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Effect of Seasons and Insecticides on Orchid Thrips Injury of Anthuriums in Hawaii

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Abstract. **Dimethoate 4EC, fenpropathrin 2.4EC, fluvalinate 2F, oxamyl 2L, chlorpyrifos 4EC, malathion 5EC, diazinon 4EC, and oxydemeton-methyl 2EC insecticides significantly reduced injury of anthurium (*Anthurium andraeanum* Lind. & Andre cv. Ozaki) flowers by the orchid thrips, *Chaetanaphothrips orchidii* (Moulton). Injury was characterized by white streaks and/or scarrings occurring primarily on the abaxial surface only or on both adaxial and abaxial surfaces of the spathe. Injury on the adaxial surface occurred only at 0.15% of all thrips-injured spathes observed during the study period. Thrips injury on anthurium flowers in control plots during Aug. 1984 to Sept. 1985 decreased to 3% during Feb. and Mar. 1985, and increased to 90% during Sept. 1985. Chemical names used: *O,O*-dimethyl *S*-[2-(methylamino)-2-oxoethyl]phosphorodithoate (dimethoate); (Rs)-α-cyano-3-phenoxybenzyl 2,2,3,3-tetramethyl cyclopropanecarboxylate (fenpropathrin); *N*-[2-chloro-4-(trifluoromethyl)phenyl]-DL-valine (±)-cyano(3-phenoxyphenyl)methyl ester (fluvalinate); *S*-{2-(ethyl suffinyl)ethyl} *O,O*-dimethylphosphorothioate (oxydemeton-methyl); methyl 2-dimethylamino)-*N*-[[(methylamino)carbonyl]oxy]-2-oxoethanimidothioate (oxamyl); *O,O*-diethyl *O*-[6-methyl-α-(l-methylethyl)-4-pyrimidinyl] phosphorothioate (diazinon); *O,O*-diethyl *O*-(3,5,6-trichloro-2-pyridyl)-phosphorothioate (chlorpyrifos); and diethyl [(dimethoxyphosphinothioyl)thio] butanedioate (malathion).**

Orchid thrips was first collected in Hawaii in 1926 and has become a common pest of ornamentals (2). The insect has a wide host range, affecting, in addition to *Anthurium andraeanum* Lind. & Andre, *Bougainvillea* spp., *Chrysanthemum* spp., wandering jew, *Tradescantia fluminensis* Vell., the family orchidaceae, and several weed and grass species (2). Orchid thrips usually feed within the narrow and concealed spaces of rolled young leaves or floral buds (2).

Adult and immature orchid thrips begin feeding within the unopened anthurium spathe soon after the bud emerges from the leaf axil. At flower harvest, the opened spathe appears deformed with white streaks and/or scarring on the abaxial and/or adaxial surfaces. Orchid thrips can injure every anthurium flower in a severely infested shadehouse and also will cause deformity and bronzing or white streaking of young anthurium leaves.

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Chemical control of orchid thrips on anthuriums is difficult for two reasons. First, thrips can injure flowers as early as 6 to 8 weeks before they are harvested. Second, thrips prefer feeding within unopened spathes and are concealed throughout most of their life cycle. Feeding by only a few thrips can cause white streaks on the spathe. If contact insecticides are used, spray coverage at the base of plants where spathe development occurs is essential to contact any exposed thrips. With contact-systemic insecticides, coverage may not be as important.

Anthurium growers presently apply several contact (chlorpyrifos 4EC, diazinon 4EC, fluvalinate 2F, malathion 5EC) or contact-systemic (dimethoate 4EC, oxydemeton-methyl 2EC, acephate 75SP) insecticides for control of *C. orchidii* at 1- to 2-week intervals thoroughout the year. However, little is known about the efficacy of these two types of insecticides for control of *C. orchidii* injury on anthuriums. Efficacies of only acephate 75SP, methomyl 1.8L, and dimethoate 2.67EC are known (R.F.L. Mau, personal communication). The purpose of this study was to monitor seasonal thrips injury and to field-evaluate registered and experimental insecticides having contact or contact-systemic action.

Tests were conducted at a commercial farm in Mountain View, Hawaii (elevation 457 m) on 'Ozaki' anthurium grown in volcanic cinders under ≈75% shade. Trials were conducted in separate sections of a 2-ha shadehouse where severe infestations were present.

Trial 1. Treatments included the following insecticides and rates (gram of active ingre-

Table 1. Effect of dimethoate, fenpropathrin, and fluvalinate on thrips injuries to the spathe of 'Ozaki' anthurium flowers during Oct. 1983 to Feb. 1984. Injury to the abaxial and adaxial surfaces (ab & ad), abaxial surface only (ab).

Treatment[z]	Injured spathes (%)									
	Oct. 1983		Nov. 1983		Dec. 1983		Jan. 1984		Feb. 1984	
(g a.i./liter)	ab & ad	ab	ab & ad	ab	ab & ad	ab	ab & ad	ab	ab & ad	ab
Dimethoate 4EC (0.60 g)	50 a[y]	24 a	31 a	14 a	16 a	11 a	5 a	4 a	1 a	4 a
Fenpropathrin 2.4EC (0.12 g)	58 a	22 a	31 a	9 a	10 a	16 a	4 a	6 a	0 a	0 a
Fluvalinate 2F (0.10 g)	57 a	13 a	40 a	7 a	18 a	14 a	4 a	13 a	1 a	1 a
Control	49 a	22 a	33 a	10 a	43 b	11 a	60 b	6 a	62 b	11 a

[z]Treatments were applied at 14-day intervals during the period 14 Oct. 1983 to 6 July 1984.
[y]Mean separation in a column by Duncan's multiple range test, 5% level.

Table 2. Effect of dimethoate, fenpropathrin, and fluvalinate on thrips injuries to the spathe of 'Ozaki' anthurium flowers during the period Spring 1984 through Spring 1985. Injury to the abaxial and adaxial surface (ab & ad) and abaxial surface only (ab).

Treatment[z]	Injured spathes (%)									
	Spring 1984 (Mar.–May)		Summer 1984 (June–Aug.)		Fall 1984 (Sept.–Nov.)		Winter 1985 (Dec.–Feb.)		Spring 1985 (Mar.–May)	
(g a.i./liter)	ab & ad	ab	ab & ad	ab	ab & ad	ab	ab & ad	ab	ab & ad	ab
Dimethoate 4EC (0.60 g)	1 a[y]	4 a	1 a	2 a	8 a	5 ab	8 a	6 b	6 a	7 a
Fenpropathrin 2.4EC (0.12 g)	2 a	1 a	1 a	0 a	2 a	1 a	5 a	2 a	5 a	4 a
Fluvalinate 2F (0.10 g)	2 a	4 a	2 a	0 a	8 a	6 ab	5 a	7 b	3 a	2 a
Control	73 b	12 b	71 b	12 b	64 b	11 b	20 b	8 b	9 a	7 a

[z]Treatments were applied at 14-day intervals during the period 14 Oct. 1983 to 6 July 1984.
[y]Mean separation in a column by Duncan's multiple range test, 5% level.

Table 3. Effect of oxydemeton-methyl, oxamyl, diazinon, chlorpyrifos, and malathion on thrips injuries to the spathe of 'Ozaki' anthurium flowers during Oct. 1984 to Jan. 1985. Injury to the abaxial and adaxial surfaces (ab & ad) and abaxial surface only (ab).

Treatment[z] (g a.i./liter)	Injured spathes (%) Oct. 1984 ab & ad	ab	Nov. 1984 ab & ad	ab	Dec. 1984 ab & ad	ab	Jan. 1985 ab & ad	ab
Oxydemeton-methyl 2EC (0.45 g)	93 a[y]	3 a	29 a	15 a	2 a	9 a	1 a	1 a
Oxamyl 2L (1.20 g)	78 a	9 a	31 a	15 a	4 a	3 a	1 a	1 a
Diazinon 4EC (0.60 g)	90 a	9 a	31 a	18 a	4 a	11 a	1 a	0 a
Chlorpyrifos 4EC (0.60 g)	80 a	9 a	19 a	13 a	1 a	2 a	1 a	1 a
Malathion 5EC (1.50 g)	88 a	8 a	19 a	12 a	0 a	1 a	0 a	1 a
Control	99 a	0 a	56 b	10 a	6 a	11 a	4 a	4 a

[z]Treatments applied at 14-day intervals from 28 Aug. to 16 Nov. 1984.
[y]Mean separation in a column by Duncan's multiple range test, 5% level.

dient per liter of water): dimethoate 4.0EC at 0.60 g, fenpropathrin 2.4EC at 0.12 g, and fluvalinate 2.0F at 0.10 g. A spreader-sticker, Triton B-1956 (Rohm & Haas, Philadelphia) at a rate of 0.23 $ml \cdot liter^{-1}$ solution was added to all treatments in Trials 1 and 2, including control plots. Trial 1 consisted of 12 plots each measuring 4.5 × 1.8 m and contained ≈200 plants per plot. A 1.4-m walkway was provided between plots and a 0.6-m buffer zone between the plot and the grower's plantings. Test plots were arranged in a randomized complete block design with three blocks and four treatments. Insecticide solutions were applied at 2338 $liters \cdot ha^{-1}$ with a compressed CO_2 sprayer (2.8 $kg \cdot cm^{-2}$) equipped with a No. 8004 Teejet (Spraying Systems, Wheaton, Ill.) nozzle. A total of 20 spray applications were applied at 14-day intervals during the period 14 Oct. 1983 to 6 July 1984.

Trial 2. Treatments included the following insecticides and rates (gram of active ingredient per liter of water): Oxydemeton-methyl 2.0EC at 0.45 g, oxamyl 2.0L at 1.20 g, diazinon 4.0EC at 0.60 g, chlorpyrifos 50WP at 0.60 g, and malathion 5.0EC at 1.50 g. Trial 2 consisted of test plots measuring 3.7 × 1.2 m and contained ≈95 plants per plot. A 0.6-m buffer zone was provided between plots. Test plots were arranged in a randomized complete block design with three blocks and six treatments. A total of seven spray applications were applied at 14-day intervals during the period 28 Aug. to 16 Nov. 1984 with similar spray equipment as Trial 1.

Anthurium flowers were harvested every 14 days at three-fourths to full maturity. Maturity was determined by the degree of color change of the spadix (1). Each harvested flower was observed for thrips injury (white streaks on the spathe). Injured spathes were classified according to thrips injury on the abaxial, adaxial, or on both surfaces. Thrips injuries were monitored from Oct. 1983 to Sept. 1985 in Trial 1 and from Aug. 1984 to Sept. 1985 in Trial 2.

Data were analyzed by analysis of variance ($P = 0.05$) and means separated by Duncan's multiple range test. Percentages were transformed to arcsin before analysis.

The mean percentages of total thrips injury in control plots in Trials 1 and 2 during the period Aug. 1984 to Sept. 1985 are presented in Fig. 1. Thrips injury did not remain constant during the observation period. Percent of injury decreased to 3% during Feb. and Mar. 1985 and increased to 90% during Sept. 1985.

Trial 1. Thrips injury on 'Ozaki' anthuriums occurred primarily on the abaxial surface of the spathe, or on both abaxial and adaxial surfaces (Table 1). Injury on the adaxial surface only occurred at 0.15% of all

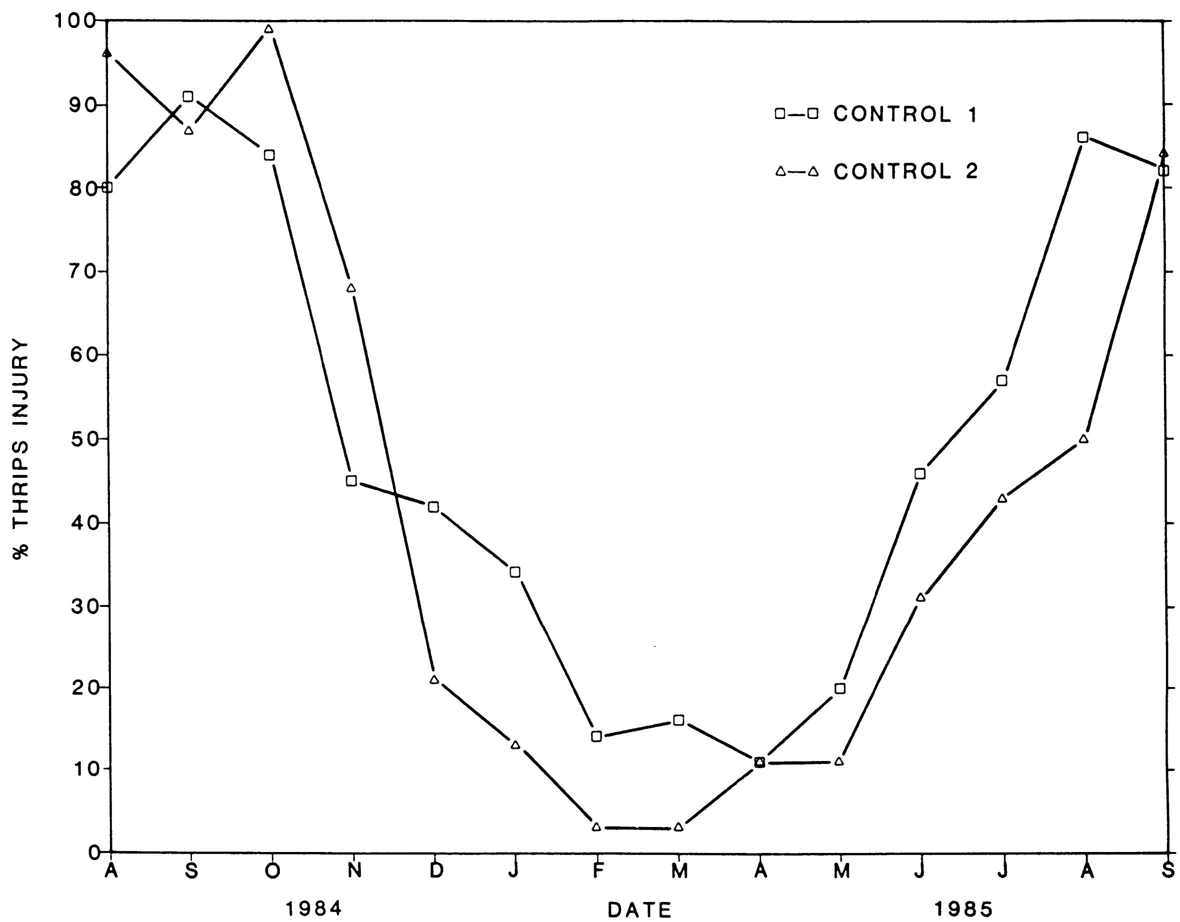

Fig. 1. Mean percentage of total thrips injury on 'Ozaki' anthurium flowers in control plots of Trials 1 and 2 at Mountain View, Hawaii during Aug. 1984 to Sept. 1985.

thrips-injured flowers observed throughout this study. In Oct. 1983, total thrips-injured flowers averaged 74% in all treatment plots, including control plots. No differences among treatments were observed in Nov. 1983. However, by Dec. 1983, after four spray applications, dimethoate-, fenpropathrin-, and fluvalinate-treated plots had significantly lower percentages of flowers with thrips injury on both abaxial and adaxial surfaces compared to control plots. The percentages of flowers with both abaxial and adaxial thrips injury differed significantly between insecticide-treated and control plots in Dec. 1983, Jan. 1984, and Feb. 1984. However, the percentage of abaxial-only flower injury did not differ among all treatments in Dec. 1983, Jan. 1984, and Feb. 1984.

Flowers with both abaxial and adaxial thrips injury in insecticide-treated plots decreased to ≤2% in Summer 1984 (Table 2). After the last spray application in July 1984, insecticide-treated plots had less abaxial and adaxial thrips injury than control plots through Winter 1985. In control plots, abaxial and adaxial thrips injury was 73% in Spring 1984 and decreased to 9% in Spring 1985. Percentages of abaxial-only injury in insecticide-treated plots were less than control plots in Spring 1984 and Summer 1984. In Fall 1984 and Winter 1985 only the fenpropathrin-treated plots had less abaxial injury than control plots.

Trial 2. Chlorpyrifos, malathion, oxamyl, diazinon, and oxydemeton-methyl significantly reduced abaxial and adaxial thrips injury in Nov. 1984 after five spray applications (Table 3). Percentages of flowers with abaxial only injury did not differ among all treatments. No significant differences were observed in percent thrips injury among all treatment plots in Dec. and Jan. 1985, probably due to low thrips populations during winter months.

Increase in thrips injury on 'Ozaki' anthurium flowers was the result of abaxial and adaxial thrips injury and not necessarily abaxial injury alone. Contact-systemic insecticides, dimethoate, oxamyl, and oxydemeton-methyl applied as foliar sprays were as effective as contact insecticides, fenpropathrin, fluvalinate, diazinon, chlorpyrifos, and malathion. All effective insecticides required a minimum of four spray applications at 2-week intervals. This 7- to 8-week-period occurred because emerging buds infested at the time of the initial spray application were harvested 6 to 8 weeks later as injured flowers. Effective insecticides sprayed at 2-week intervals protected newly developing anthurium flowers from thrips injury.

Fluctuations of thrips injury on anthurium flowers in control plots suggest that frequent insecticide spray applications may not be needed throughout the year. Generally, thrips injury increased during the summer and decreased during the winter, and spray applications may be needed only during May through August. Reasons for decrease in thrips during the winter may be due to rainfall and temperature. Future research should focus on establishing action threshold levels for *C. orchidii* in an anthurium-integrated pest management program. Action threshold levels for the orchid thrips on anthuriums will depend primarily on market demand for flowers and seasonal trends of thrips.

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Effect of Soil-applied Paclobutrazol on 'Cheyenne' Pecans

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Abstract. **Paclobutrazol was applied 30 Mar. 1984 as a soil drench to 3rd-leaf pecan [*Carya illinoensis* (Wangenh.) C. Koch] 'Cheyenne' at concentrations between 0.05 to 2.60 g a.i./cm^2 trunk cross-sectional area. Paclobutrazol inhibited tree growth, shoot extension, and trunk and limb growth during 1984 and 1985. Relative water content of leaflets was positively related and leaflet area was negatively related to paclobutrazol concentration. Paclobutrazol promoted lateral branching on a unit length basis on 1983 wood, although no significant relationship was apparent on 1984 wood. Leaflet weight under stress and turgid conditions was reduced with increasing paclobutrazol concentration. Net CO_2 assimilation rate, leaf conductance, transpiration rate, leaf chlorophyll, and kernal weight measured during 1985 were not affected by paclobutrazol. The effects of soil-applied paclobutrazol under field conditions persist at least 3 years. Chemical name used: β-[(4-chlorophenyl)methyl]-α-(1,1-dimethylethyl)-1*H*-1,2,4-triazole-1-ethanol (paclobutrazol).**

Maximum pecan production per hectare at conventional 15 × 15 m or greater spacings requires 20 to 30 years. To expedite investment returns, growers are setting trees at increasingly close spacings, despite the fact that dwarfing rootstocks are not currently available. Thus, alternate tree removal or yearly pruning may become necessary in as little as 8 to 15 years under intensive management systems in the southeastern United States.

Paclobutrazol (ICI Americas, Goldsboro, N.C.), a potent inhibitor of gibberellin biosynthesis (2, 5, 13), has reduced shoot growth and internode length of many tree species including apple (12), cherry (8), nectarine (4), pecan (6, 14), and pear (9). Other vegetative responses have included reduced leaf area (3, 11, 14), increased leaf chlorophyll content (14), and an increased root : shoot ratio (6, 12). Paclobutrazol has been reported to enhance flowering, fruit set, and yield of deciduous fruit trees (3, 4, 9).

A plant growth regulator that reduces vegetative growth while enhancing nut production may reduce the need for pruning, facilitate spraying and harvesting, and increase tree yield and yield efficiency on a unit-land-area basis. Paclobutrazol-induced changes in pecan morphology and physiology have not been reported under field conditions, and the residual effects have not been reported for any tree crop.

The objective of this study was to determine the effect and persistence of paclobutrazol on field-grown pecan trees.

'Cheyenne' pecan trees planted Feb. 1982 at the Agricultural Research and Education Center, Monticello, Fla. were treated on 30 Mar. 1984 with paclobutrazol (10 UL formulation). Paclobutrazol was applied at random to 40 trees at 0.5, 1.0, 2.0, 4.0, or 8.0 g a.i./tree, resulting in doses ranging from 0.05 to 2.60 g a.i./cm^2 trunk cross-sectional area (TCA) 60 cm above the ground. Paclobutrazol was mixed with 1 liter of water and applied as a soil drench to a 30-cm-diameter area surrounding the trunk base. Ten control trees were treated with 1 liter of water. A small mound of soil around the outside circumference prevented runoff. At time of treatment, soil moisture was near field capacity and soil temperature varied from 13° to 18°C at the 10-cm depth and was ≈17° at

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