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Cultural and Biological Control of Phytophthora Root Rot

M. D. Coffey,
Department of Plant Pathology,
University of California, Riverside, CA 92521

Cooperators: R. Gees, S. D. Campbell, G. Greer, D. Appel, B. Gabor, R. Bekey, G. Bender, Lyle Pohl, Steve Moore, G. A. Goodall

Cultural Control

The ultimate aim of this new program is to provide the knowledge for a balanced and integrated approach to the effective control of the root rot disease caused by *Phytophthora cinnamomi.* Some cultural factors that may increase the degree of severity of root rot include:

1) impeded soil drainage
2) drought stress
3) "waterlogging" stress
4) salt stress
5) lack of beneficial microorganisms in rhizosphere
6) presence of detrimental microorganisms (root nibblers)

This is by no means a complete list but does help to outline some important factors that may accelerate the decline of avocados in *Phytophthora*-infested soils.

The cultural control program is attempting to examine both the young tree replant scenario and the plight of mature bearing trees in a root rot situation. Young trees on resistant rootstocks frequently fail to establish properly in replant situations. Factors being examined include the root quality of the replant trees, the impact of mounding or ridging, the effect of organic amendments, the beneficial aspects of mulching and the impact of various physiological stresses.

Currently we estimate that approximately 80 percent or more of replants are unlikely to establish productive groves when root rot is present. This is despite the fact that resistant rootstocks and systemic fungicides are now available and are used. The failures undoubtedly relate to our totally inadequate knowledge of the correct cultural

procedures to use and the relative importance of the various underlying factors involved. Several field plots have been initiated to look at some of these factors and more are planned.

With mature trees on susceptible rootstocks, the only experimentally available technology for directly combating the disease involves trunk injection with a phosphonate fungicide. Results of fungicide injection work initiated in November 1983 indicate that in 50 percent of cases (2 out of 4 injection plots) there was a failure to see a good response after 2 years treatment. In the balance of plots, the responses have been less than desirable taking longer than has been reported in other countries. The intrinsic problem again appears to be an inadequate cultural approach to root rot control. We have been investigating the use of various mulching procedures to improve the efficacy of this potentially powerful new fungicide technology. A grove in Carpinteria is the primary focus of the good fortune of obtaining the advice of an organic grower Steve Moore in these new programs.

In 1989 we are hoping to initiate further work in this important area of cultural control in cooperation with Gary Bender in San Diego County.

Biological Control

Cultural and biological control in reality are not separate entities. As pointed out in the initial discussion on cultural control, many of the factors underlying the effects of such control are biological in nature. To this end we have embarked on an ambitious program to identify some of the specific biological factors involved in suppression of *P. cinnamomi* in certain groves in California. The existence of such groves has been known for many years. In fact one grove in Santa Barbara was identified by Dr. Zentmyer as having *P. cinnamomi* back in the early 1940s. Now over 40 years later that grove still produces avocado fruit, looks healthy and yet *P. cinnamomi* can be isolated from the root systems of those avocado trees. In total, we have identified three groves which may possess such properties.

A rigorous screening over a two year period of the rich microflora in the soil of one of these groves, produced over 100 microorganisms, both bacteria and fungi. These have now been screened in an in vivo bioassay, involving *Persea indica* seedlings, for their antagonistic effects on root rot. Out of all these, a single organism, the fungal strain TW, has proven to be consistent in suppressing *P. cinnamomi* to a level similar to that of a systemic fungicide. Further screening of more soils to find additional organisms is needed. However, at present our limited resources have been directed towards developing formulation methods with TW so that it can be used with avocado clonal rootstocks. The development of appropriate technologies involved in handling biocontrol agents so as to permit their cost-effective use under field conditions is a crucial need.

The future challenge is to develop effective cultural and biological control strategies which will reduce our dependence on fungicides for control of root rot. In addition it is hoped that such new cultural technologies will help to improve the general performance of avocados, especially in permitting the more successful establishment of young nursery trees in replant situations.

a) Cultural control

Two experimental plots have been established in Carpinteria, Santa Barbara County in order to assess the value of mulching practices; one with Hass on clonal rootstocks (2-year-old replants) on mounds and the other with approx. 15-year-old Hass on Mexican seedling rootstocks receiving fungicide trunk-injections. Vigor and productivity of these two sets of trees will be assessed. The mulch in both cases consists of a straw casing into which is incorporated a commercially available, composted chicken manure. These mulching experiments were initiated in April 1987 and assessment is planned over a 10-year-period.

b) Biological control

A major screening program was initiated in 1986-88 in which over 100 microorganisms were repeatedly screened in a *Persea indica* bioassay for their ability to suppress root rot caused by *P. cinnamomi.* In these tests several microorganisms proved to have root rot control efficacies similar to systemic fungicides. One of these microorganisms (a fungus designated strain TW) has been repeatedly tested. Even in a range of severe test soils where additional *P. cinnamomi* inoculum was added, this fungal strain was equivalent in efficacy to a systemic fungicide. Aims of the 1987-88 program are:

a) to develop techniques for reliable and efficient inoculation of avocados with strain TW.

b) evaluate the persistence of strain TW on avocado in natural soils.

c) attempt to determine the mechanisms of *Phytophthora*-suppression operating with strain TW.