Reduced Pesticide Use in an IPM Program for Anthuriums

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ABSTRACT An integrated pest management program (IPM) for anthuriums successfully reduced pesticide applications without reducing production and marketability. During 1986 and 1987, insecticide, acaricide, and fungicide applications at three farms studied were reduced by 45, 79, and 96%, respectively, by economically justifying spray applications. No significant increase in thrips, mite, or anthracnose injuries occurred, nor did total cost for treatment and pest damage increase. Our study indicated that the IPM concept implemented on a floricultural crop can reduce pesticide applications and increase profitability.

KEY WORDS Insecta, anthurium, floriculture, integrated pest management

ANTHURIUM, *Anthurium andraeanum* Andre, is an herbaceous perennial grown in Hawaii for its colorful, long-lasting, cut flower. Major economic pests of anthuriums are anthurium thrips, *Chaetanaphothrips orchidii* (Moulton) (Thysanoptera: Thripidae); false spider mites, *Brevipalpus* spp. (Acari: Tenuipalpidae); and anthracnose, *Colletotrichum gloeosporioides* (Penzig), a fungal disease attacking the spadix. Many anthurium growers apply several insecticides and fungicides at 1- to 3-wk intervals to control thrips and anthracnose (Hara et al. 1989). However, Hara et al. (1987) demonstrated that seasonal decreases in population of pests, such as thrips, may reduce the number of pesticide applications necessary for control.

Development of integrated pest management (IPM) strategies in floriculture has lagged far behind those in other crops (Parrella & Jones 1987). Formerly, growers considered the cost of pesticides relatively insignificant because the aesthetic value of commercial flowers contributed to a very low economic threshold (Parrella & Jones 1987). Anthuriums are of no exception (Hawaii Agricultural Statistics Service 1988). The costs and risks of pesticide use has dramatically increased so that an IPM program for anthuriums now becomes a necessity.

The objective of our study was to compare the economics of a proposed IPM program with those of conventional pest control used by anthurium growers. IPM pesticide applications were determined by monitoring pest and disease injury levels and economics, while the growers' applications were determined primarily by calendar schedule.

Materials and Methods

The test sites, typical of the surrounding anthurium growing areas in east Hawaii County, were at Hilo (Farm 1, elevation 122 m), Pahoa (Farm 2, elevation 182 m), and Kurtistown (Farm 3, elevation 305 m). Each farm was composed of a grower section, which was sprayed on a calendar basis, and an IPM section, where pesticides were applied when damage approached economic injury levels (EIL). Within each section (506 m²/section), at least three replicate plots (9 by 2 m) each containing about 190 plants were established for monitoring pests and diseases and for obtaining data on flower damage at harvest. Developing flowers in IPM plots were monitored once every 2 wk for pests and diseases by observing for signs and symptoms as reported by Bushe et al. (1987). For example, anthurium thrips were monitored by observing developing flowers for white streaks and distortions on upper or lower surfaces of the spathe. Developing flowers in the grower section were not monitored. All anthurium flowers that were three-fourths to fully matured were harvested from all plots from September 1985 to August 1987 on weeks when developing flowers in IPM plots were not monitored (once every 2 wk). Unmarketable flowers were categorized by damage caused by anthracnose, mites, and thrips. Data were collected from all three farms from fall 1985 to summer 1986, but only from Farm 2 and Farm 3 from fall 1986 to summer 1987. Farm 1 implemented the IPM concept on their anthurium production after the first year's trial.

In the IPM section, control measures (Higaki et al. 1979, Hara & Mau 1987) were implemented only when injury levels approached the EIL of about 6% flower injury due separately to thrips, mites, or anthracnose. The EIL is defined as the critical pest density, at which the loss caused by the pest equals in value the cost of available control measures (Luckmann & Metcalf 1982). The EIL was determined by comparing pesticide application costs and value of pest injury using a modified

Table 1. Worksheet for determining economic injury levels (EIL) for pests of anthurium. Example is given for thrips at the economic injury level of 6.55% (modified from Stuckey et al. 1984)

1. Anticipated returns without thrips injury	
a. Estimated yield per ha per mo (doz)	1,730
b. Expected market price per doz ($)	3.50
c. Gross returns per ha (1a × 1b) ($)	6,055.00
2. Anticipated loss damages without treatment	
a. Estimated percent yield loss	6.55%
b. Dozens loss per ha per mo (1a × 2a)	113.31
c. Dollar loss per ha per mo (1b × 2b)	396.59
3. Cost of control treatment	
a. Total cost of pesticide per application at 1870.7 liters/ha (Malathion 5 EC)	34.59
b. Cost of pesticide application per ha (labor, fringe benefits, equipment maintenance)	49.42
c. Cost of treatment per ha (3a + 3b)	84.01
d. Total number of applications required to control pest	4
e. Total cost of treatment per ha (3c × 3d)	336.04
4. Anticipated loss even with treatment	
a. Estimated percent yield loss with treatment	1%
b. Dozen yield loss per ha treated (yield/ha − 1,730 × 4a)	17.3
c. Dollar loss per ha ($ per doz × 4b)	60.55
5. Determining economic justification for pesticide application	
a. Per acre value of increased yield from pesticide [increase yield (2c) minus loss with treatment (4c)]	336.04
b. Net returns—(increase yield minus cost of control)	0.00

worksheet developed by Stuckey et al. (1984) (Table 1). Pesticide application costs were based on suggested retail price of the pesticide, labor, fringe benefits, and equipment maintenance. The value of thrips, mites, and anthracnose injuries was determined on the expected wholesale price of anthurium flowers. For example, based on an expected wholesale price of $3.50/doz for medium size 'Ozaki' anthuriums, the EIL for thrips was 6.6%, which equaled control costs (Table 1).

Pesticides in the IPM sections were applied at a rate of 1870.7 liters of finished spray per ha (twice the rate of growers), which was needed to ensure thorough coverage. Anthurium thrips was controlled by three to four applications of malathion 5.0 emulsifiable concentrate (EC) (Malathion, Hopkins Agricultural Chemical Company, Madison, Wis.) or dimethoate 2.67 EC (Dimethoate, FMC Corporation, Philadelphia) at 2-wk intervals. The false spider mite was controlled by two to three applications of fenbutatin-oxide 50 wettable powder (WP) (Vendex, Shell Chemical Company, Houston) at 2-wk intervals; anthracnose was controlled by one to two applications of mancozeb 80 WP (Dithane M-45, Rohm & Haas Company, Philadelphia).

Growers applied pesticides (935.4 liters of finished spray per ha), at 1- to 2-wk intervals until control was achieved. Acephate 75 soluble powder (Orthene, Chevron Chemical Company, San Francisco), malathion 5.0 EC, diazinon 50 WP (Diazinon, CIBA-GEIGY, Greensboro, N.C.), dimethoate 2.67 EC, carbaryl 50 WP (Sevin, Union Carbide Agricultural Products Company, Research Triangle Park, N.C.), or fluvalinate 2.0 flowable (Mavrik, Sandoz Crop Protection Corporation, Des Plaines, Ill.) was used to control anthurium thrips, fenbutatin-oxide 50 WP, or dicofol 35 WP (Kelthane, Rohm & Haas Company, Philadelphia) was used to control the false spider mite; and mancozeb 80 WP, thiophanate-methyl 70 WP (Topsin M, Pennwalt Corporation, Philadelphia), or Zyban 75 WP (Mallinckrodt, St. Louis) was used to control anthracnose.

Data are percentages of total flowers harvested because number of flowers harvested varied among plots. Arcsine transformation was performed on data before analysis by paired t tests (SAS Institute 1987).

Results and Discussion

From fall 1985 to summer 1987, 67 and 37 insecticide applications were made for thrips control in the grower and IPM sections. Grower sections

Table 2. Anthurium flowers (flwr) injured by thrips, mite, and anthracnose (anthra) from plots in grower and IPM sections from fall 1985 to summer 1987 at Hilo, Pahoa, and Kurtistown, Hawaii

Section	% Injured flowers											
	Hilo				Pahoa				Kurtistown			
	No. flwr examined	Thrips	Mites	Anthra	No. flwr examined	Thrips	Mites	Anthra	No. flwr examined	Thrips	Mites	Anthra
	Fall 1985–Summer 1986											
Grower	3,098	2.5a	0.0a	4.1a	2,644	1.4a	0.0a	1.4a	3,859	3.4a	1.0a	0.0a
IPM	2,839	4.8a	0.0a	0.8a	2,639	1.9a	0.0a	2.3a	3,919	2.8a	0.2a	0.0a
	Fall 1986–Summer 1987											
Grower	—	—	—	—	1,937	18.4b	0.1a	0.7a	1,310	2.9a	0.5a	0.1a
IPM	—	—	—	—	2,296	6.6a	0.0a	1.8a	1,398	2.5a	3.4a	0.0a

Four replicate plots for each section, except at Pahoa in Fall 1986–Summer 1987.
Means within columns followed by the same letter are not significant different ($P < 0.05$, t test).

Table 3. Cost of control and pest damage loss in grower and IPM sections from fall 1985 to summer 1987 at Hilo, Pahoa, and Kurtistown, Hawaii

	Hilo		Pahoa		Kurtistown	
	Grower	IPM	Grower	IPM	Grower	IPM
			Fall 1985–Summer 1986			
Cost of control ($)/ha[a]						
Thrips	734	840	702	588	1,053	588
Mites	949	0	237	0	222	188
Anthracnose	507	0	598	64	0	0
Subtotal	2,190	840	1,537	652	1,275	776
Pest damage ($)/ha[b]						
Thrips	1,816	3,488	1,017	1,381	2,470	2,034
Mites	0	0	0	0	727	145
Anthracnose	2,871	581	1,017	1,671	0	0
Subtotal	4,687	4,069	2,034	3,052	3,197	2,179
Total (cost of control + pest damage)	6,877	4,909	3,571	3,704	4,472	2,955
			Fall 1986–Summer 1987			
Cost of control ($)/ha[a]						
Thrips	—	—	1,322	588	596	504
Mites	—	—	0	0	74	376
Anthracnose	—	—	625	0	0	0
Subtotal	—	—	1,947	588	670	880
Pest damage ($)/ha[b]						
Thrips	—	—	13,369	4,796	2,107	1,816
Mites	—	—	73	0	363	2,470
Anthracnose	—	—	509	1,308	73	0
Subtotal	—	—	13,951	6,104	2,543	4,286
Total (cost of control + pest damage)	—	—	15,898	6,692	3,213	5,166

[a] Total cost of applications per ha based on suggested retail price of acaricides plus $49 for labor, fringe benefits, and equipment maintenance. Grower applied 935.4 liters of finished spray per ha and IPM applied 1,870.7 liters/ha.

[b] Pest damage loss based on estimated yield of 1,730 doz/ha/mo and wholesale value of $3.50/doz for a gross value of $72,660/ha/yr.

had up to 18.4% thrips injury, while thrips injury in the IPM sections, with 44.8% less applications, was <6.6% (Table 2). Thrips injury was only significantly less in the Pahoa IPM section for fall 1986–summer 1987 ($t = 3.1$, df = 4, $P < 0.05$) than in the corresponding grower's section. Overall, insecticide application costs for the IPM sections averaged $259.45 ± 172.97 (SEM) per ha less than the grower sections (Table 3).

Results were similar for acaricide and fungicide applications (Table 2 and 3). IPM sections, all with mite injury <3.4%, had 78.6% fewer acaricide applications and application costs averaging $182.85 ± 210.04 (SEM) per ha less than grower sections. Likewise, IPM sections had an anthracnose injury level <2.3%, a 96.1% reduction in fungicide applications and average application cost $333.58 ± 289.11 (SEM) per ha less than grower sections. Anthracnose injury was significantly less in the IPM section at the Hilo site during the 1985–1986 season ($t = 2.9$, df = 6, $P < 0.05$). No other significant differences were found with mite or anthracnose injury levels between both sections for all sites and growing season.

Generally, the IPM costs were lower than those of the grower (Table 3). The Hilo grower was so impressed by the economic savings that he converted his whole operation to IPM. Even with an incidental mite infestation at the IPM site in Kurtistown, a paired t test showed no significant difference of yearly total costs (including values for pest damage) between grower and IPM strategies at all farms ($t = 1.3$, df = 9, $P > 0.05$).

Moreover, the IPM sections had a 61.3% reduction in pesticide applications (insecticides, acaricides, and fungicides) as compared with grower sections with no significant increase in thrips, mite, or anthracnose injuries. Fewer applications have numerous advantages—not only direct economic benefits, but also reduced risks to the applicator, the crop, and nontarget organisms.

These results indicate that the IPM concept implemented on a floricultural crop can reduce pesticide applications and increase profitability. Because of the increasing costs and risks of pesticides, economic injury levels can be developed for many pests of floricultural crops. Growers of floricultural crops should be encouraged to use pesticides judiciously and consider cost/benefit and benefit/risk of pesticides.

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References Cited

Bushe, B. C., W. T. Nishijima, A. H. Hara & D. M. Sato. 1987. Identifying anthurium flower injuries. University of Hawaii Manoa, Hawaii Institute of Tropical Agriculture and Human Resources (HITAHR) Brief 073.

Hara, A. H. & R. F. L. Mau. 1987. Guide to chemical control of insect and mite pests of anthurium. University of Hawaii Manoa, HITAHR Brief 008.

Hara, A. H., R. F. L. Mau, D. M. Sato & B. C. Bushe. 1987. Effects of seasons and insecticides on orchid thrips injury of anthuriums in Hawaii. HortScience 22: 77–79.

Hara, A. H., W. T. Nishijima, B. C. Bushe & D. M. Sato. 1989. Mechanical injury—primary type of unmarketable anthurium flowers in Hawaii. HortScience 24: 846–847.

Hawaii Agricultural Statistics Service. 1988. Statistics of Hawaiian agriculture 1987. Hawaii Agricultural Statistics Service, Honolulu.

Higaki, T., P. P. Watson & K. W. Leonhardt. 1979. Anthurium culture in Hawaii. University of Hawaii Cooperative Extension Service Circular 420.

Luckmann, W. H. & R. L. Metcalf. 1982. The pest-management concept, pp. 1–31. *In* R. L. Metcalf & W. H. Luckmann [eds.], Introduction to insect pest management. Wiley, New York.

Parrella, M. P. & V. P. Jones. 1987. Development of integrated pest management strategies in floricultural crops. Bull. Entomol. Soc. Am. 33: 28–34.

SAS Institute. 1987. SAS/STAT guide for personal computers, version 6 ed. SAS Institute, Cary, N.C.

Stuckey, R. E., R. F. Nyvall, J. P. Krausz & C. W. Horne. 1984. Corn disease management, pp. 1–8. *In* National Corn Handbook, NCH-4, Cooperative Extension Service, Purdue University, West Lafayette, Ind.

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