The Orchid Weevil, *Orchidophilus aterrimus* (Waterhouse)[1]: Insecticidal Control and Effect on Vanda Orchid Production[2]

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ABSTRACT

Control of the orchid weevil, *Orchidophilus aterrimus* (Waterhouse) with acephate 75SP, bendiocarb 76WP, chlorpyrifos 2.0EC, and microencapsulated methyl parathion 2.0F significantly increased the number of marketable flowers of *Vanda* "Miss Joaquim" and decreased the number of unmarketable, white streaked flowers. The significant reduction in larval infestations, adult feeding injury and the rate of white streaked flowers in insecticide-treated vanda plants suggests that orchid weevil infestation and/or injury may be responsible for white streaked flowers. The relatively long life cycle of 144 days and the toxicity of tested insecticides to only the adult stage of the orchid weevil were probably reasons which made it necessary to apply 6 spray applications before a severe infestation (>14 weevils per week) was reduced to a minimum level (<4 weevils per week) in *Vanda* "Miss Joaquim."

The orchid weevil, *Orchidophilus aterrimus* (Waterhouse) is a serious pest of cultivated orchids in Hawaii and repeated applications of an effective insecticide are usually needed to control established infestations of this pest. Acephate 75WP, bendiocarb 76WP, and microencapsulated methyl parathion 2.0F are among the more effective insecticides for control of the orchid weevil on *Dendrobium* orchids in greenhouse testing (Mau and Hara 1985). Chlorpyrifos 2.0EC was also reported by orchid growers as being effective against the orchid weevil. Mau (1980, 1983) recommended a 14-21 day spray interval for orchid weevils based on its long life cycle, long preoviposition period, and on the persistence of recommended insecticides.

The purpose of this study was to field evaluate effective insecticides on weevil-infested vanda orchids, test the effectiveness of a 21-day spray application interval and quantify effects of the orchid weevil on vanda orchid production.

MATERIALS AND METHODS

This study was conducted at a vanda orchid farm at Umauma, Hawaii (61.0 m elev.) on the Island of Hawaii on the hybrid, *Vanda* "Miss Joaquim" (*V. teres* × *V. hookeriana* Reichb. f.). The following insecticides were tested at the following rates (g of active ingredient/100 liters of water): acephate 75SP (Orthene®) at 120.0 g, bendiocarb 76WP (Ficam®-W) at 120.0 g, chlorpyrifos 2.0EC (Dursban®) at 60.0 g, and microencapsulated methyl parathion 2.0F (Penncap-M®) at 60.0 g. A spreader-sticker, Triton B-1956® (Rohm and Haas, Philadelphia, PA) at a rate of 23 ml per 100 liters solution was added to all treatments except for microencapsulated methyl parathion.

Tests were conducted on vanda plants grown in an open field on tree fern logs (25.4 cm in length) with ca. 23 plants per log. Each treatment plot measured 4.3 m × 0.6 m, and contained 26 tree logs placed two abreast with ca. 600 plants per treatment

[1]Coleoptera: Curculionidae.

[2]Journal Series No. 2950, the Hawaii Institute of Tropical Agriculture and Human Resources.

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plot. A 0.6 m buffer zone was provided between plots and a 1.0 m walkway between rows. The treatments were replicated 4 times and completely randomized in 3 rows. Plants received the grower's standard fertilization practices. Insecticides were applied to runoff with a compressed CO_2 sprayer equipped with a No. 8004 Teejet® (Spraying Systems Co., Wheaton, Ill.) nozzle. A total of 12 applications were applied at 21-day intervals during the period October 12, 1982 to May 31, 1983.

The number of orchid weevil adults on ca. 276 vanda plants on 12 fern tree log per treatment plot was determined once a week (9:00 to 10:00 a.m.) throughout the study period. In addition, insecticide residues were analyzed by bioassay to evaluate the residual activity of insecticides. Three vanda terminal (7.6 cm in length) were sampled from each treatment plot at 1, 7, 14, and 21 days after each of 4 spray application. Terminals were placed singly in 470 cc unwaxed paper containers. Five field-collected weevil adults were added to each container, covered with a plastic lid having three organdy-covered holes (2.2 cm diam.), and held in the laboratory at 21° C. Weevil mortality was determined after 5 days exposure to treated terminals.

On June 9, 16, and 23, 1983 at the peak flowering of *Vanda* "Miss Joaquim," the number of marketable and streaked flowers harvested from each treatment plot were recorded. Marketable flowers were characterized by unblemished and normal colored flower parts, while streaked flowers were characterized by the occurrence of white lines on the sepal and labellum.

At the conclusion of the study (June 24, 1983), each treatment plot was evaluated by examining 5 vanda terminals (each having 6 leaves) for adult weevil feeding punctures, and by dissecting and examining ten plants for larval infestations.

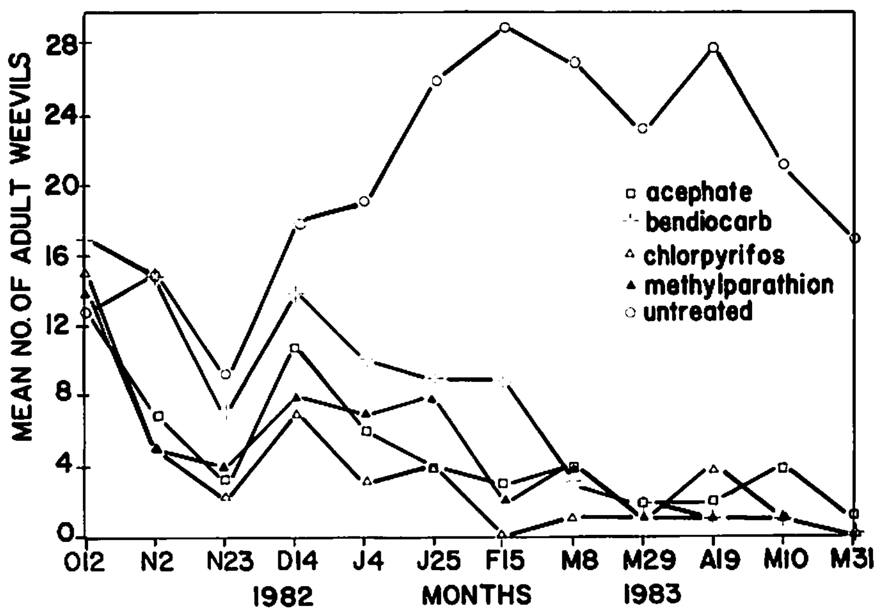

FIGURE 1. Number of *O. aterrimus* adults observed weekly during 9:00 – 10:00 a.m. from October 12, 1982 to May 31, 1983 at Umauma, Hawaii on *Vanda* "Miss Joaquim" treated with acephate 75SP, bendiocarb 76WP, chlorpyrifos 2.0EC, microencapsulated methyl parathion 2.0F, and untreated. Each data point is the mean of 3 weekly weevil counts on 4 plots per treatment.

Data was analyzed by ANOVA ($P<0.05$) and means separated by Duncan's Multiple Range Test (Little and Hills 1978).

RESULTS

Field Evaluation: Adult weevil populations averaged 14.8 per week in treated plots at the onset of the study. After 1 spray application (November 1982), adult populations in acephate, chlorpyrifos, and microencapsulated methyl parathion plots were significantly reduced to 7.0, 5.3, and 5.0 adults per plot per week, respectively (Fig. 1). Adult numbers declined to less than 4 per plot per week in each of these treatments in February 1983 after the 6th spray application. Bendiocarb significantly reduced weevil adults after the 4th spray application (January 1983) and decreased to less than 4 weevil adults per week, after the 7th spray application (March 1983). In the untreated plots, weevil adults increased to greater than 29 weevil adults per week by February 1983.

Residual Activity: Bioassay of treated plants showed that tested insecticides degraded rapidly under field conditions. One-day post-treatment residues of acephate, bendiocarb, and microencapsulated methyl parathion resulted in 89, 100, and 100% mortality, respectively. In contrast, chlorpyrifos residues and untreated plants killed 2% and 0% of adult weevils, respectively. Seven-day post-treatment residues of all tested insecticides were non-toxic to weevils.

Flower Production: There were significantly more marketable flowers produced from treated as compared with untreated plants (Table 1). Less than 1% of the flowers from treated plants were streaked while 27.5% of the flowers from untreated plants were streaked. Insecticide-treated plots had significantly fewer grub-infested plants and fewer adult feeding punctures on plant terminals (Table 2).

DISCUSSION

Results demonstrated that without insecticidal control, the orchid weevil can seriously affect flower production of *Vanda* "Miss Joaquim." In addition to increased marketable flowers, insecticide treatments reduced the occurrence of white streaked flowers. The significant reduction in larval infestations, adult feeding punctures, and the rate of white streaking in insecticide-treated *Vanda* "Miss Joaquim" suggests that orchid weevil infestation and/or injury could be responsible for white streaking of

TABLE 1. Effects of the orchid weevil, *O. aterrimus*, and certain insecticides on the number of marketable and percentage of streaked flowers of *Vanda* "Miss Joaquim" in June 1983.

Treatment[a] (g AI/100 liters)	No. Marketable[b]	% Streaked[b]
Untreated	40.7a	27.5a
Acephate 75WP (120 g)	79.0b	0.9b
Bendiocarb 76WP (120 g)	101.3b	0.0b
Chlorpyrifos 2.0EC (60 g)	133.7c	0.2b
Methyl Parathion[c] 2.0F (60 g)	97.7b	0.3b

[a]Treatments applied from October 12, 1982 and continued at 21-day intervals to May 31, 1983.
[b]Mean number of marketable and mean percentage of white streaked flowers observed on flowers harvested on June 9, 16, and 23, 1985. Means followed by different letters in a column are significantly different by Duncan's Multiple Range Test.
[c]Microencapsulated.

TABLE 2. Number of plants infested with live orchid weevil grub and the number of adult feeding punctures on *Vanda* "Miss Joaquim" on June 24, 1983.

Treatment[a] (g AI/100 liters)	No. plants infested w/live grubs[b]	No. feeding punctures per terminal[c]
Untreated	1.8a	38.2a
Acephate 75WP	0.2b	11.7b
Bendiocarb 76WP	0.0b	12.7b
Chlorpyrifos 2.0EC	0.0b	15.2b
Methyl Parathion[d] 2.0F	0.0b	12.2b

[a]Treatments applied on Oct. 12, 1982 and continued at 21-day intervals to May 31, 1983.
[b]Mean number of infested plants observed in 10 randomly chosen plants per treatment plot. Means followed by different letters in a column are significantly different by Duncan's Multiple Range Test.
[c]Mean number of weevil adult feeding punctures on the leaf surfaces of 5 plant terminals per treatment plot.
[d]Microencapsulated.

flowers. However, the thrips, *Anophothrips corbetti* Pr. and the color-break virus disease have produced similar symptoms (Murakishi 1951). Thrips may be ruled out as a causal agent in our study, because no thrips were recovered from bud and flower samples in untreated plots. The color-break disease cannot be ruled out, but symptoms observed in our study appeared to be different than those reported by Murakishi (Carter 1973).

The relatively long life cycle of 144 days and the toxicity of tested insecticides to only the adult stage of the orchid weevil could explain why 6 spray applications (126 days) of acephate, chlorpyrifos, and microencapsulated methyl parathion were needed to reduce a severe infestation of orchid weevils (>14 weevils per week) to a minimum level (<4 weevils per week) in *Vanda* "Miss Joaquim." The time (126 days) that it took to reduce weevil populations in treated plots was remarkably similar to the average egg to adult developmental time of the orchid weevil. Immature stages of the orchid weevil which occurred within the vanda plant were evidently not affected by the insecticide treatments and completed development to adults before being killed by these insecticides. After all developing immature stages of the orchid weevil emerged as adults, insecticide-treated plants were not reinfested by eggs laid by the few weevil adults which were found on the plants.

Mau and Hara (1985) demonstrated that acephate is toxic to orchid weevils for 7 days after treatment, and bendiocarb and microencapsulated methyl parathion are toxic up to 20 days after treatment on *Dendrobium* plants irrigated daily by overhead sprinklers in a fiberglass greenhouse. In our study, bendiocarb, microencapsulated methyl parathion, acephate, and chlorpyrifos residues on vanda terminals were toxic to weevil adults for less than 7 days. This reduction in residual activity could be attributed to more rapid degradation of insecticide residues on vanda terminals due to direct sunlight and high rainfall averaging 8.0 inches per month during the test period.

Despite the apparent rapid degradation, chlorpyrifos gave excellent control of orchid weevils and resulted in the greatest increase of marketable flowers. Since chlorpyrifos is known to bind with organic matter and remain active for long periods (Anon. 1983), a plausible explanation for its superior performance was that weevils did not remain only on foliage and stems but rather moved to tree fern logs where weevils were contacted with toxic residues.

Since all of the tested insecticides acted as adulticides, repeated applications at 3 week spray intervals were very effective in controlling weevils and preventing reinfestation. However, alternatives to calendar applications of insecticides are more desirable. Very efficient control could be obtained with fewer spray applications if systemic insecticides are effective against immature stages of the orchid weevil. Other control tactics such as microbial control and biological control could also reduce the reliance on calendar applications of insecticides.

ACKNOWLEDGMENTS

We gratefully acknowlege Mr. and Mrs. Masami Takasaki for their cooperation; Lorna Arita for critically reviewing this manuscript; and Angel Magno and Brian C. Bushe for assistance in collecting biological data.

REFERENCES CITED

Anonymous. 1983. Dursban® insecticides technical information. Dow Chemical U.S.A., Technical Data Sheet 134-289-38, 12 pp.

Carter, W. 1973. The clinical aspects of plant virus diseases. Pages 351-433, *In* W. Carter, Insects in relation to plant disease. John Wiley & Sons, Inc., New York.

Little, T.M. and F.J. Hills. 1978. Agricultural Experimentation. John Wiley & Sons, Inc., New York. 350 pp.

Mau, R.F.L. 1980. Biology and control of the orchid weevil. Pages 72-6, *In* F.D. Rauch and K.W. Leonhardt (eds.), Proc. Third Annu. Ornamentals Short Course, Hilo, Hawaii. Hawaii Institute of Tropical Agriculture and Human Resources, Univ. of Hawaii, Research Extension Series 007.

———. **1983.** Development of the orchid weevil, *Orchidophilus aterrimus* (Waterhouse). Proc. Hawaii. Entomol. Soc. 24:293-7.

Mau, R.F.L. and A.H. Hara. 1985. Toxicity and residual activity of insecticides to *Orchidophilus aterrimus* adults. Hawaii Institute of Tropical Agriculture and Human Resources, Univ. of Hawaii, Research Series (In press).

Murakishi, H.H. 1951. Symptoms resembling color break on the flowers of *Vanda* "Miss Joaquim" caused by thrips. Hawaii Agricultural Expt. Stn., Univ. of Hawaii, Progress Notes No. 72, 3 pp.