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The use of phosetyl-Al against Phytophthora root rot in avocados

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SYNOPSIS
Phosetyl-Al has been used for several years to control tree decline due to Phytophthora cinnamomi. *Yield benefit has been shown by treating apparently healthy trees.*

INTRODUCTION

Phosetyl-Al[i] is a systemic active ingredient used extensively to control downy mildews and root rots caused by fungi of the genus *Phytophthora.* Since 1978, it has been tested in avocados for the control of *Phytophthora cinnamomi* (Rands), the causal agent of avocado root rot.

In South Africa, Darvas *et al* (4) and Wood *et al* (13) showed that young trees required at least a monthly-applied foliar spray of 300 g/hl of phosetyl-Al. This proved to be valid in nurseries and groves during the first year of plantation where conditions are favourable for *Phytophthora cinnamomi* development. In the USA, Coffey *et al* (3) demonstrated the efficacy of a preplant treatment by drench at 1,5 g/plant, while in Morocco, Vanderveyen *et al* (12) confirmed that a preplant drench, or a dip in a bath, containing 3000g/plant of phosetyl-Al may help young trees to overcome planting stress. Many other trials have been done in bearing avocados, all concluding that the minimum rate must be 300 g ai/hl with a treatment interval of two to three months. Nevertheless the speed of vigour recovery is greatly dependent on the status of trees at the first application: the more defoliated they are, the longer the time required for complete recovery. When started at the first signs of defoliation, applications of phosetyl-Al give visible improvements the following year. When trees are heavily defoliated, Coffey *et al* (3) and Wood et al (13) demonstrated the necessity of cutting-back the trees to stimulate regrowth before treating with phosetyl-Al.

The current recommendation is to apply phosetyl-Al at a minimum dose of 300 g ai/hl with treatment intervals of one month in nurseries, one to two months in groves during the first year, two months in non-bearing trees and two to three months in bearing trees. We recommend a foliar spray as a standard treatment practice as this allows growers to obtain the maximum benefits from the basipetal systemicity of phosetyl-Al.

This paper demonstrates the importance and interest of the downwards systemicity of phosetyl-Al as a factor for increasing the productivity of groves.

PHOSETYL-AL: A BASIPETAL SYSTEMIC FUNGICIDE

Setting up evidence of systemicity

First evidence comes from grape metabolism studies of phosetyl-Al with p^{32} ratio-labelled active ingredient (2) After depositing droplets of labelled phosetyl-Al on some leaves of young grape cuttings, it was found that after 11 days, 30 per cent of the applied radio-activity was internal, and the majority of it (80 per cent) was in the form of phosphonate. Another study in grafted grapes, following the same protocol, yielded similar results with 20 per cent of the applied radioactivity being absorbed and 95 per cent of this present in the form of phosphonate after 23 days.

Chemical analyses made by Lutringer *et al* (8) confirmed this systemicity of phosphonates. In pot-grown tomatoes, upper and lower leaves were sprayed with phosetyl-Al. Unsprayed parts and the soil were protected during the treatment with polyethylene bag which were removed after the spray had completely dried. The contents of different parts of the plants were then analysed (the interval between treatment and the harvest of samples for analysis varied between two hours and two weeks). The results demonstrated that the product migrates in the form of phosphonates which are slowly converted into phosphorous acid. When comparing plants treated with phosetyl-Al with plants treated with phosphorous acid, Lutringer *et al* also demonstrated that phosphorous acid was absorbed and disappeared, faster than phosteyl-Al. The hypothesis they proposed to explain this, was that phosphorous acid is excreted by roots. Further studies confirm that phosphonates reach the extremity of roots and that excretion is possible (5,6).

In summary, these studies demonstrate that phosteyl-Al is systemic in the form of phosphonate which is progressively converted to phosphorous acid.

The practical interest of these properties

The slow conversion of phosetyl-Al into phosphorous acid reduces the risk of phytotoxicity, as it is known that sudden penetration of large amounts of phosphorous acid can cause cell destruction. This property also allows the prolonged protection of all parts of the treated plants and is the basis of the long-term efficiency of phosetyl-Al. Field results from Israel by Barak *et al* (1), which show that phosphorous acid does not protect citrus fruit from brown rot as long as phosetyl-Al does, further support this point.

In addition to the long-term efficacy, another important characteristic of phosetyl-Al is its basipetal systemicity. The translocation of active ingredient from leaves to the root system takes place regardless of root depth or distance from the point of application. This natural distribution of phosetyl-Al by internal means to the soil, provides protection within any part of the plant where *Phytophihora cinnamomi* can develop, even in the very new rootlets. No other soil treatment can achieve such an efficient localisation of a product.

This distribution to the extremities of the plant provides further advantages in the terms of the dynamics of microbial population in the soil:

- only micro-organisms in the immediate neighbourhood of roots, or in contact with them can be affected by treatment. This reduces the risk of disturbing non-target microorganisms, some of which are competitors for *P. cinnamomi.* This may also avoid the occurrence of a secondary problem related with the suppression of the inhibition of possible other pathogens by beneficial micro-organisms.
- as far as *P. cinnamomi is* concerned, the same situation occurs: only individuals attacking roots can be affected by the product. Should a product-tolerant subpopulation occur, it would be in competition with 'wild type' subpopulation suffering a permanent situation of numeral inferiority. Such a situation would contribute to reduce the risk of development of such a strain (7), (10), (11).

Therefore, the use of phosetyl-Al as a foliar spray, is the best way of keeping the root system permanently free of *P. cinnamomi,* without affecting the natural balance of other soil mircoorganisms.

AVOCADO YIELD IMPROVEMENT

The yield benefits obtainable with a treatment programme of phosetyl-Al is demonstrated by the following results.

Materials and Methods

Field trials were initiated on the tree variety Miguel, rootstock Walden, The trees were young enough so as to be clearly separated from their neighbours. All trees had a similar vigour at the beginning of the trial and were free of symptoms of decline due to *P. cinnamomi.* Experimental design was completely randomised with 10 to 12 replications, except for one trial where only four replicates were used. In all cases, plots consisted of one tree per plot and each plot was separated from its neighbours with one buffer tree. Treatments were made every two months using rates of 240 and 480 g/hl of phosetyl-Al in a spray volume sufficient to allow thorough coverage of leaves. The product was applied with a single nozzle power sprayer. The formulation used was the 80 per cent ai wettable powder named Aliette.

Two types of observations were made:

- measurement of growth of laterals marked at the beginning of the year. For this measurement, only the growth over the current year was taken into account.
- harvest of each tree and measurement of yield (expressed in weight of fruit) and calibration. The latter was carried out on samples of 20 fruit per tree either by weighing each fruit or by measuring their volume in a water-filled graduated glass.

Results

Growth measurements are presented in Table 1. The differences become noticable during the second year of treatment where the advantage of phosetyl-Al treatment reaches a level of 20 per cent over non-treatment. The difference is higher in situations where disease pressure is more severe.

In three trials in the USA, yield increase was in the order of 12 per cent where *P. cinnamomi* infestation was moderate and reached several hundred per cent in other situations (see Table 2) under high disease pressure.

Calibration measurements, presented in Table 3, show an important improvement of fruit calibration. This improvement accounts for only a part of the total yield increase. The other part is related to the increase in fruit numbers. Similar results have been reported by Coffey *et al* in California (3).

DISCUSSION AND CONCLUSION

Until recently, the efficacy of fungicides against *P. cinnamomi* in avocados was assessed by the vigour and mortality of trees which were selected for exhibiting visual decline symptoms. Trees without apparent symptoms were considered to be healthy and able to achieve their full yield potential.

Trials were initiated in trees which displayed no external symptoms of disease, assuming that hidden root rots might reduce growth and production before inducing tree decline. In all tests, a yield increase of at least 12 per cent was obtained. This means that nonvisible development of *P. cinnamomi* in trees is possible and reduces production for a long time before decline symptoms are apparent.

Applications of phosetyl-Al on apparently healthy trees in groves where Phytophthora root rot is present, therefore provides an extra benefit of yield increase. This justifies, in many situations, the treatment not only of trees with visible symptoms but of all trees in the grove. Furthermore, the specific basipetal systemicity of phosetyl-Al ensures that, where treatment programmes of groves are adopted, there are no adverse effects on the natural balance of soil micro-organisms.

TABLE 1 Influence of bi-monthly sprays of phosetyl-Al on twig growth.

Active ingredient	Dose g/hl	CHILE* Twig growth in cm			USA Lateral growth in cm			
					Test 1		Test 2	
		T+ 180	T+ 450	T+ 720	Year 1	Year 2	Year 2	Year 3
Untreated		27	28	8 a	23	8	6	9
phosetyl-Al	240				23	10		
phosetyl-Al	320	29	29	40 a				
phosetyl-Al	480				22	9	9	20
*after A. Pinto de Torres (9)								

TABLE 2 Influence of bi-monthly sprays of phosetyl-Al on yield (USA).

Active ingredient	Dose g/hl	Yield by tree (5 kg)		
		Test # 1 2 years	Test # 2 3 years	Test #3 2 years
Untreated		26 a	0	2 a
phosetyl-Al	240	38 b		
phosetyl-Al	480	35 ab	12	29 b

after M Coffey *et al* (3)

TABLE 3 Influence of sprays of phosetyl-Al on fruit calibration.

Active ingredient	Dose g/hl	AUSTRALIA	USA		
		Volume of 1 fruit (ml)	Test # 5 size of a fruit (g)		Test # 4 diameter in cm
			Year 1	Year 2	
Untreated		195 a	170	460	not harvestable
phosetyl-Al	240				9
phosetyl-Al	300	280 b	200	850	
phosetyl-Al	480				9

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[i] Active ingredient of ALIETTE®, wettable powder containing 80 per cent phosetyl-Al.