California Avocado Society 1947 Yearbook 32: 40-42

The Cinnamon Fungus and Avocado Decline

George A. Zentmyer and L. J. Klorz [1,2]

Paper presented at 18th Annual Avocado Institute La Habra, California, October 31, 1947

For the benefit of those who have become avocado growers recently, perhaps we should first define the term "avocado decline." It is a disease of avocado trees occurring primarily on soils that tend to stay wet for varying periods, and with which a soil-inhabiting fungus known as **Phytophthora cinnamomi** (the cinnamon fungus) is practically always associated. The term "decline" is an ambiguous one; "avocado root rot" would seem to be a more definite and more descriptive term.

It has been said numerous times that most of the avocado decline occurs on soils that should never have been planted to avocado trees in the first place, that the trouble merely occurs where it would be expected on the basis of topography. That seems to be the case in many but not necessarily all instances. Even so, this doesn't relieve the fact that the problem is there and is severe on several thousand acres. True, there probably would not be so much decline if better soils had been planted. The citrus industry would not have the quick decline problem either if so much sour root stock had not been used. Both problems seem very worth investigating; if there is any possibility of bettering the present situation or improving future prospects, it should be determined. We have a number of different types of experiments underway with such possibilities in view.

First, as to our present ideas on decline—from field and laboratory work and field observations, it is apparent that in typical avocado decline, or root rot, two factors are involved. One is the root-rotting fungus, the cinnamon fungus; the other is high water content of the soil, or conversely, low oxygen content. This latter could result either from high rainfall or over irrigation. The cinnamon fungus is favored by moist soil. It has a bad record of attacking roots of a number of plants, including cinnamon trees, pineapple, chestnut, heather, pine nursery stock, rhododendron, in addition to avocado.

Research in the pathology division has, of course, been aimed primarily at determining whether or not any definite pathogen or infectious agent is connected with this disease. Our laboratory and field experiments are thus planned to use chemicals or other materials that in this case would affect a soil fungus. If control of the disease is obtained by such an approach, this is a good indication that the soil fungus is a primary factor.

We are conducting two main types of experiments; one is on replanting decline spots, the other is on treating sick trees to see if they can be made to recover.

First, to consider the replanting phase, a year or so ago we found that sterilization in the greenhouse of soil taken from around declining trees in the field resulted in markedly

better growth of seedlings replanted in this soil than that obtained in nontreated soil. Initial work was with steam sterilization and chloropicrin or tear gas. More recently we have tried some of the readily available soil fumigants, such as ethylene dibromide (EDB) and Dowfume N[3] (a simple organic compound containing chlorine, carbon and hydrogen), which have been primarily known as soil insecticides rather than fungicides. EDB and Dowfume N gave good results in greenhouse and laboratory tests, although high dosages were required. Various fungicidal materials are also being tested.

This type of work led to some extensive field trials on replanting this season. On 13 different properties treatments have been applied in locations where 230 avocado trees have been subsequently replanted. Also included in the experiment are 117 untreated control spots where trees have been replanted. Treatments have been applied by means of weed guns, tractor applicators, and by use of emulsiflable forms of the fumigants applied in basins.

Much of the fieldwork has been done with EDB and Dowfume N, some with chloropicrin and various other miscellaneous treatments. Unfortunately, most of these plots have not been established long enough to determine the effect of the treatments. However, in the few cases where the replants have been in 6 months or longer, the fumigation has definitely aided growth to date. As an example, of 30 trees replanted last March in treated area*, 28 are now making good growth. Of 43 trees planted last March in untreated adjacent areas, only 13 are making normal growth. In all of these cases trees were replanted in spots where avocado trees had declined previously. This is just a small beginning, however; this is a report on 30 out of 230 treated trees and it is only 6 months after planting. It is also questionable how long this initial benefit may last; by next spring all of the trees may be dead. However, the results to date are encouraging and warrant much further research.

As to the other phase of our work, that of various experiments on sick trees, about 250 trees are involved in nine different groves. Materials applied have been of two types:

(1) Fungicides or materials that it was hoped would be directly toxic to soil fungi such as the cinnamon fungus.

(2) Materials which in themselves would not be harmful to the cinnamon fungus but which would stimulate growth of harmless types of fungi and bacteria, which in turn would counteract the cinnamon fungus. This is a well-known principle in work on root rot diseases; many fungi and bacteria will attack other fungi and bacteria in the soil or will form substances (antibiotics) harmful to them. It was with this idea in mind that we have used such materials as manure, alfalfa meal, soil sulfur, cottonseed meal, and soybean meal. In one greenhouse experiment and in a field experiment this type of treatment has shown some promise, warranting much further work along these lines and we are continuing this type of investigation. This is an exceedingly promising field. There is a complex population of fungi and bacteria present in all soils. The presence of a harmful fungus, such as the cinnamon fungus in large amounts in soil, presents an abnormal condition. There maybe a fairly delicate balance between conditions favoring the cinnamon fungus and its attack on avocado roots, and those which counteract it.

The fungicidal or toxic chemicals which have been applied to the root zone of trees in the field include ethylene dibromide (light applications have shown some initial benefit),

Dowfume N, copper sulfate, and various organic fungicides. We have also included some work on the effect of variable watering on decline. At the Bradbury ranch in Carpinteria 3 rows of trees in various stages of decline receive different types of irrigation. In one row every other tree receives half as much water as in the "normal" irrigation period by watering half as long; in the next row every other tree receives two times as much watering by watering twice as often as the "normal" period; and in the third row every other tree receives twice as much water by watering twice as long each time. In this group the worst looking trees, those that are declining the fastest, are those receiving twice as much water as "normal" by watering twice as long at one time.

Other types of work in relation to decline include investigation of barrier zones with the possibility of halting the spread of the cinnamon fungus. If it is actually spreading and not already present in low amount. Two barrier zones have been established on one ranch. On a hill above the upper margin of the decline area a zone has been injected at 4-month intervals. Trees have been examined for presence or absence of the cinnamon fungus prior to and some months after treating.

We are also studying susceptibility of various avocado varieties to the cinnamon fungus and another similar fungus which causes cankers (discolored, bleeding areas) on trunks of avocado. This has been investigated both from the aspect of resistance to trunk inoculations and resistance of roots to waterlogging and to the cinnamon fungus. To date, the Guatemalan varieties tested (Kashlan, Nabal, Itzamna) are more susceptible to injury by species of **Phytophthora** and waterlogging than are the Mexican varieties (Mexicola, Ganter, Puebla, Harmon, Topa-Topa).

Another phase of the work is that of investigating the possibility that the cinnamon fungus can be spread by nursery stock. There is no doubt of this— it has been found on poor-looking nursery trees. Such trees should of course be avoided if possible; however, it is doubtful if this is the main method of spreading the fungus. Evidence indicates that it may already be fairly widely distributed in soil; however, one should not bring in a high population of the pathogen in the nursery ball.

To summarize briefly the decline or root rot picture at present on the basis of the above information, it seems fairly clear that both wet soil and the root-rotting fungus are involved. Any measures to remedy either situation should help to remedy decline. To improve the wet soil conditions, this may mean drainage, if possible, preventing accumulations of winter rainfall, and an intelligent and careful irrigation program with particular attention paid to spots that tend to stay wet. On some of the worst soils it may be impossible to do much in this regard. To reduce the cinnamon fungus population we have no definite recommendations at present, however, several of our experimental treatments as mentioned previously show promise and may be of benefit here. There are many questions to be answered in this regard. Will a given treatment provide benefit to last over a considerable period; will it be too costly; is the material easy to apply, easy to obtain? If the treatment does reduce the population of cinnamon fungus will the same trouble reappear when the soil becomes very wet again? The answer to the latter is probably "yes," unless conditions which initially led to waterlogging of the soil are remedied.

As to the replanting picture, it seems clear here that build-up of the cinnamon fungus in soil around declining trees is the main reason why these areas cannot successfully be replanted. Significant in this regard is an experiment comparing growth of seedlings in soil from around declining avocado trees (cinnamon fungus present), with growth in soil from around healthy avocado trees or from around trees in which the cinnamon fungus was not found. Twenty-six out of 30 seedlings in "decline" soil either died or were not growing 2 months after planting; 15 seedlings in "non-decline" soil have all made good growth. Initial fumigation work indicates that it is possible to reduce the population of the cinnamon fungus or eliminate it so as to permit good growth of trees under greenhouse conditions, and in a few cases under field conditions, at least for a short time. Whether these treatments will last over a considerable period or can be successfully extended to large-scale field treatments remains to be determined.

1. Cooperative experimental plots with F. Arnold White, Assistant Farm Advisor, Santa Barbara County, have been established on all phases of the decline work at the C.W. Bradbury ranch in Carpinteria. This excellent cooperative arrangement has been of great value in furthering our knowledge of the avocado decline problem.
2. Assistance of Assistant Farm Advisors J. J. Coony, Richard Puffer, Kenneth Smoyer, and F. Arnold White of the Agricultural Extension Service in San Diego, Orange, Los Angeles, and Santa Barbara Counties respectively, in various phases of the field work is gratefully acknowledged.
3. EDB and Dowfume N kindly supplied by the Dow Chemical Co. Many of the field trials with these materials have been applied in cooperation with Dr. L. J. Meuli, John R. Fisher, and Harold Lembright, of the Dow Chemical Co., Seal Beach and Santa Barbara, California.