

Injection of Established Avocado Trees for the Effective Control of *Phytophthora* Root Rot

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Summary

Spectacular root rot control has been achieved on fully grown avocados by injecting fosetyl-AI twice per season at 0,4 g a.i. per m² canopy area. The treatment resulted in a significant reduction of *Phytophthora cinnamomi* incidence in the feeder roots and it has proved to be a safe, commercially applicable technique to combat root rot. A negligible amount of phytotoxicity was observed on the foliage of some of the fosetyl-AI injected trees.

Metalaxyl injected at 0,028 g a.i. and Dowco 444 at 0,4 g a.i. per m² canopy area of the trees provided an unsatisfactory degree of control of root rot. Some of the trees injected with Dowco 444 showed serious phytotoxic symptoms.

Introduction

Root rot caused by *Phytophthora cinnamomi* Rands is the most devastating, disease of avocados (*Persea americana* Mill.) in most avocado producing countries, with the result that chemical control of this disease has received much attention. Zentmyer (1955) developed a laboratory method for the screening of fungicides against *P. cinnamomi* and later reported on the controlling effect of Dexon (Zentmyer, 1973). Good progress has been made in the chemical control of root rot with recently developed fungicides of which metalaxyl, fosetyl-AI, Ethazole, and Dowco 444 have given encouraging results (Zentmyer, 1980; Darvas 1983a). The commercial use of metalaxyl and fosetyl-AI has contributed significantly to the development of the South African avocado industry over the past few years.

However, due to the sharp decline in the efficacy of metalaxyl after two years of continued use (Darvas, 1983a) and the slow initial reaction and high application costs with fosetyl-AI (Darvas, 1983a), it was regarded as necessary to develop more effective, low cost chemical control measures. In preliminary trials, three systemic fungicides were tested in the form of trunk-paint application (Darvas, 1983b). Similar trunk treatments have been investigated on young as well as established trees by Snyman (1982; 1983).

This paper reports on the first results obtained from the development of a new technique of injecting systemic fungicides into the trunks of established avocado trees for the control of *Phytophthora* root rot.

Materials and Methods

Ten year old Fuerte trees on root rot susceptible Guatemalan rootstocks were used for the experiment in block 14 of Westfalia Section of Westfalia Estate. The experiment started in 1980, and there were ten single-tree replications in each treatment. Trees were injected in the main trunk by using a slightly modified form of the technique of Buitendag and Bronkhorst (1980). It consisted of drilling holes five mm in diameter and 40 mm deep into the trunk of the trees and using 60 ml capacity syringes. A volume of 20 ml material per syringe was injected under pressure. The number of syringes needed for a tree was established according to tree size based on canopy area (m^2), and the injection holes were evenly spaced around the trunk approximately half a meter above ground level. On the completion of the injection, holes were sealed with tree seal. Drills were sterilized after the treatment of each tree by dipping them into 1% Cahypochlorite solution to prevent the possibility of virus or other disease transmission.

The treatments used in the experiment were as follows:

1. Fosetyl-Al: injected twice per season, first in August and again in October, at a rate of 0,4 g a.i. per m^2 canopy area.
2. Metalaxyl: injected at 0,028 g a.i./ m^2 in August and in October.
3. Dowco 444: injected at 0.4 g a.i./ m^2 in August and in October.
4. Control (not injected).

The assessment of the results was based on rating of the trees according to a disease index of 0 (healthy) -10 (dead) during the winter months each year.

Root samples were collected under four trees in each treatment at monthly intervals in the first year of the experiment. A total of 16 freshly killed feeder roots were removed from each sample and surface sterilized in 0,1% $HgCl_2$ solution for five seconds and rinsed in sterile water. Five 2 mm long pieces were cut from each feeder root and placed onto Potato Dextrose Agar in Petri dishes. The isolated fungi were identified and the mean percentage occurrence of the following organisms was calculated for each treatment:

Phytophthora cinnamomi Rands, *Pythium* spp., *Cylindrocladium scoparium* Morgan, *Rhizoctonia solani* Kuhn, *Macrophomina phaseolina* (Tassi) Goid., *Fusarium oxysporum* Schlecht., and *Cylindrocarpon destructans* (Zins.) Scholten.

Results

The mean disease rating of trees in the various treatments at the commencement of the experiment (1980) and in subsequent years is given in Table 1.

The best control of *Phytophthora* root rot was obtained by injecting fosetyl-Al into the trunk of the trees. The treatment showed little effect in the first year of its use, but it dramatically improved the condition of the trees in the second year. On the other hand, poor control was given by the injection of metalaxyl and Dowco 444 (Table 1).

Table 1: The control of *Phytophthora* root rot by injecting fungicides into the trunks of established avocado trees.

Treatments	Mean disease rating (0-10) N=40		
	1980	1981	1982
Fosetyl-Al injected at 0.4 g a.i./m ²	5,3	5,0	1,0
Metalaxyl injected at 0,028 g a.i./m ²	4.1	4,6	5,8
Dowco 444 injected at 0.4 g a.i./m ²	4,1	5,0	5,6
Control	5,0	4,8	6,4

The mean percentage of the seven most common avocado root infecting fungi in dead feeder roots in the first year of the experiment is presented in Table 2.

A statistically lower incidence of *P. cinnamomi* was found in the roots of fosetyl-Al injected trees than control trees. Metalaxyl and Dowco 444 also tended to reduce the pathogen in the roots, but this reduction was not statistically significant if compared to the control trees. None of the treatments influenced significantly the occurrence of the other pathogens in this survey (Table 2).

Table 2: The incidence of common root pathogens in dead roots of trees injected with fungicides.

Treatments	Mean frequency in dead feeder roots N = 3480						
	<i>P. cinn.</i>	<i>Pythium</i> spp.	<i>C. scop.</i>	<i>R. sol.</i>	<i>M. phaseol.</i>	<i>F. oxysp.</i>	<i>C. destr.</i>
Fosetyl-Al	2,2 b	0,5 a	0,8 a	2,2 a	5,7 a	21,8 a	25,8 a
Metalaxyl	7,1 ab	0,1 a	0,4 a	1,0 a	6,8 a	12,7 a	30,1 a
Dowco 444	6,3 ab	0,07a	0,7 a	1,0 a	6,6 a	19,8 a	22,2 a
Control	14,1 a	0,7 a	2,7 a	1,2 a	3,6 a	21,2 a	23,2 a

Means with the same letter do not differ statistically at .05 level.
(Duncan's multiple range test)

A few of the sparsely foliated trees in advanced stages of root rot showed symptoms of phytotoxicity following injections with fosetyl-Al. Symptoms included the development of chlorotic areas between veins of the young leaves. However, these symptoms disappeared in the second year when a large number of new leaves appeared which presumably diluted the fosetyl-Al reaching the foliage.

Some of the Dowco 444 injected trees developed phytotoxic symptoms with the formation of abnormally small, brittle leaves often showing tip burn or burn on the edge of the leaf blades and defoliation in the more advanced stages. Trees with less foliage appeared to be more severely damaged than trees with good leaf cover.

Discussion

The most outstanding control of *Phytophthora* root rot ever recorded on established avocado trees was achieved by the injection of fosetyl-Al into the trunk of the trees. Various dose rates have been tested in other experiments (unpublished) in which it was confirmed that the rate of 0,4 g a.i. fosetyl-Al per m² canopy area gives satisfactory control. The treatment has been tested on Fuerte, Hass, Edranol, and Ryan cultivars with good results. As to the after-effect of fosetyl-Al injection, it was found that when trees were cut back eight months after the last injection, typical phytotoxic symptoms developed on the leaves of the new flushes. This indicates that the two fosetyl-Al injections in a season give at least a full year's residual effect. Probably, there is some residual overlap with the next year's treatment; and it may be possible that after the second or third year, when the trees have regained full vigor and are healthy, fosetyl-Al injected once a year will be sufficient to maintain their condition.

Investigations of the woody parts of the trunk following fosetyl-Al injections revealed that a certain amount of discoloration occurs above and below the point of injection, but this decreases with time, and it causes no serious damage to the transporting elements in the trunk (Engelbrecht, 1981). Holes drilled in the trunk callused rapidly after injection with secondary infections.

The metalaxyl active ingredient for the injection was extracted from the wettable powder formulation and, due to its solubility in water, a dose rate of 0,028 g a.i. per m² canopy area was administered into the trees. It is possible that a more effective control would be obtained at higher dose rates.

Dowco 444 experimental material at a rate of 0.4 g a.i. per m² canopy exhibited little controlling effect against the disease.

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