such as pea and tomato, whose roots also exude glutamic and aspartic acids. The relative quantities of these and other amino acids may be of significance here. Also there is a possibility that there is some other more specific or unique chemical that is responsible for the attraction.

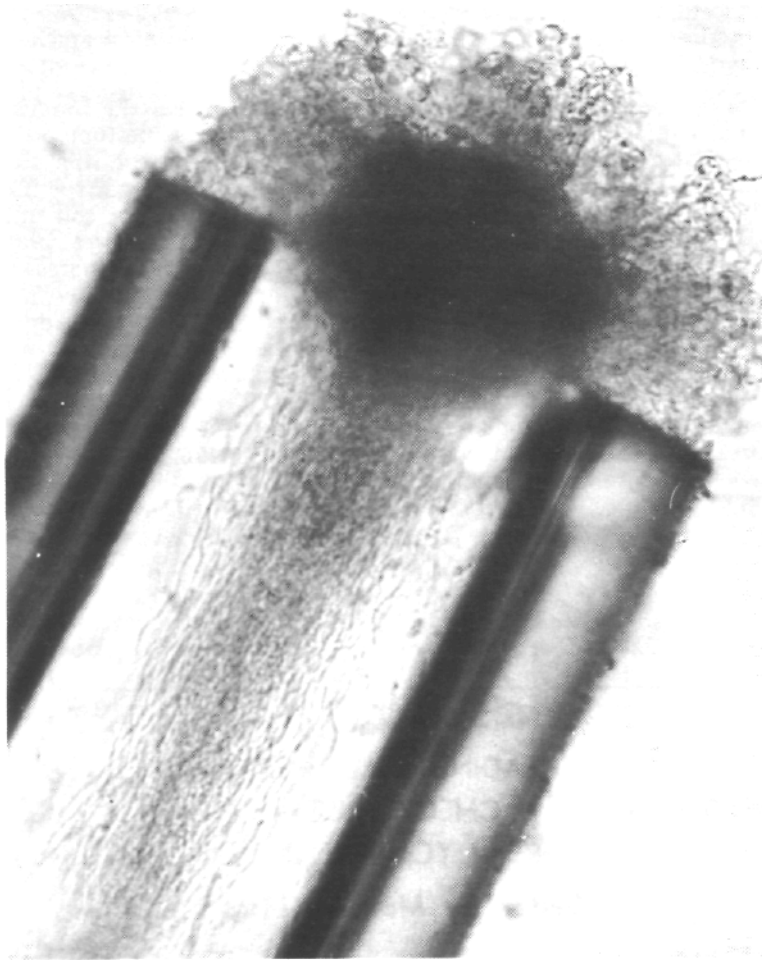


Figure 2. Zoospores of avocado root rot fungus attracted to an amino acid, glutamic acid, contained in agar in a small capillary tube. Spores have been attracted to the end of the tube where the amino acid is slowly released into the water. Photomicrograph, enlarged 500 times.

Another fascinating phase of these studies is that zoospores of some other species of *Phytophthora*, such as the species attacking cacao and the one attacking citrus, are attracted to some of the same amino acids, but also to different amino acids than are the spores of the avocado root rot fungus. Research is continuing on this important and fascinating phase of the root rot problem. If we can find out the chemical that attract the spores, this information can be very useful in combating the fungus,

Saprophytism

Another problem in relation to soil fungi such as the avocado root rot fungus, is how they live over in soil under adverse conditions or in the absence of a plant that they can invade. We now have much more information on this phase of the life cycle of *P. cinnamomi*.

Studies begun about 12 years ago have shown that the fungus is a quite efficient saprophyte—it can invade and live for some time on dead organic matter and can grow to some extent through the soil. Recent studies in our laboratory have shown that the avocado root rot fungus forms resistant spores (chlamydospores and oospores) in soil and in avocado roots. These spores, particularly the chlamydospores, play an important role in survival of the fungus in the soil. These spores, however, cannot survive dry conditions, so are important primarily in soils with moisture content over 3 to 4 per cent for a sandy loam soil. Additional studies in this aspect of the project include factors involved in production and germination of chlamydospores, spread of the fungus (passive and active), production of sporangia in different soil types, effect of root exudates of host plants and non-host plants on chlamydospore germination, and survival of various stages of the fungus. This information will be presented in another article in the *Yearbook* next year.

Appreciation is expressed to Farm Advisors R. M. Burns, G. Goodall, C. D. Gustafson, B. W. Lee, and John Pehrson, and to recently-retired Farm Advisor C. C. Delphey, and to many growers for cooperation and assistance in the field phases of these studies.