New Zealand Avocado Growers' Association Annual Research Report 2004. 4:1 – 7.

EVALUATION OF PHYTOPTORA CONTROL IN AVOCADOS

I. J. HORNER AND E. H. JENSEN

Hort Research, Private Bag 1401, Havelock North.
Corresponding author: ihorner@hortresearch.co.nz

ABSTRACT

In spring 2001, trials were established on three Bay of Plenty avocado orchards, to investigate control of Phytophthora root rot, a disease caused by the fungal pathogen *Phytophthora cinnamomi.* Timing of phosphorous acid injections, and a number of potential biological control agents (Tri-D25, DRH Trichoderma, Effective Microorganisms/Bokashi, and Agrimm Trichoderma) were evaluated. Treatments were applied for two consecutive seasons. Only trees showing moderate to severe decline were selected for the trial. Tree health was monitored using a canopy health rating system and comparison with photographs taken at the start of the trial. Root health was assessed using a feeder root tip health scoring system. Final assessments were made two years after commencement of the trial. The change in tree canopy health using photographs taken at the start of the trial proved to be the most useful measure of treatment effectiveness. Measurement of root health was time consuming and not as useful for separating treatments, but has potential as a tool for more rapid assessment of treatment response, rather than waiting for canopy symptoms to develop. On average, the only trees to show improvement over the course of the trial were those treated with phosphorous acid. Injecting trees in both spring and autumn tended to give a greater and more rapid improvement in tree health compared to injecting trees only in either spring or autumn. In untreated controls and in all biological treatments, average tree health declined over the two-year trial period. Thus, none of the biological products tested were effective as remedial treatments for trees already infected and showing moderate to severe Phytophthora symptoms. However, the potential of these biological treatments as part of a preventative programme was not tested in this work

Keywords: *Phytophthora cinnamomi, biological control, chemical control*

INTRODUCTION

Phytophthora root rot is a major problem in New Zealand avocado orchards, causing significant tree decline and death on both conventional and organic orchards. The disease is caused by the fungal pathogen *Phytophthora cinnamomi.*

For the past few years the disease has been reasonably well controlled on conventional

orchards by use of phosphorous acid injections (e.g. Foli-R-Fos®, Tree-Doc®). However, the optimum time for injecting is poorly understood, the injection process is tedious, and there are concerns about potential impacts of the long-term use and build up of residues in the fruit. Additionally, organic growers have no proven tools available to combat Phytophthora root rot, and in some cases have to fore-go their organic status and inject with phosphorous acid to save the trees.

The trial covered in this paper investigated the most appropriate timing of phosphorous acid injections and tested the efficacy of potential alternative *Phytophthora* treatments, some of which may be acceptable for organic growers.

MATERIALS AND METHODS

In spring 2001, a replicated trial was set up across three western Bay of Plenty avocado orchards. All orchards were under organic management, and none of the trial trees had been treated previously with phosphorus acid.

Only trees showing moderate to severe decline were selected for the trial. Prior to treatment allocation, canopy health was recorded on a 0 to 6 scale, where 0 was healthy and 6 was dead. All selected trial trees were in the range 3 (slight dieback and/or defoliation) to 5 (severe dieback and defoliation). One of ten treatments (Table 1) was assigned to each tree, with six replicates of each treatment spread across the three sites. Care was taken to avoid bias in tree symptom severity within different treatments at the start of the trial. All trees were photographed, as a benchmark for comparison in future assessments of tree health (Figure 1).

Table 1. Trial treatments and application dates.

Treatment	Application Dates
1. Untreated control	
2. Foli-r-fos® (spring injection)	2/10/01, 8/10/02
3. Foli-r-fos® (autumn injection)	1/2/02, 12/2/03
4. Foli-r-fos® (spring & autumn injection)	2/10/01, 1/2/02, 8/10/02, 12/2/03
5. Tri-D25 (6-8 weekly)	18/10/01, 4/12/01, 3/2/02, 14/3/02, 29/4/02 12/12/02, 31/1/03, 12/3/03
6. Tri-D25 (2-3 x per annum)	18/10/01, 14/3/02, 29/4/02, 12/12/02, 12/3/03
7. GroChem DRH (high rate)	18/10/01, 15/2/02, -/10/02
8. GroChem DRH (low rate)/Enviroblast*	18/10/01, 15/2/02, 10/10/02*
9. E.M. (Effective microorganisms)	18/10/01, 21/11/01, 31/1/02, 5/3/02, 9/10/02†, 10/12/02, 13/2/03†, 7/5/03
10. Agrimm: Trichoject®+Trichodowel® +Trichoflow®+Trichopel®	18/10/01, 31/1/01**, 9/10/02††, 13/2/03††

* October 2002, DRH applied using Enviroblast.
† EM applied as 'bokashi' in sawdust in Oct '02 and Feb '03, otherwise as E.M. liquid drench.
** Trichopel only
†† Trichopel and Trichoflow only

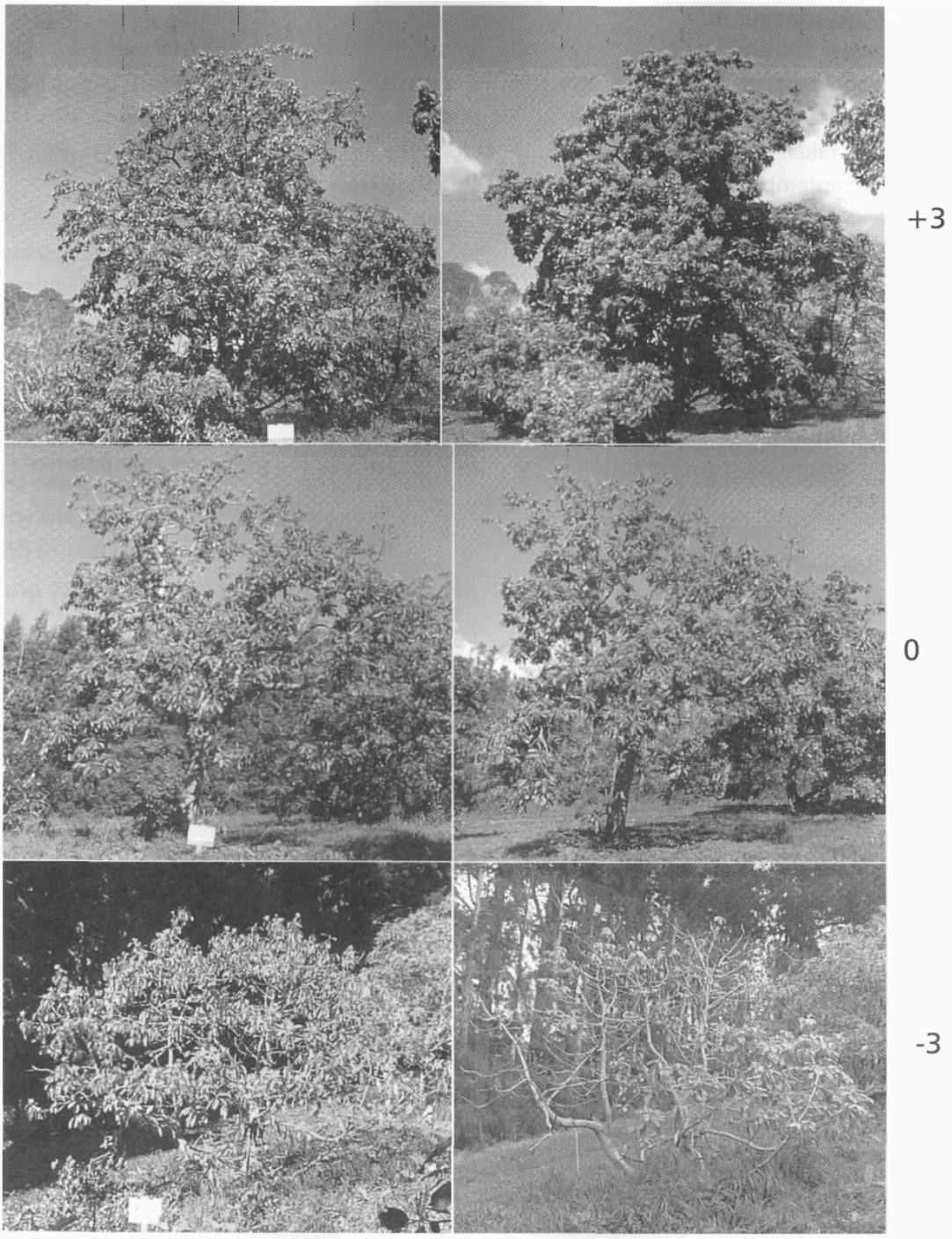


Figure 1. Typical before and after pictures of trial trees, used in part to make assessments of the changes in tree health. Pictures on the left were taken in September 2001, before the first treatment application. Pictures on the right were taken in September 2003. Top = substantial improvement, middle = little change, bottom = substantial decline.

Three phosphorous acid and six biocontrol treatments were investigated. Treatments

and application dates are shown in Table 1. In general, treatments were applied to coincide with the start of the spring root flush (October-November) and/or the autumn root flush (February-April). Phosphorous acid injections were at a rate of 20 ml of 50:50 Foli-r-fos®400 per meter of canopy diameter.

Tree health assessments

In early October 2002 and late September 2003, one and two years after the trial was established, tree health was again assessed. Canopy health and vigour was assessed using the same 0 to 6 scale as at the start of the trial (0 = healthy, 6 = dead). In addition, tree health was compared to that in the photographs taken at the start of the trial, before the first treatment application. For the final assessment (September 2003) trees were scored using the following scale:

Substantial decline	-3
Moderate decline	-2
Slight decline	-1
No apparent change	0
Slight improvement	+1
Moderate improvement	+2
Substantial improvement	+3

Typical comparisons are shown in Figure 1. For consistency of scoring, the same person carried out all of the assessments.

Root health assessments:

Feeder root health assessments were made at the end of the seasonal flushes in root growth, in December 2001, May 2002, December 2002, and May 2003. On each occasion, four feeder root samples were taken at cardinal points around each tree. Where possible, roughly 80-100 feeder root tips were collected in each of the four samples. Sampling was ceased once sufficient root tips were found, or after 5 minutes searching, whichever came sooner. Roots were gently washed to remove soil, and then all root tips were counted as alive and healthy, or diseased and/or dead. Mean percentage root decay was assessed for each tree.

RESULTS AND DISCUSSION

A summary of final tree and root health assessments is given in Table 2. Data were analyzed using Tukey's pairwise comparisons, with a family error rate of 0.05. Figure 2 shows the average change in canopy health, as determined using the initial photographs (Figure 1).

Two years after the initial treatments, trees treated with phosphorus acid tended to have better canopy health ratings than trees treated with the biologicals or those left untreated. For trees treated with phosphorus acid in the spring + autumn, differences were statistically significant.

A similar trend in treatment response was seen in the spring 2002 and 2003 comparisons with photos taken one and two years previously (Table 2 and Figure 2). Again, the phosphorous acid treatments rated the best, significantly better than the untreated controls.

Table 2. Average canopy disease and root disease ratings following various treatments in the avocado Phytophthora root rot trial. Letters after numeric values indicate significance classes based on Tukey's Pairwise Comparisons (family error rate 0.05). Absence of letters indicates that differences were not statistically significant.

Treatment	Canopy disease* (Sept 03)	Change in canopy health Sept01-Oct02** (from photos)	Change in canopy health Sept01-Sept03 ** (from photos)	Percentage feeder root decay Dec '02	Percentage root decay May '03
1. Untreated control	4.77 b	-1.08 c	-1.83 d	70.2	57.9
2. Foli-r-fos (spring)	3.63 ab	+0.9 ab	+1.25 ab	58.1	44.1
3. Foli-r-fos (autumn)	3.50 ab	+0.2 abc	+0.92 abc	49.1	44.6
4. Foli-r-fos (spring & aut.)	3.17 a	+1.3 a	+2.42 a	57.9	47.6
5. Tri-D25 (6-8 weekly)	4.42 ab	0 abc	-1.08 bcd	53.3	52.6
6. Tri-D25 (3 x per annum)	4.72 ab	-0.42 abc	-1.50 cd	61.8	52.1
7. GroChem DRH(high rate)	4.38 ab	-0.08 abc	-0.83 bcd	72.0	59.2
8. GroChem DRH (low rate)	4.70 ab	-0.5 bc	-1.67 d	65.6	51.8
9. E.M. (Effective micros.)	4.88 b	-1.33 c	-2.00 d	81.5	55.7
10. Agrimm: Tricho-	4.55 ab	-0.08 abc	-1.00 bcd	66.7	48.2

* mean canopy disease ratings, scored on a 0 to 6 scale, where 0 was healthy and 6 was dead.

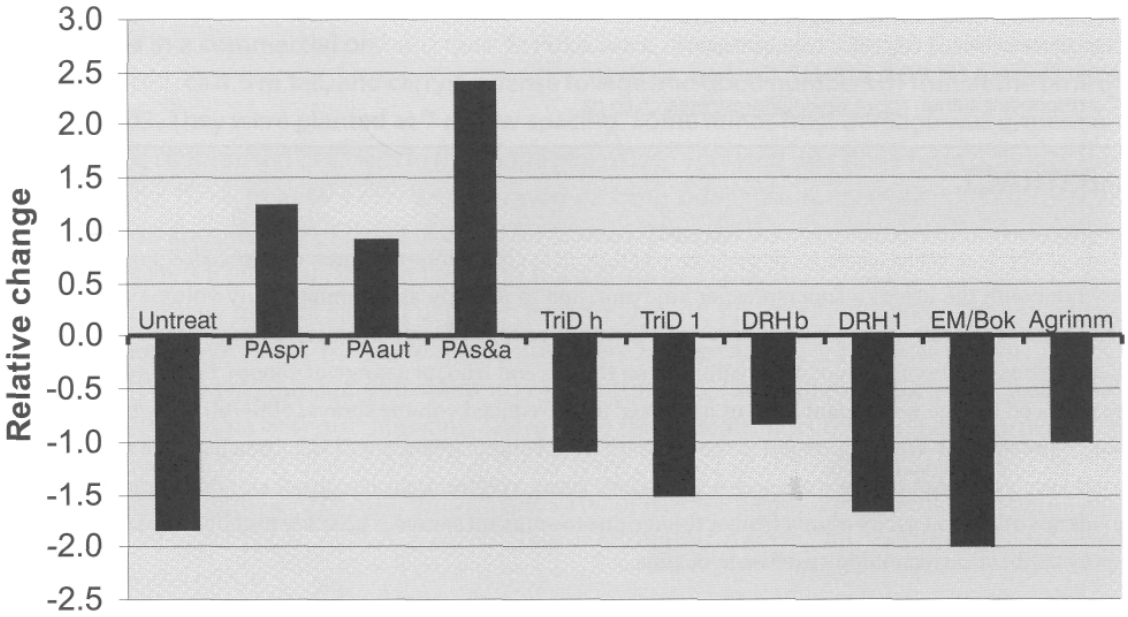
** change in canopy health, based on photographs taken in September 01, and used for comparison in October 02 and September 03. Positive numbers indicate improvement in health and vigour, negative numbers indicate decline in health and vigour.

In the assessments of feeder root decay, none of the differences between treatments were statistically significant, but trees treated with phosphorous acid tended to be towards the healthier end of the scale. Percentage feeder root mortality was relatively high in all treatments (49 80% in December 2002, 44 59% in May 2003), probably reflecting the fact that trial trees were moderately to severely diseased at the start of the trial. A quick check of roots in nearby healthy blocks indicated lower root mortality.

The overall ranking of treatments is roughly similar regardless of the assessment method used. For all assessments the phosphorous acid treatments ranked highest, with the spring + autumn treatment generally being the best. The untreated control and Effective Micro-organisms/Bokashi treatments were consistently the poorest treatments. The remaining treatments are grouped in the middle, not significantly different from either untreated controls or phosphorous acid treatments, though in general closer

numerically to the untreated control.

Figure 2. Mean Relative change in tree health, two years after first treatment application. Change scored in September 03 by comparing current symptoms to photographs taken at the commencement of the trial (Sept 01) on a 3 to $^{+}3$ scale, where 3 = substantial decline, 0 = no change and $^{+}3$= substantial improvement in tree health.



Treatments:

Untreat	=	Untreated control
PAspr	=	Foli-r-fos® (spring injection)
PAaut	=	Foli-r-fos® (autumn injection)
PAs&a	=	Foli-r-fos® (spring & autumn injection)
TriD h	=	Tri-D25 (6-8 weekly)
TriD l	=	Tri-D25 (2-3 x per annum)
DRH h	=	GroChem DRH (high rate)
DRH l	=	GroChem DRH (low rate)/Enviroblast
EM/Bok	=	E.M. (Effective microorganisms)/Bokashi
Agrimm	=	Agrimm: Trichoject®+Trichodowel® +Trichoflow®+Trichopel®

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The comparison with photos taken at the start of the trial proved the most useful technique of all the assessments used. The camera angle was noted, so direct comparisons could be made on representative parts of the canopy, and judgments made in the field on whether health had improved or declined. It was less subjective than scoring trees on an arbitrary disease scale, though this technique was also useful. Assessments of feeder root decay gave a similar ranking of treatments to the other techniques, but it was far more labour intensive and in the end was unable to separate treatments statistically. Root assessment does however give a rapid assessment of recent *Phytophthora* infection, rather that waiting 6-12 months for such activity to be reflected in tree canopy performance. The technique does have room for improvement, and is still a potentially useful tool for research purposes.

CONCLUSIONS

Phosphorous acid injection is the most effective remedial treatment of avocado trees showing canopy symptoms of Phytophthora root rot. Two applications, in spring and autumn appear to give better results than a single treatment at either of these times. None of the biological controls tested gave any significant remedial effect over the course of this trial. However, the biocontrol were not tested as potential components of preventative treatment in orchards, and their potential for this purpose cannot yet be ruled out.

ACKNOWLEDGEMENTS

This work was funded by the Avocado Industry Council through an AGMARDT grant. The co-operation of James Croskery, David Hayman and Ian Lankshear for the provision of trial trees is gratefully acknowledged. Tim Callaghan (Roots Shoots and Fruits Ltd) and Keri Walker (GroChem Ltd.) helped with application of Tri-D25 and DRH treatments, respectively. Agrimm Ltd supplied the ‘Tricho-' series products and The NZ Nature Farming Society supplied the EM and Bokashi treatments.