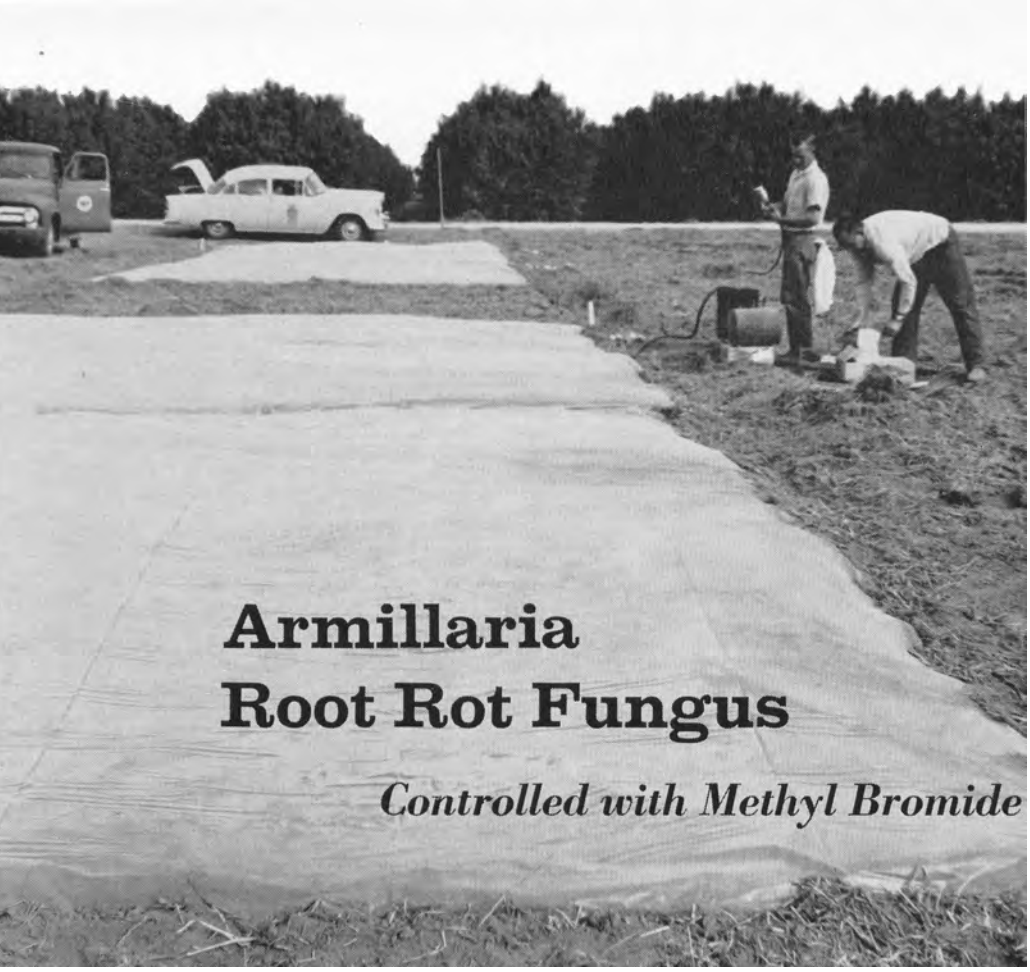

Armillaria Root Rot Fungus

Controlled with Methyl Bromide Soil Fumigation

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Soil fumigation with methyl bromide applied under a polyethylene tarp at 2 pounds per 100 square feet of soil, controlled Armillaria root rot fungus in Tulare County tests.

ARMILLARIA ROOT ROT is found in most of the fruit-growing sections of California. The disease is caused by *Armillaria mellea*, known also as the oak root rot fungus. Peach, apricot and almond trees are particularly susceptible, but it also takes a heavy toll of ornamental trees and shrubs in many urban areas. It may be serious in orchards planted along stream and river banks, on old flood plains, alluvial fans, or where roots of infected native plants have been transported from the place of original infections. Any susceptible plants planted on land where oak trees have been growing may become infected.

The fungus usually spreads from diseased to healthy plants by direct root contact. Small root-like structures, called rhizomorphs, grow from the fungus and penetrate the healthy roots. These rhizomorphs are also able to grow a short distance through the soil and may contact nearby roots or the crown region of another tree. If the roots invaded are some distance from the crown, trees may survive for from one to several years before harmful effects are noted. If the crown is invaded directly, trees are soon girdled and may die within several months. The fungus may spread as rapidly as one tree row in each direction each year, depending on susceptibility of the host and soil conditions.

Once the fungus becomes established, it is difficult to control. It can remain alive in dead, infected roots in the soil for many years. Soil fumigation with carbon bisulfide has been the only recommended means of obtaining practical control of the fungus. Preliminary trials in 1960 with other materials led to further tests comparing methyl bromide fumigation with the standard carbon bisulfide treatment.

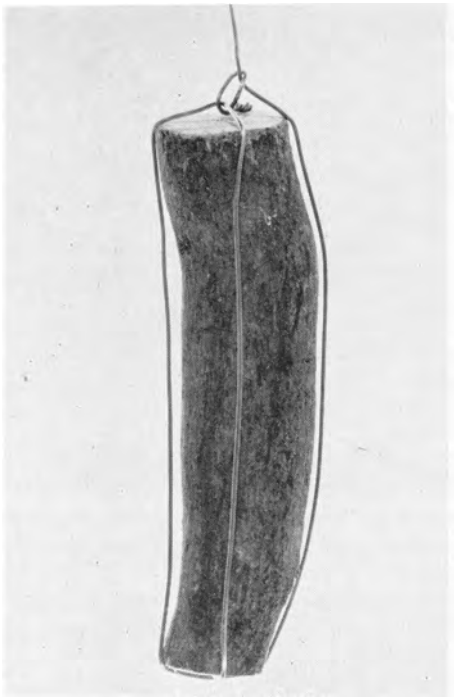
First test

The first full-scale test to compare these two materials was located on the Dale Hester ranch near Farmersville. The plots were randomized and each treatment was replicated three times. The Department of Plant Pathology, Riverside, supplied the laboratory-inoculated orange roots. These infected roots were 2 to 3 inches in diameter and approximately 6 inches long. They were buried in the soil prior to fumigation. The fungus was grown on these root pieces for six months prior to the tests to insure penetration of the mycelium.

Prior to fumigation, the soil (Cajon fine sandy loam) was ripped to a depth of 18 inches, disked and smoothed with a drag. The individual plots measured 19 by 21 feet (approximately the size of one tree site). Within this area, four 3-inch auger holes were dug to a depth of 5 feet. The inoculated root was fastened to one end of a 5-foot piece of baling wire and lowered to the bottom of the hole. The soil was replaced and tamped, leaving the wire to mark the location and aid recovery of the root section.

Each methyl bromide plot was covered with a polyethylene tarp and the edges were tightly sealed by covering them with soil. The methyl bromide was vaporized by passing it through a copper tube immersed in hot water to be sure it entered beneath the tarp as a gas. Applications were made at rates of one, two and four pounds per 100 square feet and the tarps were left in position for one week.

The carbon bisulfide was applied at the rate of two liquid ounces per hole spaced 18 inches apart (approximately



Inoculated root piece, approximately 6 inches long, similar to those buried prior to fumigation with wire attached to aid recovery for check on effectiveness.

300 gallons per acre). Injections were made with a Mack weed gun at a depth of 6 inches. Immediately after injection, the soil was sealed with water to a depth of 1 inch.

Soil temperature

The soil temperature was 67° F at 6 inches at the time of injection. Soil moisture varied from 6.1 per cent by weight at 1 foot, to 10.3 per cent at 4 feet. Two months after treatment the root pieces were removed and examined at Riverside for living *Armillaria*. The fungus was not alive in any of the treated root pieces from the fumigated plots, but was alive in three of the five check roots buried outside the treated area.

In November, 1961, a similar test was conducted on Cajon fine sandy loam soil at the Marshall Wanzer ranch, also located near Farmersville. No irrigation water had been applied to the plot for about three months prior to fumigation. Weeds, as well as the infected plum trees, were left to extract soil moisture. Then the trees and large roots near the crown were removed. The plot was chiseled to a depth of 18 inches, disked and smoothed to keep sticks or roots on the surface from puncturing the polyethylene tarp.

In this test, methyl bromide applications at two pounds per 100 square feet were compared with the standard carbon bisulfide treatment. Five inoculated root pieces (two citrus, two peach and one fig) were buried 5 feet deep in each 19 by 21-foot plot. The treatments were replicated four times. At the time of treatment, the soil temperature was 55°F at 6 inches. The soil moisture was 3.5 per cent by weight at the soil surface and 5 per cent at the 5-foot level.

Plot results

After two months, none of the root pieces in the treated plots contained live *Armillaria*. Eleven roots were also buried 1 foot apart and 5 feet deep in a row beginning at the edge and extending out from one of the methyl bromide plots. The fungus in the first three roots next to the treated plot was not alive. This suggests a lateral gas movement (with concentrations high enough to induce kill of *Armillaria*) of about 2 feet at the 5-foot depth.

These tests indicate that methyl bromide applied at the rate of two pounds per 100 square feet of soil (approximately 870 lbs. per acre) is comparable to the standard rate of carbon bisulfide in controlling the Armillaria root rot fungus. Minimum conditions for successful treatment appear to be low soil moisture and soil temperatures above 50°F. Although one pound of methyl bromide per 100 square feet controlled the fungus in one test, other tests indicate that this rate of gas applied under a polyethylene tarp does not control *Armillaria* in soil somewhat higher in moisture and lower in temperature.

Other variations in application methods, including methyl bromide injection into the soil at various rates and depths, will be investigated.

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Harold Lembright of Dow Chemical Company, and BHC Crop Service, Visalia, supplied material and assistance with the project. Dale Hester and Marshall Wanzer supplied plot sites and additional equipment.

Methyl bromide was vaporized, before application under polyethylene tarp, by passing it through a copper tube immersed in container of hot water visible in center of photo.