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RESULTS OBTAINED IN 1980 FROM AVOCADO ROOT ROT FIELD TRIALS

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OPSOMMING

Die effek van sekere boordpraktyke en swammiddels op Phytophthora dnnamomi-wortelvrot by avokadobome is in vyf veldproewe getoets. By erg besmette vo/wasse borne is boomtoestand tydelik verbeter d.m. v. strawwe snoei. Die effek is nog beter by borne wat 4 tot 6-weekliks in die somer met fosetiel-Al bespuit is of met 2 tot 3 grondtoedienings van metalaksiel behandel is. By een perseel is die effek van fosetiel-Al nog waarneembaar 18 maande na die finale toediening op teruggesnoeide borne en vir 30 maande by ongesnoeide borne. In twee proewe waar metalaksiel en fosetiel-Al vergelyk is, was metalaksiel beter in die een geval en fosetiel-Al in die ander, 'n Kombinasiebehandeling van die twee middels bet uitstekende resultate gelewer. Etasool, wat in een proef uitgetoets is, was teleurstellend.

Ander praktyke, nl. kalktoedienings, 'n tussengewas van fluweelbone asook hoendermistoedienings, was nie in staat om te voorkom dat borne verswak a.g.v. wortelvrot nie en kon selfs nadelig gewees het.

Waar Jong boompies uitgeplant is in grond met 'n swaar Phytophthora-bemsetting, het metalaksiel @ 0,5 tot 4,25 g aktiewe bestanddeel/m^2 die groei van die boompies betekenisvol verbeter in vergelyking met onbehandeldeof fosetiel-Al-behandelde boompies.

SUMMARY

The effects of certain orchard practices and anti-fungal compounds on Phytophthora cinnamomi-induced root rot in avocados were tested in five field trials. In the case of badly diseased, mature trees, severe pruning temporarily improved tree condition. This effect was enhanced by applications during summer of either fosetyl-Al sprays at 4 to 6-week intervals or metalaxyl granules or soil drench, applied 2 or 3 times. At one site, the beneficial effect of fosetyl-Al was evident for 18 months after the last application to stag horned trees and for 30 months in the case of un-pruned trees. In two trials where metalaxyl and fosetyl-Al were compared on mature trees, metalaxyl gave better results in one case, while fosetyl-Al was more effective in the other. A combination of these two products gave excellent results. Ethazol was tried in one experiment, but its performance was disappointing.

Other practices, viz. liming, cover-cropping with velvet beans, or applying chicken manure, were ineffective in preventing trees from declining as a result of root rot and

may even have been detrimental.

In a replant situation with heavy disease pressure, metalaxyl at rates varying from 0,5 to 4,25 g ai/m^2 caused significantly improved growth of young trees as compared with trees which were either untreated or treated with fosetyl-Al.

INTRODUCTION

In 1973, Milne etal, reported on unsuccessful attempts to control root rot (caused by Phytophthora cinnamomi Rands) in mature avocado trees using fenaminosulph (Dexon) and other chemicals and mulches. Subsequently, a number of other products such as captafol, pyroxychlor, prothiocarb and ethazol w.p. were tested by the CSFRI, also without success (unpublished). During 1975 and 1976, sufficient quantities of ethazol e.c. and fosetyl-Al were obtained for small field trials and later, metalaxyl also became available. This report presents results obtained in field trials where the last-mentioned three products were tested.

METHODS AND RESULTS

TRIAL 1:To determine the effect of chemical treatments following the severe pruning of avocado trees affected by root rot

Procedure A large block of mature Fuerte trees on the property of H.L. Hall & Sons Ltd. near Nelspruit was rated for disease severity using the 1 to 5 system described by Milne et al. (1973), where a score of 1 = healthy and 5 = dead. Thirty trees with disease rating 2 1/2were stag horned (cut back to a framework of main branches) in late-1975 and lime-washed to prevent sunburn. Chemical treatments

TABLE 1: Treatments applied to staghorned avocado trees in Trial 1

Treatment	Rate	NO. & FREQUENCY OF APPLICATIONS			
		1976/77	1977/78	1978/79	1979/80
1 Control	—	—	—	—	—
2 Fosetyl-Al foliar spray	0,3% ai	6 @ 6 wks	3 @ 6 wks	0	0
3 Fosetyl-Al soil drench	30 g ai/10ℓ/m^2	3 @ 12 wks	2 @ 12 wks	0	0
4 Fenamiphos soil drench	4 g ai/40ℓ/m^2	6 @ 6 wks	0*	0	0
5 Ethazol ec soil drench	3,5 g ai/45ℓ/m^2	6 @ 6 wks	2 @ 12 wks	0	0

*This was stopped because of the product's high mammalian toxicity

(see Table 1) were applied in a randomised blocks design of five treatments and six replicates from June 1976 until January 1977 and again during the 1977/78 summer. After this, no further treatments were applied.

Results One tree in the fosetyl-Al spray treatment died soon after the commencement of the experiment, apparently from causes other than root rot. It was disregarded when assessments were made Average disease ratings of the other trees are given in Table 2.

TABLE 2: Average disease ratings (on a 1–5 system) of trees in Trial 1 at different times

Treatment	Before Cutback	Jun '76	Mar '77	Mar '78	Mar '79	Sep '79	Aug '80
1 Control	2,5	1,0	1,1	1,9	2,2	2,2	2,3
2 Fosetyl-Al spray	2,5	1,0	1,0	1,3	1,3	1,3	1,9
3 Fosetyl-Al drench	2,5	1,0	1,0	1,3	1,6	1,8	2,1
4 Fenamiphos drench	2,5	1,0	1,2	Terminated			
5 Ethazol drench	2,5	1,0	1,0	1,5	1,7	1,9	2,2
					Last application Jan. 1978		

These results show that fosetyl-Al maintained the trees in an almost perfectly healthy condition for at least 18 months after the last spray application. Thereafter, the trees again began to decline. Drench treatments of fosetyl-Al or ethazol were not as effective as the fosetyl-Al spray treatment. It should be noted that the last rating was done when the trees were under stress because of a shortage of irrigation water.

TRIAL 2 To test fosetyl-Al as a spray or drench on avocado trees with mild symptoms of root rot

Procedure Nine trees in the same block as Trial 1 (with disease rating 2) were used. Replicates were limited to three because of the limited quantity of experimental material available at the time. The first treatments were applied in September 1976 and thereafter, they were applied at the same times as the equivalent treatments in Trial 1. Details appear in Table 3.

TABLE 3: Details of treatments applied in Trial 2

Treatment	Rate	NO. & FREQUENCY OF APPLICATIONS			
		1976/77	1977/78	1978/79	1979/80
1 Control	–	–	–	–	–
2 Fosetyl-Al spray	0,3% ai	4 @ 6 wks	3 @ 6 wks	0	0
3 Fosetyl-Al drench	30 g ai/10ℓ/m²	2 @ 12 wks	2 @ 12 wks	0	0

Results Averge disease ratings appear in Table 4.

TABLE 4: Average disease ratings of trees in Trial 2 at different times (1 to 5 system)

Treatment	Sep '76	Mar '77	Mar '78	Mar '79	Sep '79	Aug '80
1 Control	2,0	2,2	2,5	2,7	2,7	2,7
2 Fosetyl-Al spray	2,0	1,7	1,8	1,7	1,7	1,7
3 Fosetyl-Al drench	2,0	1,7	1,5	1,0	1,7	1,8
				Last treatment Jan. 1978		

Both fosetyl-Al treatments brought about an improvement in the tree condition which persisted for 30 months after the final applications.

TRIAL 3 To determine the effect of different cutback regimes and chemical treatments on severely diseased avocado trees

Procedure An 8-year-old block of severely diseased trees at the CSFRI's Friedenheim Research Station was rated in mid-1976. A factorial experiment was then laid out with four-tree plots, three severities of cutback and three chemical treatments, replicated four times. The cutback regimes were:

1. Zero cutback
2. Moderate stag horning
3. Severe staghorning.

The chemical treatments are detailed in Table 5.

TABLE 5: Details of chemical treatments in Trial 3

Treatment	Rate	No. and Frequency of Applications		
		1977/78	1978/79	1979/80
Control				
Fosetyl-Al spray	0,3 % ai	4* @ 8 wks	5 @ 4 wks	6 @ 4 wks
Metalaxyl 5% gran soil application	10 g ai/tree	4 @ 8 wks	3 @ 10 wks	3 @ 10 wks

*The first treatment was not a spray, but a soil drench @ 210 g/70l/tree

The trees were rated at intervals according to a system of 0 = healthy; 10 = dead.

Results The mean ratings for the last assessment (9 October 1980) are given in Table 6.

TABLE 6: Mean ratings (0 to 10 system) of trees from each treatment in Trial 3

Severity of Cutback	Chemical Treatment			
	Control	Fosetyl-Al	Metalaxyl	Mean
Zero cutback	6,6	5,2	5,3	5,7
Moderate staghorn	5,7	3,6	2,2	3,8
Severe staghorn	5,1	3,4	2,2	3,6
MEAN	5,8	4,1	3,2	—

Both chemicals effected an improvement in tree condition, with metalaxyl being the more effective of the two. Staghorning was clearly beneficial, particularly where this was combined with a chemical treatment. No distinction can, however, be drawn between moderate and severe Staghorning.

TRIAL 4 To test the effect of metalaxyl and fosetyl-Al on the growth of avocado plants replanted into Phytophthora infested soil

Procedure At Cairn Trust, West of Nelspruit, 240 avocado trees were removed from a block which had been abandoned because of root rot. The following month (November

1978) these trees were replaced with young plants which were planted into the same planting sites as the original trees. The replant trees were Fuerte (all graftwood from a single mother tree) on seedling rootstocks (all seed taken from one tree of the Mexican race).

Ten treatments, replicated six times, were applied to four-tree plots as detailed in Table 7. The stem diameter of each tree was measured with vernier calipers at a point immediately above the graft union at 6-monthly intervals. The data obtained at planting and at 18 months appears in Table 7.

TABLE 7: Treatments applied in replant experiment (Trial 4) and stem diameters at planting and 18 months later

Treatment	Rate	No. & Frequency of Application		Mean Stem Diam. (mm) After:	
		1978/79	1979/80	0 mths	18 mths
1 Control	—	—	—	9,15	27,1 ab***
2 Metalaxyl 5% gran	0,32 g ai/m²*	3 @ 8 wks	2 @ 19 wks	9,68	35,9 bc
3 "	0,5 g "	"	"	9,83	41,7 cd
4 "	0,75 g "	"	"	9,15	40,7 cd
5 "	1,0 g "	"	"	9,70	43,4 cd
6 "	1,5 g "	"	"	9,57	43,3 cd
7 "	2,125 g "	"	"	9,27	42,3 cd
8 "	4,25 g "	"	"	10,18	46,7 d
9 Fosetyl-Al spray	0,32% ai	6 @ 4 wks	5 @ 4 wks	9,95	24,7 a
10 Fosetyl-Al drench	16 g ai/5ℓ/m²**	3 @ 8 wks	2 @ 8 wks	9,47	28,1 ab
Coefficient of variation				8,73	12,97
LSD's (2 Treatment means) (Tukey):			5%	N.S.	9,299
			10%		10,97

* In the metalaxyl treatments, an area of 7m² was treated around each plant
** Applied in a basin of 1m² around each tree
*** Treatment means followed by the same letter do not differ significantly at the 5 % level according to Tukey's test of significance

It is evident from these results that, in a replant situation, fosetyl-Al is ineffective. All rates of metalaxyl, except the lowest, gave significantly improved growth and the highest rate was significantly better than the lowest.

TRIAL 5 To assess the combined effects of certain orchard practices and different chemicals in the control of avocado root rot

Procedure This trial was designed and laid out at Westfalia after discussions with J.C. Toerien and J.M. Darvas of Westfalia Estates and it was conducted as a co-operative trial in all aspects. It was a semi-commercial trial in which an area containing 241 trees was divided into six blocks, with the number of trees in each block varying between 20 and 51. A different treatment was applied to each block, but ineffective treatments were terminated and others added at various times as it was thought fit. These included four new treatments which were begun in mid-1978. The treatments were as follows:

0. Control, untreated as from Sept. 1977
1. Fosetyl-Al, 6 sprays/annum @ 4-week intervals @ 0,3% ai, beginning in Sept. 1977
2. Lime, dolomitic broadcast @ 2,5 t/ha in Nov. 1977 and gypsum broadcast @ 2,5

t/ha in Feb. 1978

3. Lime, as in 2, plus metalaxyl @ 2,5 g ai/m^2, applied in 1977/78 as a soil drench in Nov., Jan. & Mar. and subsequently, as a granule, twice/annum @ 10-week intervals
4. Lime, as in 2, plus an inter-row cover crop of velvet beans each summer, plus chicken manure applied in late-1978 @ 4 kg/tree
5. Lime, plus cover crop, plus chicken manure, plus metalaxyl, all applied as detailed under 2, 3 & 4 above
6. Staghorning in July, 1978, plus metalaxyl granular @ 2,5 g ai/m^2, applied twice per season (Sept. & Jan.), beginning in September 1978
7. Metalaxyl, applied as in 6, but without Staghorning
8. Metalaxyl without staghorning, as in 7, plus fosetyl-Al, 6 sprays/annum @ 4-week intervals @ 0,3% ai, beginning in September 1978
9. Staghorning only.

Disease ratings on the 0 to 10 system were done at various times and these are reflected in Table 8.

TABLE 8: The effects on root rot symptom severity in avocados of various treatments applied in a semi-commercial trial

Treatment	Average Disease Rating (0 to 10)			
	Nov. 1977	Jul. 1978	Jul. 1979	Feb. 1980
0 Control	4,5*		7,2	6,6
1 Fosetyl-Al	5,3*		3,5	2,2
2 Lime	2,8*		6,9	—**
3 Lime & metalaxyl	3,7*		4,0	3,7
4 Lime, cover crop & chicken manure	1,8*		6,2	—**
5 Lime, cover crop, chicken manure & metalaxyl	3,4*		3,0	4,0
6 Staghorning & metalaxyl	—	5,6*	0,5	0,1
7 Metalaxyl	—	6,0*	5,8	4,0
8 Fosetyl-Al & metalaxyl	—	5,3*	4,5	1,5
9 Staghorning	—	5,9*	1,4	2,3

* Rating prior to commencement of treatment
** Treatment terminated

These results show that staghorning was once again effective in reducing symptom severity, but stag horned trees again began to deteriorate after some time. Staghorning plus metalaxyl, however, gave excellent results. Of the non-stag horned treatments, the best response was obtained with a combination of fosetyl-Al and metalaxyl. Next best were fosetyl-Al and metalaxyl, in that order.

Trees treated with lime, either alone or with a cover crop and chicken manure, deteriorated at least as quickly as untreated trees. These treatments also appeared to reduce the efficacy of metalaxyl.

DISCUSSION

The beneficial effect of staghorning exhibited in Trials 1, 3 & 5 is to be expected as it merely confirms previous results in this regard. Since staghorning has no effect on the pathogen in the roots and soil, however, it is not surprising that stag horned trees decline again if not treated with an effective fungicide.

Velvet bean cover crops and applications of lime or chicken manure appeared to be detrimental to the trees under the conditions of the semi-commercial trial. Furthermore, lime alone, or combined with a cover crop and chicken manure, appeared to reduce the efficacy of metalaxyl. This was an unexpected result.

The ineffectiveness of fosetyl-Al in a replant situation is probably because the young plants have an inadequate leaf canopy to absorb sufficient of the material. When applied as a soil drench, its poor performance in this trial and its good performance in Trial 2 is an anomaly that, from a practical point of view, can be ignored, since the costs of drench applications would be prohibitive.

On mature trees, both fosetyl-Al and metalaxyl are effective, with metalaxyl being superior to fosetyl-Al on a sandy soil at Friedenheim and fosetyl-Al outperforming metalaxyl under the heavier soil and higher rainfall conditions prevailing at Westfalia. A combination treatment of these two products at Westfalia gave excellent results and, when it is considered that a stag horned tree loses at least one year's crop, this combination, applied in the first season instead of staghorning plus one chemical, may well prove economically feasible.

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