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## Introduction:

*Phytophthora cinnamomi*, the casual agent of avocado root rot, is a limiting factor in avocado production in most avocado-producing countries. On all varieties of avocado, this pathogen attacks the feeder roots, which can result in death of the tree. Although the disease has been studied for more than 60 years, definitive control measures have not been found. However, many control strategies have been discovered which will reduce the impact of avocado root rot. An integrated management approach to root rot will allow the continued economical production of avocados in the presence of *P. cinnamomi*.

## Symptoms:

The first signs of the disease are observed in the tree canopy. The leaves are small, pale green, often wilted with brown tips, and drop readily. Shoots die back from the tips, and eventually the tree is reduced to a bare framework of dying branches (Fig 1). Tree death may take from a few months to several years, depending on soil characteristics, cultural practices and environmental conditions (Fig 2). The small feeder roots on diseased trees may be absent in the advanced stages of decline. When present, they are usually black, brittle and decayed. Healthy trees which have an abundance of creamy-white feeder roots (Fig 3).

## Disease Management:

Since no definitive measures have yet been found to control the disease, an integrated approach to managing the disease has been found to be most effective. This approach includes the following preventative measures, cultural practices and chemical treatments:

### Cultural Practices:

- Provide favorable soil conditions
- Use certified disease-free nursery stock
- Use *P. cinnamomi*-tolerant rootstocks
- Prevent soil or water movement from infested areas
- Irrigate carefully, not too much water
- Apply gypsum and mulch
- Provide appropriate nutrition

### Chemical Control:

- Phosphorous Acid Applications
- Fosetyl-Al (Aliette<sup>®</sup>) or potassium phosphonate can be applied as soil drench, foliar spray, trunk paint, trunk injection (buffered) or with irrigation water
- Trunk injection (buffered solution)
- Metalaxyl (Ridomil<sup>®</sup>) can be applied as granular, a drench or with irrigation water

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Fig 1. Phytophthora root rot symptom on a young tree



Fig 2. Phytophthora root rot symptom on an older tree



Fig 3. Phytophthora root rot symptom on feeder roots

## Phosphorous acid applications

Phosphite in roots has been shown to directly inhibit *Phytophthora* (Fenn and Coffey, 1984), and additionally stimulates defense mechanisms in plants (Guest and Bompeix 1984). The stimulation of a defense response is probably far more important, since phosphite itself is diluted out by the time it reaches all the individual feeder roots.

## Disease Prevention Program

According to the Phosphite label, 1-3 qts. of Phosphite per 100 gal/water is applied as a foliar spray at 2-4 week intervals after the trees become established. If applied through drip or mini-sprinkler irrigation, 2-3 qts. in at least 100 gal. is applied. In either case, no more than six applications per year can be made. The area should not be irrigated again for at least 24 hrs. It is important to have functional check valve, vacuum relief valve, and a low-pressure drain in order to avoid contaminating the water source. Agri-Fos is not registered as an application through the irrigation system, but is registered as a foliar spray at 1/3 fl. oz. per gal. of water, spray to runoff at 2 – 2 1/2 gal of solution per adult tree. Applications should be started in spring, with up to 4 applications per year.

## Disease Control Program

If root rot symptoms are apparent (i.e. leaf drop, and slightly brittle and chocolate-brown colored feeder roots), then trunk injection is the most effective method for getting phosphite into the tree. According to the Fosphite label, 3 teaspoons per linear yard of canopy width at breast height is applied with a proper injection syringe. Applications should be repeated 2-4 times per year until root rot is under control.

According to the Agri-Fos label, 1/4 fl. oz of undiluted product is injected per yard of canopy diameter for skeletal trees. For details on quantity and timing of injection, please refer to the label. It is important to inject phosphite into trees at the right time. Newly expanding leaves and developing fruit have greater sink strength than roots. Given that phosphite moves towards sinks with the highest strength, injections should be conducted just as leaves harden, when they are no longer sinks, and right before fruit development so the phosphite will move appropriately to the actively growing roots. The timing for this is usually in late spring (May) and summer (August), but these dates may vary according to local conditions. Rather than phosphite, phosphorous acid fertilizers should be used on healthy trees free from root rot.



Wrong phosphorous acid injection with drilling a big hole to use undiluted material



Recommended Phosphorous acid injection using tree-



Recommended Phosphorous acid injection using Chemjet

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