POTENTIAL OF BIOLOGICALLY-DERIVED NEMATICIDES FOR CONTROL OF ANTHURIUM DECLINE†

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RESUMEN

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Cinco alternativas de base biologica para fenamiphos fueron evaluadas para el control del deterioramiento del anthurio en un invernadero. Plantas de *Anthurium andreanum* cv. Midori inoculadas con 4 300 nematodos barrenadores, *Radopholus citrophilus,* fueron tratadas con ABG-9008 (28, 56 y 280 kg/ha), Nematrol® (19, 258 y 1 290 kg/ha), Clandosan® (2 240, 4 479 y 22 400 kg/ha), Sincocin® (0.5, 1.0 y 5 L/ha) o Farewell® (70 140 y 700 L/ha). Su crecimiento fue comparado contra el tratamiento de fenamiphos (3.4 kg/ha) y un tratamiento control. Plantas aplicadas con fenamiphos fueron las que más crecieron, mientras que las tratadas con Clandosan murieron o su crecimiento fue sevcramente limitado. Poblaciones del nematodo barrenador fueron altas en las plantas tratadas con Nematrol (129 kg/ha). Las plantas aplicadas con la dosis alta de Nematrol (258 kg/ha) crecieron más que las plantas no aplicadas pero menos que las plantas aplicadas con fenamiphos ($P \leq 0.05$). Una evaluación de campo de ABG-9008, Farewell y Sincocin puede ser necesaria debido a que estos productos son designados para interactuar con la microflora del suelo que a lo mejor no estuvo presente en la evaluación de invernadero.

Palabras clave: ABG-9008, *Anthurium andreanum,* Clandosan, Farewell, fenamiphos, nematodo barrenador, *Radopholus citrophilus,* Sincocin.

Anthurium decline is a serious and chronic problem in anthurium culture in Hawaii (Aragaki and Apt, 1984). The disease is caused by the burrowing nematode Radopholus citrophilus (Huettel *et al.,* 1986) and can reduce flower production by up to 50% (Aragaki and Apt, 1985). Current control strategies range from use of tissue-cultured plants and preplant soil treatments with metam-sodium to post-plant applications of fenamiphos (Higaki *et al.,* 1994). Environmental concerns have led to the desire for alternative, less toxic, and more socially acceptable control methods for anthurium decline.

Several non-traditional pesticides are currently marketed in Hawaii for nematode control. Clandosan 618® contains chitin byproducts from crab shells and purportedly enhances nematode trapping fungal soil activity (Rodríguez-Kábana *et al.,* 1989). Farewell®, a hydrolyzed protein solution, also claims enhancement of soil-borne fungi which attack nematodes. ABG-9008, currently under development by Abbott Laboratories, is derived from a killed soil fungus that is toxic to nematodes (Warrior *et al.,* 1995). Sincocin®, a fatty acid-based product, is a soil supplement claiming multiple modes of action against nematodes (El-Nagar *et al.,* 1994). Nematrol® is ground sesame plant which directly acts upon the nematode. The objective of this research was to evaluate

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these biologically-derived pesticides for efficacy against burrowing nematode and for phytotoxicity on anthurium.

Eighty-five plants of *Anthurium andreanum* cv. Midori propagated from tissue culture were obtained from a burrowing nematode-free nursery, weighed, and transplanted into 15-cm-diam clay plots filled with sterile volcanic cinder (9.5-19 mm diam). The transplants were maintained in the greenhouse and fertilized once, 2 months after transplanting, with 5 g of slow release fertilizer (14-14-14)/pot.

One month after transplanting, 4 300 mixed life stages of burrowing nematode suspended in 2 ml aliquots were pipetted near the base of each plant. Nematodes were obtained from a laboratory culture of *Radopholus citrophilus* originally isolated from anthurium on the island of Hawaii. The nematodes were maintained on alfalfa callus (Ko *et al.*, 1996) and extracted using a mist chamber.

Four weeks after inoculation, treatments consisting of (1) ABG-9008 (28, 56, or 280 kg formulated product/ha) (Abbott Laboratories, Long Grove, IL), (2) Nematrol® (129, 258, or 1 290 kg formulated product/ha) (B. McBrayer, Acampo, CA), (3) Clandosan 618® (560, 1 120, or 5 600 kg a.i./ha) (IGENE Biotechnology Inc., Columbia, MD), (4) Sincocin® (3, 5, or 30 ml a.i./ha) (Appropriate Technology, Ltd., Dallas, TX), and (5) Farewell® (70, 140, and 700 L formulated product/ha) (Organic Alternatives Inc., Visalia, CA) were applied to the plants. The ABG-9008, Sincocin, and Farewell were mixed in 50 ml of water and applied around the base of the plants. The Nematrol and Clandosan treatments were broadcast over the surface of the pot. The concentrations evaluated represent 0.5×, 1×, and 5× labeled rates. An untreated control and a fenamiphos (Nemacur 3) 3.4 kg a.i./ha treatment were included as standards for comparison. Each treatment was replicated five times in a completely random experiment blocked according to initial plant weight.

The experiment was terminated with plant harvest at 5 1/2 months after treatment, sufficient time for the completion of at least six nematode generations. Root and shoot fresh weights were recorded. A 20 g root subsample was placed in the mist chamber for 3 days to collect nematodes. The leaves were separated from the stem, and the stem placed into the mist chamber to extract nematodes. Nematodes were counted and the tissue oven-dried at 60°C to a constant weight. Relative plant growth and nematodes per g plant tissue were calculated. Data were analyzed for variance and a Waller-Duncan means separation procedure was used where appropriate.

Burrowing nematodes were found in all living anthurium plants (Fig. 1) in both the root and stem tissue (Fig. 2). The total burrowing nematode population was greatest in those anthurium treated with the low rate of Nematrol and lowest in the dead Clandosan-treated plants (Fig. 1). Nematode populations did not decrease in response to increasing concentrations of any of the treatments. Although differences were detected among the numbers of nematodes per g dry root (Fig. 2), no linear response was detected with any product. In the stem tissue, nematode numbers were greatest in the untreated plants but no differences were detected among the treatments ($P \geq 0.05$) (Fig. 2). The final nematode population and nematodes/g tissue did not reflect efficacy of the compounds. Higher numbers of nematodes frequently occurred in the plants with greater growth because healthy plants can probably support greater numbers of nematodes.

The anthuriums exhibited few symptoms of phytotoxicity (yellowing or decreased growth) to the products except for Clandosan. Recommended fertilization

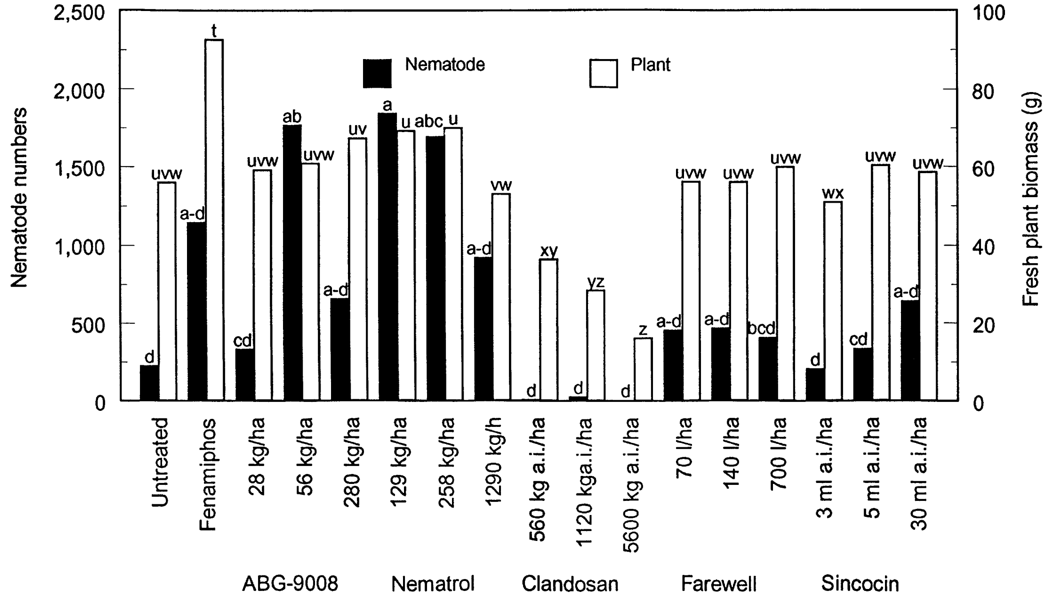

Fig. 1. Population of burrowing nematode, *Radopholus citrophilus,* in the roots and stem and total fresh weight at harvest of *Anthurium andreanum* cv. Midori treated with different nematicides at three rates. Bars with the same letter are not different according to a Waller-Duncan k ratio t-test (k = 100).

rates are 336 kg N/ha/year and organic fertilizers are commonly used in anthurium (Higaki *et al.,* 1994). Plants treated with the higher rates of Clandosan may have suffered fertilizer burn. However, even the low rate of Clandosan (233 kg N/ha) caused phytotoxicity. The nitrogen may have been released too quickly for the plants in the Clandosan treatments. Plant growth was greatest in those anthurium treated with fenamiphos (Figs. 1 and 2).

Fenamiphos was the most effective treatment in reducing anthurium decline in terms of enhanced plant growth. Nematrol decreased anthurium decline slightly, whereas the other products had little effect on nematode damage to the anthurium plants. ABG-9008 was effective against root-knot and cyst nematodes (Warrior *et al.,* 1995) but may not be as effective against burrowing nematodes. Farewell and Clandosan reportedly enhance biological activity of soil (Rodríguez-Kábana *et al.,* 1989). This was not observed in the greenhouse perhaps due to the sterile cinder media used in this experiment. Therefore, no nematode control occurred. Sincocin is a multicomponent product that may have few effects on the burrowing nematodes but may be beneficial in controlling secondary invaders, such as *Pythium* and *Phytophthora* that occur in fields. Consequently, Sincocin may provide better control in field situations where these facultative pathogens are present and contribute to the severity of anthurium decline.

None of the non-traditional alternatives evaluated provided control comparable to fenamiphos. Nematrol, however, may offer an acceptable non-traditional control option where fenamiphos is unavailable or undesired. Other non-traditional nematicides, such as Sincocin, merit field evaluations before their efficacy is determined.

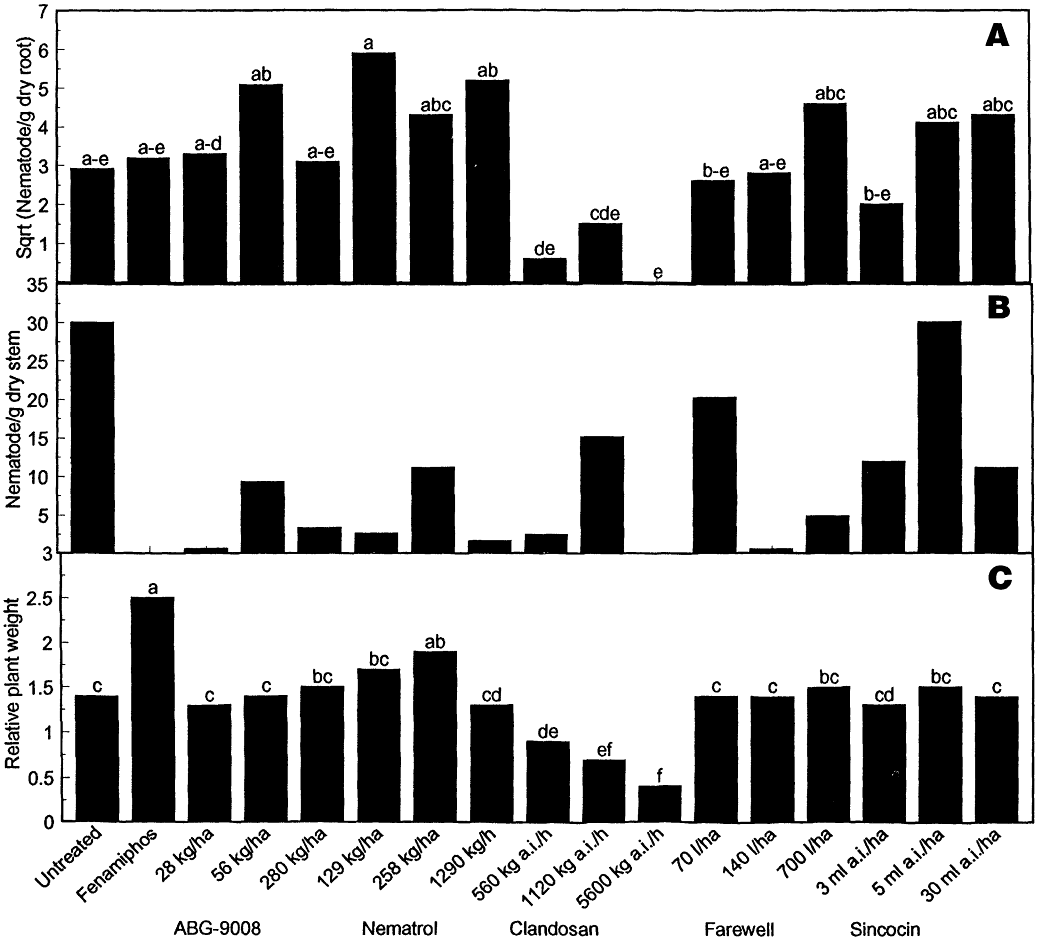

Fig. 2. Numbers of *Radopholus citrophilus* and growth of *Anthurium andreanum* cv. Midori treated with different biologically-derived non-traditional nematicides. A) Square root transformation of nematodes per g dry root. B) Nematodes in the stems. C) Relative plant growth = final plant weight divided by weight at transplanting. Bars with the same letter are not different according to a Waller-Duncan k ratio t-test (k = 100).

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