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CHEMICAL SOIL TREATMENTS FOR THE CONTROL OF ROOT ROT OF AVOCADO

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Several chemicals have shown promise for the eradication from the soil of the avocado root rot fungus, **Phytophthora cinnamomi**. The purpose of such a treatment is to eliminate the fungus as completely as possible, and to prevent the spread of the causal agent to adjacent healthy trees and uninfested areas. At this time it does not seem possible to save the treated trees since all of the chemicals used are also highly injurious to avocados at rates usually sufficient to be effective against the fungus.

Most information has been obtained on the fungicide, Vapam. Recently, more work has been done with other materials including DD, Telone, Chloropicrin, and Methyl Bromide. The following is a summary of our research up to this date on the general qualities of these materials for root rot control and how they may be applied. Experimental plots have been located in most of the large avocado growing areas including San Diego, Los Angeles, Ventura, and Santa Barbara counties.

VAPAM

This material is highly fungicidal against **P. cinnamomi**. In early laboratory and greenhouse studies Vapam was the most effective chemical of 47 fungicides evaluated, being particularly active when applied to soil as a water drench. Field studies have substantiated these early findings. To date at least 98 diseased tree sites or plots have been treated with various dosages of the chemical. Most of the major avocado growing areas have been involved including several distinct soil types. In each case the material was applied in or followed by high amounts of water. The results are presented as follows:

Dosage Gal/Acre	No. of infested tree sites treated	Tree sites P. cinnamomi not recovered after treatment	
		Number	Per Cent
82-165	55	50	91
55	6	4	67
40	19	8	42
27.5	18	4	22

This table shows that dosages of 82-165 gals, of Vapam per acre are most effective

with lower rates less likely to eliminate the fungus from the soil. A dosage of 110 gallons per acre has been adopted as a standard recommendation. This amounts to one quart of Vapam 4-S per 100 square feet. The chemical is carried into the soil in 4 gallons of water per square foot.

Three application methods have given apparently equal success. The Vapam has been (1) added to water in basins, (2) fed into irrigation systems, and (3) sprinkled onto the soil surface immediately followed by water.

In the third method, a proportioner on a hose has been used in most cases to distribute the Vapam over the soil. The water has then been applied through sprinklers arranged throughout the treated area in such a way as to obtain even distribution. With this method a split application appears to be more effective; one half of the Vapam followed by one half of the water; and this process then repeated.

In addition to the above treatments of individual trees, in at least two cases, larger areas have been treated (1/6 and 1 1/2 acre). In one, the fungus has not been recovered after treatment. In the second, only one of four tree sites sampled still is infested but to a lesser extent than before treatment. Such a high reduction of the fungus should help to check the spread to adjacent disease free areas.

Although the results reported above clearly indicate that low dosages of Vapam did not eliminate Phytophthora from a satisfactory number of plots, a significant reduction in the amount of the fungus present after treatment was usually apparent. Furthermore lower dosages were not as injurious to the trees as the higher rates. However, the extent of injury was not always clear as the trees were often showing disease symptoms when treated.

Studies were recently initiated to determine the value of very low dosages of Vapam applied at frequent intervals for controlling root rot. The objective is to keep the fungus population at extremely low level or to keep healthy trees from becoming infected.

DD AND TELONE

These chemicals contain the same active fungicidal ingredient which in early greenhouse studies and limited field plot work appeared very promising. The chemical is a liquid which vaporizes in the soil and diffuses there as a gas. Injections are made into the soil at a depth of 8 to 12 inches. Work during 1957-58 snowed that about 13 cc. of the liquid applied per square foot (150 gallons per acre) is highly effective. This amount of chemical remains in the soil for several months killing more of the fungus as time passes. Although Telone contains twice as much of the active fungicide as DD, it appears that equal amounts of either of these two materials must be used to assure satisfactory results.

The soil should be well prepared before treatment to allow for penetration of the applicator probe and good diffusion of the gases. Immediately after application the soil surface should be raked or dragged and firmed to seal the chemical in.

The following table summarizes the recent field work with these two materials.

Material	Dosage (Gal/A)	No. of infested plots treated	No. plots P. cinnamomi not recovered after treatment
DD	150	4	4
	230	1	1
	300	5	5
Telone	75	2	0
	150	6	6
	300	4	4

CHLOROPICRIN

Chloropicrin was promising in early greenhouse and field tests. This chemical is injected into well prepared soil with a suitable applicator. Based on results from treating 10 plots during 1957-1958 the following conclusions may be drawn.

Injections of 6 cc. per square foot (960 Ibs./acre) at a depth of 12 to 18 inches have been most satisfactory. One half this rate or injections 6 inches deep have not been effective. Raking of the soil and a heavy sprinkling of water must immediately follow application. The use of a gas mask when working with this chemical may be necessary and under some conditions is essential.

Because of both cost and irritation of chloropicrin to the operator, DD and Telone seem preferable as materials to inject into the soil at this time.

METHYL BROMIDE

This chemical is available as a gas under pressure which is injected according to certain recommended methods under a tarpaulin covering the infested area. Previous investigations have shown that methyl bromide is effective only on light soil. This has been substantiated by recent tests on two distinctly different soil types. In a sandy soil underlain with clay in the Fallbrook area of San Diego County, one pound of the chemical per 100 sq. ft. was sufficient to kill the fungus to a depth of 36 inches. However, four times this amount failed to penetrate below 24 inches in a heavy clay soil in Ventura County.

Studies have shown that the above chemicals when properly applied usually do an excellent job of reducing the population of **P. cinnamomi** in the soil. In many cases it has been impossible to isolate the fungus after treatment. Experience indicates, however, that the fungus has often spread to adjacent trees or areas before the disease is detected and treatment carried out. Thus, it is extremely important to determine by soil sampling which trees are diseased before treatment is begun. The area treated should probably include at least one row of trees beyond the known diseased area to compensate for the difficulty of detecting small amounts of the fungus in the soil.

Chemical control is not likely to prove practical on steep hill side, terraced plantings, because of the difficulties of application.

Limited work on the possibility of replanting into treated soil has not revealed conclusive answers, but further studies are under way. At this time it would seem unwise to replant with susceptible rootstock.

New materials are constantly being tested as potential fungicides for the eradication of **P. cinnamomi** from the soil. One material under investigation in the field is Mylone, which is believed to break down in the soil to form the same active fungicidal agent as Vapam. Other materials are not yet at the field stage of development.

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