

# Avocado Root Rot Studies

preliminary tests indicate soil fumigation may permit replanting

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**Soil fumigation** trials to determine if areas where avocado trees have been removed because of root rot—decline—can be replanted successfully have shown considerable promise.

A root-rotting fungus, *Phytophthora cinnamoni*—the cinnamon fungus—is involved in this disease. The parasitism of the fungus is favored by moist soil conditions, such as often are maintained for considerable periods in heavy soils or in soils with an impervious layer near the surface.

A complicating factor in the problem is that the avocado is very sensitive to lack of oxygen in the soil, and root damage will result also from a very low concentration of oxygen, as under totally waterlogged conditions.

It has been found to be practically impossible to make young avocado trees grow where diseased trees have been removed from an area of root rot. This is a common experience of growers even though the soil may no longer be in a waterlogged condition.

When soil from around diseased trees was taken into the greenhouse and placed under well-drained and aerated conditions in clay pots the same difficulty in replanting to avocado seedlings developed. The cinnamon fungus was readily isolated from roots of dead and dying seedlings planted in such soil.

Experiments then were set up with the aim of determining what effect killing the cinnamon fungus in the soil would have on replanting. Complete sterilization of infested soil in the greenhouse, using steam, resulted in excellent growth of replants. Several chemical fumigants, including chloropicrin and the dichloropropane-dichloropropene complex—Dowfume N, Shell D-D—were found to give similar success in replanting seedlings in infested soil. Ethylene dibromide was effective only at extremely high dosages.

During the past two seasons soil fumigation plots, involving replanting over 600 avocado trees in areas where trees were removed because of root rot, have been established on 22 properties in San Diego, Orange, Los Angeles, and Santa Barbara counties. Soil has been treated by means of weed gun applicators and by tractor or jeep-drawn mechanical applicators. Areas varying in size from 10' × 10' squares around the new tree site to entire tree rows or blocks of several rows 150' to 200' long have been treated. Where possible the materials were given a severe test by replanting in the same locations from which diseased trees had been removed.

Results are available to date from only a portion of the plots but some of the treatments are showing marked benefit. For example, of 26 trees replanted in infested soil first fumigated with Dowfume N, 22 trees or 85% were making good growth in the fall of 1948—14 months to 18 months after replanting. Of 64 trees replanted in comparable untreated soil, 17 of them or 27% were making good growth while 37 trees or 58% were dead or nearly dead.

The oldest plots on this problem were established in 1947—only two years ago this spring. The treatments are holding up well to date; how long they will continue to do so is a matter of conjecture at present. At least, fumigation will enable young trees to become successfully reestablished in root rot areas.

The possibility of reinfestation must always be kept in mind. The very poor soils—exceptionally heavy or very shallow soils—which consistently remain wet in spite of careful management should not be replanted to avocados. The possibility that the cinnamon fungus again

may become a limiting factor to growth of avocado trees in such areas seems too great to warrant the expense of fumigating and replanting. Many areas where trees are being removed because of root rot are in soils which, with proper management, probably can be kept from staying wet and from building up concentrations of the cinnamon fungus.

## Suggestions

Suggestions for soil fumigation before replanting in avocado root rot areas:

1. The material that has proved most effective and easily handled in the field trials is the product known as Dowfume N or Shell D-D.

2. Dosages of from 60 to 100 gallons of these materials an acre are suggested.

3. For small plots a soil injection gun, also known commercially as a weed gun and obtainable at many feed and seed stores, is satisfactory. For larger areas mechanical applicators are available and are effective if the slope of the land is not excessive.

4. The procedure for fumigating small plots with the weed gun is as follows: The soil should have a medium moisture content, not dry and not wet to field capacity. The area to be treated around the new tree location should be marked off

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Effect of soil fumigation on avocado trees replanted in root-rot areas. Left, tree in soil fumigated at dosage of 60 gallons to an acre; right tree in soil which has not been treated.



## AVOCADO

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in one-foot squares, or some sort of measuring device should be used so that the area can be injected uniformly at 12-inch intervals in a diamond pattern.

For a dosage of 60 gallons an acre, the weed gun should deliver slightly less than one fifth of a fluid ounce—5.2 milliliters—a stroke; for 100 gallons an acre the gun should deliver a bit less than one third fluid ounce a stroke—8.7 milliliters—at 12-inch intervals. One fluid ounce equals 29.6 milliliters, or two tablespoons or six teaspoons. The amount delivered by the gun is regulated by adjusting the position of the set screw on the plunger.

The material should be injected six to eight inches deep and the hole closed by stepping on it immediately after the injection. To insure adequate kill of the fungus in the central area of the new planting site, four extra, double shots six inches from the center and 1½ to two feet deep are suggested. Most of the work to date has been done in the typical avocado hillside soils, which are not over two

to three feet deep. On deeper soils the injection pattern probably would have to be supplemented in the central area with several shots at a four-foot depth, as in fumigation for the oakroot fungus.

There is a little indication that where feasible, lightly sprinkling the plots with water to wet the top one half to one inch of soil may be of benefit in retaining the chemical. This is not as essential with Dowfume N or Shell D-D as it is with the more volatile chloropicrin or carbon disulfide.

Following treatment the areas should not be replanted for at least four weeks, to permit all of the chemical to escape from the soil. Otherwise, considerable injury to the young tree will result. The planting hole should be dug 24 to 48 hours prior to planting the new tree to permit additional aeration of soil that will immediately contact the balled tree.

### Caution Urged

Ample precautions should be taken in handling these materials, in accordance with instructions on the labels on the con-

tainers in which the products are marketed, and in pamphlets issued by the companies marketing the chemicals. These fumigants are poisonous to humans as well as to fungi and higher plants. If any chemical is spilled on the clothing or shoes, the articles should be removed immediately and not worn until the odor of the chemical cannot be detected. Otherwise a serious blister will result from confinement of the vapor. If the chemical comes in contact with the skin, immediate washing with soap and water or with large quantities of water is recommended. All work with the materials should be done in the open air; prolonged inhalation of the vapors may prove to be harmful to the operator.

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*Treatment of test plot soils by tractor or jeep-drawn applicators was accomplished with the cooperation of Dr. L. J. Meuli, Seal Beach, California.*

## HARVESTER

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ing any piling up of the soil in front of the knife standard.

At maturity, the onion tops break over at a point about 1½" or 2" above the bulbs. It is then necessary to mechanically lift the tops to feed them into the pick-up belts. This is accomplished by a pair of two-bladed, rotating, flexible rubber flippers mounted on shafts which are inclined forward at about 30° with the vertical. The flippers are driven at such a speed

as to cause their tips to brush the ground every 2" along the row when the tractor is moving at 1½ miles per hour.

The onions are lifted between two round, endless belts 13/16" in diameter and 105" long. These belts are driven by two 8", C-section, sheaves at the rear end of the machine and are supported by six pairs of spring mounted idlers. This arrangement allows heavy and light tops to be held firmly while being elevated. Two 5" diameter fixed idlers are set on 12 centers at the front of the machine, forming a 6" throat into which to feed the tops. The pick-up belts are mounted so as to provide a short horizontal section parallel with the ground at the front of the machine followed by an inclined section making an angle of 30° with the horizontal. The belts are driven about 10% over ground speed in the reverse direction, of course.

Directly above the pick-up belts, and driven at the same speed, are a pair of top disposal belts, extending rearward from a point about halfway along the machine to about 14 inches beyond the drive sheaves. Mounted between these two sets of belts are two driven, overlapping, five-inch topping discs. The tops are thus held above and below the topping discs as the onions are carried through the machine. After topping the bulbs are dropped at the end of the pick-up belts and the tops carried out the rear of the machine.

The topped onions are dropped into a hopper and elevated to a sacker at the side of the tractor. The field practice is to catch about 60 pounds of onions in a barley sack, twist the top and set it off in the field to dry.

Any green material coming through the machine will be sacked along with the onions of all sizes, so that it is necessary to grade these field sacks and resack for market or storage.

Lack of uniform topping is a weakness of the harvester. The onions are not uniform in the row at harvest time, so each top is not held at the same distance above the bulb. It is important to set the horizontal section of the pick-up belts at the position, with respect to the ground, which yields the best topping and recovery. This does not always give either close or uniform topping.

The performance of the machine reflects the condition of the field and crop at harvest time. Field experiences from Siskiyou to Los Angeles counties have shown that cultivation practices resulting in uniform stands in clean fields result in premium crops, even though machine harvesting is not contemplated. It would appear that growing methods may profitably be altered to yield optimum harvesting conditions for the machine.

The machine is not yet commercially available, although it is ready for manufacture. Plan drawings for the machine are expected to be made available soon.

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Knife blade of harvester, adjustable as to depth and angle of cut, frees onion bulbs from roots.