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EVALUATION OF COMMERCIALLY AVAILABLE PHOSPHONATE PRODUCTS FOR CONTROL OF *Phytophthora cinnamomi*

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There are numerous phosphorous acid products on the market that are sold as fertilizers but can have the same effect as a phosphonate fungicide on avocado root rot. Six different products, which were sold as either buffered fungicides or fertilizers, were tested for their efficacy against *Phytophthora cinnamomi* using avocado 'Topa Topa' seedlings planted in 5 X 15 cm liners with an organic potting mix. Products were applied as a drench equivalent to 2 liters of active phosphonate per hectare. One product was applied twice during the trials. The experiment included non-inoculated, as well as inoculated controls. There were 20 replications of each treatment. After disease progression had occurred the plants were separated into root and shoot portions, weighed, dried and reweighed. The trial was repeated two times. There were no differences in the efficacy of any of the materials, nor in single versus double applications. Trees treated with phosphonate had significantly greater root weights than untreated, inoculated trees, but less than untreated and uninoculated trees.

Key words: Phosphorous acid, Phosphite, Root rot, Avocado, *Persea americana, Greenhouse*

EVALUACIÓN DE PRODUCTOS FOSFONATOS DISPONIBLES COMERCIALMENTE PARA EL CONTROL DE *Phytophthora cinnamomi*

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Actualmente, existen diferentes alternativas en el mercado de productos con ácido fosforoso, que son vendidos a su vez como fertilizantes, pero que además poseen el mismo efecto que los fungicidas fosfonatos para el control de la "tristeza del palto". Seis productos distintos que se venden como fungicidas o fertilizantes tampones, fueron evaluados para medir su eficacia contra *Phytophthora cinnamomi* en la variedad 'Topa Topa' plantada en macetas de 5 por 15 cm sobre una mezcla orgánica. Las plantas fueron mojadas con soluciones de estos productos equivalentes a 2 litros de fosfonato activo por hectárea. Uno de ellos, fue aplicado dos veces durante el periodo de prueba. El experimento incluyó testigos inoculados y no inoculados, con veinte repeticiones de cada tratamiento. Después del desarrollo de la enfermedad, las plantas fueron separadas en parte aérea y parte radicular, las que luego, cronológicamente fueron: pesadas, secadas y pesadas una vez más, y en dos ocasiones. No hubo diferencias entre la eficacia de los materiales; ni siquiera con los tratamientos que recibieron dos aplicaciones. Sin embargo, las plantas

tratadas con fosfonato mostraron un peso de raíces significativamente mayor que las que no fueron tratadas pero si inoculadas y un peso menor que las que las que no fueron ni tratadas ni inoculadas.

1. Introduction

South African plant pathologists were the first to show that root rot in avocado could be controlled by trunk injection with phosphorous acid and the patented material Aliette® (Darvas *et. al.*, 1984). Aliette was briefly registered in California in the late 1980's, but the registrant soon lost interest in pursuing a full pesticide registration when it became apparent that other researchers believed phosphorous acid could be registered as a fertilizer - a process much less costly and simpler than a pesticide registration. The company continued to hold on to the patents for the product and the breakdown products that were useful in root rot control. By holding onto the patent, this effectively stopped other companies from pursuing a pesticide registration for phosphorous acid. In 1990, a publication reported that phosphite could be used as a source of phosphorus fertilizer and this became the basis for the registration of phosphite as a fertilizer (Lovatt, 1990). Subsequently, when the original patent expired, at least two materials have been registered as fungicides containing phosphite – Fosphite® and Agri-fos®. There are, however, numerous phosphite materials that have been registered as fertilizers (for some brands see Brunings *et. al.*, 2005), and every day seems to bring more brands onto the scene each making claims of having the best efficacy.

The objective of this study was to evaluate the efficacy of several brands of phosphite, either sold as a fungicide or as a fertilizer material.

2. Materials and Methods

Three-month old 'Topa Topa' seedling avocados with cotyledons removed were planted into a *Phytophthora cinnamomi* ($1\%_{vol/vol}$ millet inoculum) inoculated organic media (Sunland Professional Potting Mix, Sunland Garden Products, Watsonville, CA) in 5 X 15 cm liners. A control was also planted without the inoculum, as well as an inoculated control. One of six different materials was then applied as a soil drench until draining from the bottom of the liner. The materials were applied at the equivalent phosphorous acid concentration of $4L \cdot ha^{-1}$. The materials included two fungicides (Aliette®, Bayer Crop Science US, Research Triangle Park, NC and Fosphite®, J.H. Biotech, Ventura, CA) and four fertilizer materials that were buffered with potassium (Phosgard®, J.H. Biotech; P.K. Fight®, Floratine, Collierville, TN; Formula 1®, Custom Ag Formulators, Fresno, CA; and Nutriphyte®, Chemical Dynamics, Inc., Plant City, FL). There were 20 replicates for each of the controls and treatments. The experiment was repeated twice, with the second trial including a treatment that received two applications of Fosphite, one at planting and another two months into the trial. The plants were blocked and randomized in a greenhouse. In both trials, plants were grown for approximately three months. At harvest, plants were separated into roots and shoots, weighed, dried and reweighed. ANOVA was analyzed by Minitab (State College, PA).

3. Results and Discussion

Root fresh and dry weights were highest for the non-inoculated trees and lowest for the inoculated controls, in both trials. All treatments associated weights intermediate between these two were statistically the same. Even the repeat application treatment in trial II didn't result in greater root weights than single application treatments. Shoot weight, both dry and fresh, was much less affected by root rot and treatments. There were no differences in fresh weight in the second trial, not even between the inoculated and noninoculated controls. For dry weight shoots in the first trial, Nutriphyte had a significantly higher weight than even the noninoculated control. The root and shoot weights of all the treatments in the second trial were higher than in the first trial, indicating that either the inoculum was not as effective or that the trial was not continued long enough to produce as much damage.

Root rot studies often have dramatic effects on root weights while shoot weights may remain little affected. It is clear from our data that phosphonates reduced the severity of root rot in this study but that there was no benefit of a single source of phosphonate relative to any other source.

4. References

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Table 1. Root and shoot biomass in *Phytophthora cinnamomi* infested media treated with various phosphonate products from two experiments.
Biomasa de partes aerea y radicular en medio infestado con *Phytophthora cinnamomi* tratado con productos fosfonatos en dos experimentos.

Treatment	**Fresh wt. Root**	**(g)**[1]	**Fresh wt. Shoot**		**Dry wt. Root**	**(g)**	**Dry Wt. Shoot**	**(g)**
Experiment	**I**	**II**	**I**	**II**	**I**	**II**	**I**	**II**
Not inoculated	94.3a	95.7a	58.2a	89.4	13.7a	15.9a	22.0bc	38.7a
Inoculated control	16.7c	58.4cd	40.4b	85.3	3.6d	9.7cd	18.9cd	34.3ab
Aliette	52.7b	71.1abcd	62.7a	65.4	9.0b	10.9bcd	25.5ab	25.0b

Fosphite	56.5b	81.6abc	59.7a	81.9	8.6b	11.0bcd	21.7c	30.9ab
Phosgard	63.6b	73.5abcd	56.6a	79.1	9.7b	13.1abcd	21.8c	34.1ab
P.K. Fight	51.3b	77.3abcd	57.4a	82.2	7.5bc	14.2ab	21.8c	35.1a
Formula 1	63.5b	70.1abcd	64.1a	77.4	9.0b	12.5abcd	25.7a	31.9ab
Nutriphyte	56.1b	89.7ab	57.0a	96.4	8.1b	14.0abc	22.0bc	37.9a
Fosphite (2X)		65.7bcd		73.3		10.5bcd		31.9ab

[1]Means followed by the same letter are not significantly different according to ANOVA and LSD $_{P<0.01}$.