Impact on Anthurium Production of Controlling an Orchid Thrips (Thysanoptera: Thripidae), an Anthurium Whitefly (Homoptera: Aleyrodidae), and a Burrowing Nematode (Tylenchida: Tylenchidae) with Certain Insecticide–Nematicides

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ABSTRACT The insecticide–nematicides aldicarb and oxamyl were effective against an orchid thrips, *Chaetanaphothrips orchidii* (Moulton), an anthurium whitefly, *Aleurotulus* sp. and a burrowing nematode, *Radopholus similis* (Cobb) Thorne on 'Ozaki' anthuriums. Abamectin controlled the orchid thrips, while phenamiphos controlled the burrowing nematode. Plants treated with aldicarb, phenamiphos, and oxamyl had increased flower production and flower stem length. Spathe area was increased by aldicarb and phenamiphos. Increase in flower production, flower stem length, and spathe area was mainly attributed to control of the burrowing nematode.

KEY WORDS Insecta, Nematoda, chemical control, anthurium

ANTHURIUM, *Anthurium andraeanum* Lind. & Andre, is commercially grown in Hawaii for its exotic, colorful, and long-lasting flowers. Three common pests which reduce marketability and production are a thrips, *Chaetanaphothrips orchidii* (Moulton), a whitefly, *Aleurotulus* sp., and a burrowing nematode, *Radopholus similis* (Cobb) Thorne. *C. orchidii* causes white streaks and distortion on the abaxial and adaxial surfaces of the spathe and can be controlled with certain contact and contact-systemic insecticides (Hara et al. 1987). The anthurium whitefly is an undescribed species of *Aleurotulus* and a relatively new pest of anthuriums first reported in Hawaii in 1978 (Nakahara 1981). *Aleurotulus* sp. usually colonizes under the flower stem or petiole sheath and secretes copious amounts of white, powdery, waxy material. No parasitoids have been recovered from *Aleurotulus* sp., and insecticides that are effective against *Aleurotulus* sp. are unknown. Burrowing nematode infestations are associated with small flowers and poor flower production and have been implicated as the cause of anthurium decline (Higaki et al. 1979, Aragaki et al. 1984). The recommended control measure for the burrowing nematode in anthuriums is phenamiphos 10 granular applied every 6 mo (Higaki et al. 1979).

Our study was done to evaluate chemical pesticides with insecticidal and nematicidal activity against *C. orchidii*, *Aleurotulus* sp., and the burrowing nematode, and to determine effects of these pests on plant growth and flower production.

Materials and Methods

Tests were conducted at the University of Hawaii, Waiakea Agricultural Experiment Station in Hilo, Hawaii (183 m) on 'Ozaki' anthurium grown in volcanic cinder under 78% shade. Each experimental plot (1.8 by 1.8 m) was delineated by concrete tile blocks and consisted of 36 plants. Plots were planted in June 1983 and fertilized with a slow-release resin-encapsulated 13.5:13.5:13.5 (NPK) fertilizer every 6 mo at 145 g/m^2. A 0.9-m walkway was provided between plots. Plots were arranged in a randomized complete block design with four blocks and five treatments.

Treatments included the following insecticide–nematicides and rates: abamectin 0.15 emulsifiable concentrate (Merck & Co., Inc., Rahway, N.J.) at 0.002 g (AI)/m^2 (0.01 g [AI]/liter), phenamiphos 15 G (Mobay Chemical Corp., Kansas City, Mo.) at 0.79 g (AI)/m^2, aldicarb 10 G (Union Carbide Agricultural Products Co., Inc., Research Triangle Park, N.C.) at 0.85 g (AI)/m^2, and oxamyl 2.0 liquid (E. I. Du Pont de Nemours & Co., Inc., Wilmington, Del.) at 0.28 g (AI)/m^2 (1.20 g [AI]/liter). A spreader–sticker, Triton B-1956 (Rohm and Haas Co., Philadelphia, Pa.) was added at a rate of 0.23 ml/liter solution to all spray treatments, including control plots. Abamectin and oxamyl were applied with a compressed CO_2 sprayer equipped with a No. 8004 Teejet (Spraying Systems Co., Wheaton, Ill.) nozzle. Phenamiphos and aldicarb were applied with a granular applicator. Treatments began on 26 November 1984 and ended 8.0–8.5 mo later. Abamectin and oxamyl were applied at 2-wk intervals to 23 July 1985 for a total of 18 applications. Phenamiphos was applied at 12-wk intervals to 19 August 1985 for a total of four applications. Aldicarb was applied at 6-wk intervals until 1 April 1985 and 17 wk later on 5 August 1985, for a total of five applications.

Table 1. Thrips injury of harvested 'Ozaki' anthurium flowers during November 1984 to November 1985

Date	Flowers injured (%)				
	Abamectin[a]	Phenamiphos[b]	Aldicarb[c]	Oxamyl[d]	Control
Nov. 1984 (pretreatment)	44a	62a	29a	76a	27a
Dec. 1984	50a	63a	68a	52a	26a
Jan. 1985	14b	35ab	65a	18b	9b
Feb. 1985	9a	24a	33a	2a	5a
Mar. 1985	7bc	39ab	12bc	1c	54a
Apr. 1985	8b	54a	19b	2b	49a
May 1985	9b	58a	23ab	6b	47a
June 1985	23b	78a	15b	9b	56ab
July 1985	25bc	45ab	10c	7c	79a
Aug. 1985	30a	30a	16a	33a	63a
Sept. 1985	15a	42a	19a	22a	45a
Oct. 1985	11a	34a	12a	38a	5a
Nov. 1985	23b	59ab	20b	80a	26b

Means followed by the same letter in a row are not significantly different ($P = 0.05$; Duncan's [1955] multiple range test).
[a] Abamectin 0.15 EC at 0.01 g (AI)/liter applied at 2-wk intervals to 23 July 1985.
[b] Phenamiphos 15 G at 0.79 g (AI)/m^2 applied at 12-wk intervals to 19 August 1985.
[c] Aldicarb 10 G at 0.85 g (AI)/m^2 applied at 6-wk intervals to 1 April 1985 and on 5 August 1985.
[d] Oxamyl 2.0 L at 1.2 g (AI)/liter applied at 2-wk intervals to 23 July 1985.

Anthurium flowers were harvested every 2 wk at three-fourths to full maturity. Each harvested flower was observed for thrips injury (white streaks on spathe), and the flower stem length and spathe area (length × width) were measured. Each anthurium plant was observed monthly for the presence of *Aleurotulus* sp. in sheaths. Nematodes were monitored from media samples taken every 3–4 mo from the root zone. Three media samples (470 ml) were taken from each plot, and nematodes were extracted from 50 ml of media using the Baermann funnel method.

Percentages were transformed to arcsine and nematode counts to $\log(x + 1)$ before analysis of variance. Means were separated by Duncan's (1955) multiple range test ($P = 0.05$).

Results and Discussion

Anthurium flowers had less thrips injury than the controls in abamectin-, aldicarb-, and oxamyl-treated plants between March 1985 and July 1985 (Table 1). Injury in control plots increased in spring and summer months and decreased in fall and winter months, confirming the seasonal trends of *C. orchidii* on anthuriums reported by Hara et al. (1987).

Whiteflies were not found on aldicarb- and oxamyl-treated anthurium plants throughout the entire period of the experiment. Phenamiphos, abamectin, and control plots had very low levels of whitefly infestations during December 1984 (<10% of plants infested); infestations increased to significant levels by May and June 1985 (Table 2). Infestations progressively declined to a very low level in July 1985. The decline was not caused by parasitoids, because none was recovered from whitefly-infested sheaths. The decline in whitefly population may be seasonal (similar to *C. orchidii*) and requires further investigation.

Table 2. Infestation of 'Ozaki' anthurium plants with a whitefly, *Aleurotulus* sp., after treatment with abamectin, phenamiphos, aldicarb, and oxamyl

Treatment[a]	Plants infested (%)			
	20 May 1985	5 June 1985	23 July 1985	19 Aug 1985
Abamectin 0.15 EC	33a	12a	4a	0a
Phenamiphos 15 G	19a	10a	0a	0a
Aldicarb 10 G	0b	0b	0a	0a
Oxamyl 2.0 L	0b	0b	0a	0a
Control	25a	9a	0a	0a

Means followed by the same letter in a column are not significantly different ($P = 0.05$; Duncan's [1955] multiple range test).
[a] See Table 1 for application rates and intervals.

The burrowing nematode population was significantly lower within 4 mo (February 1985) of initial treatments in the aldicarb, phenamiphos, and oxamyl treatments compared with controls (Table 3). Eight months (June 1985) after initial treatment, all treatments had significantly lower nematode levels than control plots. Aldicarb and oxamyl provided the best control in September 1985 compared with abamectin, phenamiphos, and control treatments. A decline in nematode population was observed in the controls such that, by 14 mo (January 1986) after initial treatment, the nematode population in the controls was similar to that in treated plots. The decline may have been due to the severe infection and rotting of roots and basal stem which were observed in control plants. The infection and rotting rendered plants incapable of supporting a large population of burrowing nematodes.

Flower production did not differ significantly among all treatments during the first 9 mo (December 1984–August 1985) after initial treatment

Table 3. Burrowing nematodes in anthurium media after treatment with abamectin, aldicarb, phenamiphos, and oxamyl

Treatment[a]	No. nematodes/50 cc media				
	Oct 1984 (pretreatment)	Feb 1985	June 1985	Sept 1985	Jan 1986
Abamectin 0.15 EC	7a	12ab	5b	5a	3a
Phenamiphos 15 G	40a	3bc	1c	2ab	2a
Aldicarb 10 G	31a	1c	1c	0b	1a
Oxamyl 2.0 L	33a	2bc	1c	0b	6a
Control	41a	34a	16a	7a	2a

Means followed by the same letter in a column are not significantly different ($P = 0.05$; Duncan's [1955] multiple range test).
[a] See Table 1 for application rates and intervals.

Table 4. Effects of abamectin, phenamiphos, aldicarb, and oxamyl on 'Ozaki' anthurium flowers harvested

Treatment[b]	Flowers harvested/plot[a]/mo				
	Winter 1985 (Dec.-Feb.)	Spring 1985 (Mar.-May)	Summer 1985 (June-Aug.)	Fall 1985 (Sept.-Nov.)	Winter 1986 (Dec.-Feb.)
Abamectin 0.15 EC	9a	9a	14a	14bc	10b
Phenamiphos 15 G	8a	9a	12a	15b	11b
Aldicarb 10 G	9a	9a	14a	17b	14a
Oxamyl 2.0 L	9a	10a	13a	20a	16a
Control	8a	8a	12a	11c	8c

Means followed by the same letter in a column are not significantly different ($P = 0.05$; Duncan's [1955] multiple range test).
[a] Each plot consisted of 36 plants.
[b] See Table 1 for application rates and intervals.

(Table 4). However, at 12 mo after treatment (fall 1985) and continuing into winter 1986, oxamyl-, aldicarb-, and phenamiphos-treated plots had significantly greater numbers of harvested flowers than the control plots. In winter 1986, production was greatest in oxamyl- and aldicarb-treated plots, followed by those in plots treated with phenamiphos and abamectin.

Flower stems were longer in the aldicarb and oxamyl treatments than controls in fall 1985 and winter 1986, while abamectin and phenamiphos treatments resulted in greater lengths than in controls by winter 1986 (Table 5). Aldicarb- and phenamiphos-treated plants had significantly greater spathe area than control plants during fall 1985 and winter 1986.

Phytotoxic symptoms were not observed on leaves or flowers of 'Ozaki' anthuriums with the insecticide-nematicides tested.

Results of this study agree with those of Aragaki et al. (1984) and Higaki et al. (1979), who showed that the control of the burrowing nematode with phenamiphos results in increased flower production and spathe area. In our study, increased flower production and size (spathe area and flower stem length) occurred with phenamiphos; however, *C. orchidii* and *Aleurotulus* sp. were not controlled. Aldicarb and oxamyl controlled nematodes, thrips, and whiteflies, and their use increased flower production and size. Abamectin effectively controlled only thrips, with minimal increases in flower production and size. Nematodes appear to be the major limiting factor in production and flower size.

This study demonstrates that certain nonfumigant insecticide-nematicides such as aldicarb or oxamyl will control insect as well as nematode pests of anthuriums with increases in flower quantity and quality.

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Table 5. Flower stem length and spathe area (length × width) of 'Ozaki' anthurium flowers after treatment with abamectin, aldicarb, phenamiphos, and oxamyl

Treatment[a]	Winter 1985 (Dec.-Feb.)	Spring 1985 (Mar.-May)	Summer 1985 (June-Aug.)	Fall 1985 (Sept.-Nov.)	Winter 1986 (Dec.-Feb.)
			Flower stem length (cm)		
Abamectin 0.15 EC	49a	46a	48a	52bc	50b
Phenamiphos 15 G	43a	42a	46a	51bc	50b
Aldicarb 10 G	50a	52a	52a	61a	61a
Oxamyl 2.0 L	52a	50a	53a	57ab	55ab
Control	47a	42a	43a	45c	45c
			Spathe area (cm^2)		
Abamectin 0.15 EC	161a	174a	174a	163ab	150ab
Phenamiphos 15 G	145a	163a	168a	171a	165a
Aldicarb 10 G	163a	187a	190a	184a	167a
Oxamyl 2.0 L	176a	162a	173a	141b	129b
Control	160a	149a	155a	137b	134b

Means followed by the same letter in a column are not significantly different ($P = 0.05$; Duncan's [1955] multiple range test).
[a] See Table 1 for application rates and intervals.

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