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Efficacy of H_3PO_3 leaf sprays and resistance of *Phytophthora cinnamomi* to H_3PO_3

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ABSTRACT

Leaf sprays of H_3PO_3 on Hass / Duke 7 trees were compared to H_3PO_3 trunk injection. Roots of treated trees were analysed for phosphonic acid residues 28 and 56 days after the second application of the treatments. Results indicated that two 0.75% H_3PO_3 leaf sprays, applied with a mist blower at 943l/ha, gave adequate levels of phosphonic acid in the roots.

Sensitivity to phosphonates, of Phytophthora cinnamomi *from phosphonate treated or untreated trees, has been determined since 1992. Results from tests done in 2000 indicated a change in the relative sensitivity to H_3PO_3 of the isolates from treated and untreated trees when compared to the previous years. A possible explanation for this is that new populations of* P. cinnamomi *could have been introduced to the trial trees during the extreme flooding which occurred in 2000, and resulted in atypical results when compared to previous years' results.*

EFFICACY OF H_3PO_3 LEAF SPRAYS

Low pressure injection of avocado trees with H_3PO_3 (with the use of syringes) is still the most popular method of injecting in South Africa, although high pressure injection equipment has been evaluated previously (Duvenhage & Köhne, 1995). However, injection of H_3PO_3 is labour intensive and time consuming, and causes injury to the wood tissue of the trunk with prolonged use (Robbertse & Duvenhage, 1999). In 1999 it was reported that fosetyl-Al or H_3PO_3 trunk sprays, applied from mid September to mid January, resulted in phosphonic acid residues comparable with two H_3PO_3 injection applications (Duvenhage, 1999). However, the cost of trunk sprays proved to be high, due to high amounts of chemical used per application, and the use of four trunk spray applications per year (as opposed to two injection applications).

A trial was then laid out to test the efficacy of leaf sprays for application of H_3PO_3 in comparison with trunk injections. Eight year old Hass trees on Duke 7 rootstock in the Tzaneen area were used for the trial. The trees were planted in 7m x 7m hedge rows which were pruned annually. Leaf sprays of 0.5%, 0.75%, and 1% H_3PO_3 were applied with a mist blower (pH adjusted to 7,2 with KOH). Ten trees were used per treatment, and sprayed after the spring and summer leaf flushes (fully expanded) as full cover sprays without runoff. The bottom nozzles of the mist blower were closed off up to a height of 1m above the ground to minimise spillage onto the soil. Ten trees were injected at the same time with 20% H_3PO_3 (pH adjusted to 6 with KOH) at a rate of 0.4g ai/m^2 of canopy area under the tree.

Root samples were taken at 28 and 56 days after the second treatment and analysed for phosphonic acid levels by the South African Bureau of Standards. Root samples were taken from 6 of

Table 1 Phosphonic acid levels in roots after the second application of the treatments

TREATMENTS	PO_3 (mg/kg) AFTER 2ND ROUND	
	28 days	56 days
2 X H_3PO_3 injections (20%; 0,4g/m^2)	18.5	7.1
2 X H_3PO_3 leaf sprays 0.5%	9.2	10.3
2 X H_3PO_3 leaf sprays 0.75%	22.6	*
2 X H_3PO_3 leaf sprays 1%	32.4	32

**** No samples analysed***

Table 2 Cost comparison between different application methods

COSTS PER HECTARE	INJECTIONS (2 rounds)	TRUNK SPRAYS (4 rounds)	0.75% LEAF SPRAYS (2 rounds)
Labour	R224/ year *	R98/ year *	R48/ year
Tractor & mist blower	-	-	R100/ year
Chemical	R160/year	R737/ year	R266/ year
Total cost	R384/ year	R835/ year	R414/ year

* Includes equipment

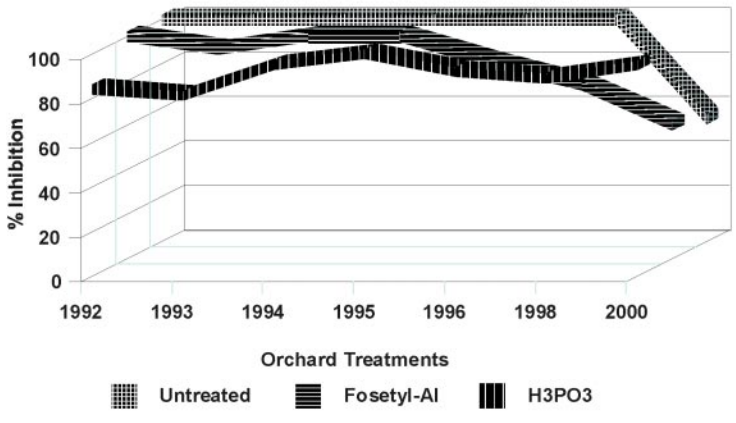

Figure 1* In vitro *inhibition of* P. cinnamomi *from different orchard treatments by H_3PO_3

the treated trees, pooling the roots of two trees per sample (taken at three places around each tree).

The 0.5% H_3PO_3 leaf sprays resulted in insufficient levels of phosphonic acid in the roots, while the 1% H_3PO_3 leaf sprays resulted in very high levels of phosphonic acid (Table 1). Leaf sprays of 0.75% H_3PO_3 resulted in phosphonic acid levels (only sampled after 28 days) comparable with that of the injections. However, the 0.75% H_3PO_3 leaf sprays were 8% more expensive than the 20% injections (Table 2). As the leaf sprays of 0,75% H_3PO_3 gave results comparable with injections, registration trials are now being carried out by Ocean Agriculture Pty (Ltd). While leaf sprays may be a convenient way of application of H_3PO_3, extreme care must be taken to minimise contamination of the soil – this may create a higher risk of *Phytophthora cinnamomi* developing resistance to phosphonates. Another factor that must be kept in mind is that the effect of rain soon after application of leaf sprays is still unknown.

RESISTANCE OF P. cinnamomi *TO* H_3PO_3

The avocado industry is reliant on phosphonates for chemical control of root rot, and phosphonates have been used world wide for root rot control since the development of the trunk injection technique at Westfalia Estate in the early 1980s (Darvas *et al*, 1983). However, it was found in 1992 that *P. cinnamomi* isolates which were exposed to phosphonates for a prolonged period (since 1980) were less sensitive to phosphonates *in vitro* than isolates from untreated trees (Duvenhage, 1994). The average decrease in the sensitivity (over the period 1992 - 1998) of isolates from phosphonate treated trees was about 13% when compared with isolates from untreated trees (Duvenhage, 1999). Similar results were also found in Australia by Weinert *et al* (1998). It was reported that the EC50 values of phosphonate, for *P. cinnamomi* isolates from untreated trees were 9 ppm ± 1.41, while that for isolates from phosphonate treated trees were 98 ppm ± 90.4. All these results indicated a shift in the sensitivity of *P. cinnamomi* after long term treatment with phosphonates.

Although the *in vitro* testing of the sensitivity of isolates towards phosphonates only reflects on the direct mode of action of phosphonates and not on the indirect modes of action, it still gives an indication of the relative sensitivity of isolates from phosphonate treated or untreated trees.

However, results from tests done in 2000 indicated a change in the relative sensitivity to H_3PO_3 of the isolates from untreated and treated trees, when compared to previous years (Figure 1). A closer look at the test orchard revealed that large volumes of surface water moved from higher lying, phosphonate treated orchards through the test orchard during the extreme floods which occurred in the first quarter of 2000 (> 2000 mm). Thereby soil and *P. cinnamomi* was distributed from these higher lying orchards through various areas of the test orchard. New populations of *P. cinnamomi* were most likely introduced to the trial trees, and probably resulted in the atypical results when determining the sensitivity of the *P. cinnamomi* isolates in 2000 as compared to previous years. This now questions the future relevance of the current orchard for determination of the long term effect of phosphonate treatment on sensitivity of *P. cinnamomi* to phosphonates.

ACKNOWLEDGEMENTS

The author wishes to thank SAAGA for financial support, Westfalia Estate for the use of experimental orchards and trees, and Mr J Modiepa and Mr H Mashele for technical assistance.

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