

## BIOCONTROL OF PHYTOPHTHORA ROOT ROT OF AVOCADO

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PROJECT OBJECTIVE: Effectively manage Phytophthora root rot of avocado using biocontrol organisms and mulches.

### 1. Biocontrol of Phytophthora root rot using mulches.

Urban and agricultural waste products generally available to avocado growers in southern California were analyzed under greenhouse conditions for their suitability to be used as mulches on avocado. The mulch materials that were used included yardwaste, earthworm-composted sewage sludge, wood compost, grass clippings, rice hulls + paper, rice hulls, sudangrass hay, orange peels, alfalfa hay, mushroom compost, composted sewage sludge, horse/cow manure, cow manure, chicken manure, milled almond hulls and milled peanut hulls. Only yardwaste significantly enhanced the root health of avocado compared to a soil control. Horse/cow manure, cow manure, chicken manure, milled almond hulls and milled peanut hulls significantly reduced root health of avocado. Only yardwaste and earthworm-composted sewage sludge significantly increased root and shoot growth of avocado over the soil control.

In a Phytophthora cinnamomi-infested field at South Coast, nursery-grown "Hass" on "Duke 7" rootstock were planted. Alfalfa hay, dairy manure, gypsum and a porous plastic tarp were applied alone or in combinations under the tree canopy as mulches. None of the mulches except gypsum significantly improved avocado yield or growth when applied alone. However, combinations of alfalfa hay, tarp, or gypsum gave significant increases in growth and yield of avocado trees. For instance, the combination of alfalfa hay and tarp gave the best yield, which was 308% of the unmulched treatment. This treatment and several other combination treatments were as beneficial as Aliette fungicide treatments. The dairy manure reduced yield and growth of the avocados. Only alfalfa significantly enhanced the microbial population of the soil. Gypsum significantly enhanced avocado root growth and reduced populations of Phytophthora. In other greenhouse experiments, gypsum significantly reduced root infection by P. cinnamomi. Gypsum appears to significantly reduce Phytophthora sporangial production by reducing both the number and size of the sporangia. In this respect gypsum acts like a weak fungicide against P. cinnamomi.

In a second mulch trial on soil heavily infested with P. cinnamomi in Somis CA, mulches have significantly improved the performance of trees after 2 years.

In a third mulch trial in *P. cinnamomi*-infested soil, mulches have provided no increase in growth of avocado after one year. However, it has been determined that mulches on these newly-planted trees reduce water requirements of these trees by 30-40% and tremendously enhance the microbial activity of the soil.

## 2. Biocontrol of Phytophthora root rot of avocados with microorganisms

We have evaluated a large number of organic mulch materials (see section #1 above) for their ability to support growth of biocontrol organisms. Of these mulches only yardwaste, rice hulls and sudangrass hay appear to be good substrates for growth of several biocontrol organisms.

Organic mulches colonized with microbial biocontrol agents, termed bioenhanced mulches, were tested for their ability to reduce Phytophthora root rot of avocado. Two biocontrol organisms, Gliocladium virens and Trichoderma harzianum, were found to grow optimally at 24C and 20% moisture on sudangrass and at 24C and 30% moisture on yardwaste. In several greenhouse experiments sudangrass hay and yardwaste infested with G. virens and used as a surface mulch could significantly reduce populations of P. cinnamomi and increase avocado growth 31-390%. Trichoderma harzianum also enhanced avocado growth, but it was not as effective as G. virens. Yardwaste composted for longer than 6 mos was no longer a good substrate for colonization by the biocontrol organisms. The biocontrol organisms survived for at least 8 mos in the bioenhanced mulches, but they became inactive and therefore less effective after 4 mos. The mulches appeared to trap zoospores of Phytophthora and reduce their ability to survive. Gliocladium virens and Trichoderma harzianum will attack and kill Phytophthora

In a very large field plot at South Coast, it appears that Gliocladium virens applied in a mulch significantly enhanced growth and yield of avocado in a root rot-infested field. In this test Trichoderma harzianum and Pseudomonas fluorescens did not enhance avocado growth.

In a second *P. cinnamomi*-infested field plot in Somis CA, G. virens and four bacterial biocontrol agents are being tested. Data on tree growth and performance have not yet been gathered.

Verticillium tenerum is a biocontrol agent which produces a unique antibiotic which is especially effective against P. cinnamomi. The chemical structure of the antibiotic has been elucidated. We are currently preparing greenhouse test with this organism and 9 other new biocontrol agents.

Three large field trials have been initiated in 1995 in which the biocontrol agent Pseudomonas fluorescens will be continuously applied through the irrigation water to avocados infested with avocado root rot. The bacteria will be grown in field fermentation tanks (Eco Soils Systems, Inc.) in the field and automatically injected in the water at every irrigation. This new technology will also be studied in the greenhouse. It has tremendous potential for delivering biocontrol agents in the field.

Effect of bioenhanced mulches on growth of avocado grown in *Phytophthora cinnamomi*-infested soil in the greenhouse.

