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PROGRESS ON CHEMICAL CONTROL OF PHYTOPHTHORA ROOT ROT

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Research on control of Phytophthora root rot of avocado at the University of California, Riverside, has covered many aspects. One of these has been the search for a fungicide with low toxicity to the avocado tree that could be applied in the irrigation water or by some similar, simple means of application. With this objective in mind a greenhouse screening program was developed six years ago, in an attempt to find such a fungicide by testing many chemicals on avocado seedlings. A number of effective chemical fumigants are known that will kill soil fungi when applied after plants have been removed from the soil, or as pre-plant treatments, but there has been relatively little information on chemicals that could be applied to living plants.

This paper describes greenhouse results and initial field results with one fungicide that has been relatively effective in controlling **Phytophthora cinnamomi**, and not damaging avocado seedlings or trees. This chemical is known commercially as Dexon; chemically it is p-dimethyl-amino-benzenediazo sodium sulfate. It has been found particularly effective against fungi in the genera Phytophthora and **Pythium**. Appreciation is expressed to the Chemagro Corporation, Kansas City, Missouri, for supplying liberal amounts of Dexon for our experimental tests.

Laboratory Tests.—Dexon has not been a highly effective fungicide against Phytophthora when tested against this fungus alone in laboratory studies in agar and in vials containing soil. Dexon does not kill the fungus even at high concentrations, but it does prevent or retard it from growing. Even 3200 ppm of Dexon did not kill the avocado root rot fungus in the standard laboratory tests in soil.

Greenhouse Tests.—For most greenhouse tests field soil naturally infested with **Phytophthora cinnamomi** was used, although in some cases the soil was artificially infested by adding laboratory cultures of the fungus. Topa Topa seedlings were grown in greenhouse soil in 4-inch pots, then were transplanted to 6-inch clay pots or 1-gallon cans containing the infested soil. As soon as the seedlings were transplanted they were watered with either Dexon or with water alone; three dosages of Dexon were used in most experiments; 10, 20, and 40 ppm of the chemical on a soil weight basis. Treatments were replicated five times, and were applied once a week for 12 weeks.

Periodic evaluation of the condition of the tops of the plants were made throughout the 12-week experimental period. At the end of this period the plants were harvested, roots and tops were weighed, percentages of healthy roots were estimated, roots were cultured to detect the presence of the root-rot fungus, and the soil was tested for presence of the fungus, using the fruit-test method. This method involved placing a firm, mature green avocado fruit in a waxed container with the soil to be tested, flooding the surface of the soil with water, incubating for from 4 to 6 days, and observing the fruit for development of typical Phytophthora spots (see Univ. of Calif. Circular 511).

In several greenhouse experiments control of Phytophthora root rot was striking with 10 and 20 ppm Dexon; the 40 ppm treatment was somewhat toxic to the avocado seedlings. Another experimental soil fungicide, Shell SD-4741 (0,0,0-trimethyl phosphorothioate) gave good control of the disease in several greenhouse tests, but dosages of 50 and 100 ppm were required; this chemical is not available on a commercial scale, and field trials with it have not been as successful as with Dexon.

Results of one of the greenhouse tests with Dexon are summarized in Table 1. These data show that avocado seedlings grew exceedingly well in soil heavily infested with root rot fungus which received weekly drenches of Dexon. Even though the plants in several dosages are healthy, the fungus was recovered from the treated soil, showing that the chemical does not kill **Phytophthora cinnamomi** in the soil, but retards disease development. In a few cases, prolonged treatments with 40 ppm of Dexon greatly reduced the fungus population.

Table 1. Control of Phytophthora root rot of avocado seedlings in the greenhouse by drenching the soil with Dexon.

Treatment	Dosage ppm	Mean Wt. of Roots (grams)	Mean Wt. of Tops (grams)	Mean Per Cent Healthy Roots	Recovery of Phytophthora cinnamomi
None	—	3.5	12.8	0	+
Dexon	10	23.4	20.4	75	+
Dexon	20	26.8	30.2	94	+
Dexon	40*	12.4	25.3	58	+

* This dosage injured the avocado seedlings.
Treatments applied once a week for 12 weeks.

Another series of tests was designed to determine how frequently Dexon would have to be applied to avocado seedlings, under greenhouse conditions, to obtain good disease control. Dosages of 10 and 20 ppm were used; different series of plants were treated once a week, once every two weeks, and once every four weeks. Figure 1 shows that, when a dosage of 10-ppm Dexon was used, treatment had to be applied once a week to obtain adequate control. When the 20-ppm dosage was used, good control was obtained by applying the fungicide once a week or once every two weeks, but once every four weeks did not give control.

Field Tests.—Following the good results with Dexon in greenhouse trials, the material was applied to large avocado trees (Hass and Fuerte varieties) in San Diego County. Two methods were used: 1) concentrated solutions were applied evenly to the soil

surface using sprinkling cans, then the chemical was watered in immediately by using low sprinklers; 2) concentrated solutions were placed in an applicator (similar to a Prizer fertilizer applicator) attached to the irrigation system, which metered the chemical into the irrigation water so that Dexon was applied to the trees by means of sprinklers set under each tree. Trees were treated at monthly intervals, using several dosages of Dexon.

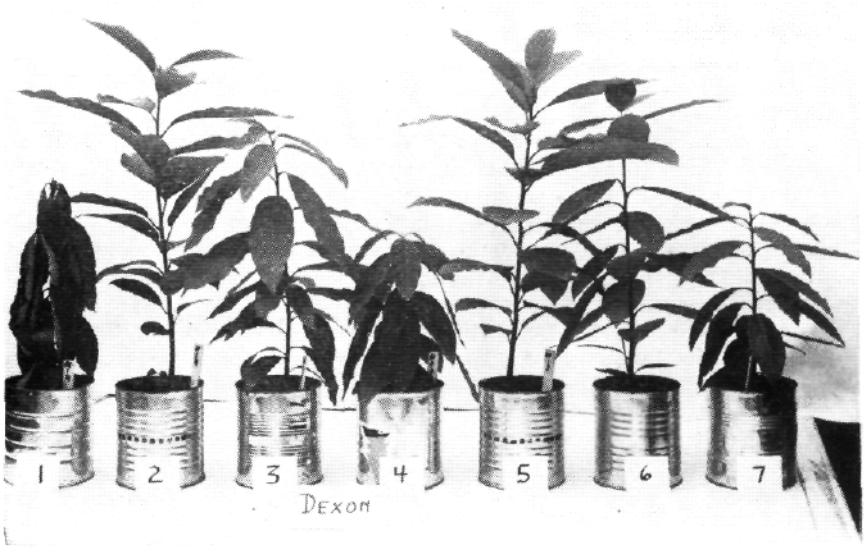

Figure 1. Treatment with Dexon over a 12-week period in naturally-infested soil (October, 1961).

1) Check plant
2) Dexon 10 ppm once a week
3) Dexon 10 ppm every 2 weeks
4) Dexon 10 ppm every 4 weeks
5) Dexon 20 ppm every week
6) Dexon 20 ppm every 2 weeks
7) Dexon 20 ppm every 4 weeks

Four plots have been established over the past four years. Three of these have shown benefit from applications of Dexon, in regarding disease symptoms and maintaining treated trees in better condition than untreated ones. In two of these the results have been striking.

The oldest plot involved 12 trees (12-14 years old) that were treated monthly; four of these received Dexon, four received SD-4741, and four received only water. After four years, all four of the Dexon-treated trees are still alive, three of the four trees treated with SD-4741 developed severe root rot and had to be removed, and three of the four untreated trees died. Three of the Dexon-treated trees are still in good condition, even though the root rot fungus has been present in the root zone for over four years.

In a larger, more recently established plot, involving 24 trees, Dexon applications of 100 ppm are appreciably retarding the progress of root rot and are permitting good tree growth in most of the replicates. Trees treated with a dosage of 50 ppm are slightly, but not significantly, better than the untreated trees. In this plot we are applying 94 grams of Dexon (70 per cent wettable powder) to each tree and using one gallon of water per

square foot to dilute the chemical. The material is applied in a split application, with 47 grams of chemical followed by one-half of the total amount of water, after which the second 47 grams of chemical is followed by the remainder of the water.

Fruit of both the Fuerte and Hass varieties from trees treated with Dexon have been analyzed for residues in our chemical laboratory by Mr. J. Hará, and by the Chemagro Corporation chemists. No Dexon residues have been found in any of the fruit from treated trees. The chemical has recently been registered for use on avocados.

The chemical Dexon shows promise of retarding root rot development and maintaining trees in healthy condition in the initial field trials; thus it may help to serve as a stop-gap until the ideal resistant rootstock is available.

Even though the results look very promising to date, it should be emphasized that field trials with this new fungicide are still in the experimental and exploratory stage, so that the chemical is not yet recommended for general use. Different types of application are being investigated, as well as different dosages and intervals of application. A new granular formulation of Dexon will soon be available; this may simplify application problems for treating a small number of trees.