The fifth study also was conducted on poinsettia at Lovell Farms, Miami, FL. Cultural practices for maintaining the crop were as discussed. Treatments evaluated were: all six treatments as discussed in the fourth study plus an additional treatment of imidacloprid (granular formulation) at the rate of 0.56 kg.ha-1. All treatments, except imidacloprid, were applied on four dates on 16, 21 and 27 June, and on 4 July 1994. Both liquid and granular formulations of imidacloprid were applied once on 16 June 1994. All other methodologies were as discussed above.

All data were transformed to the square root (x + 1) for analysis of variance. The means reported in the tables are nontransformed means of silverleaf whitefly immatures per square centimeter area. Transformed data were analyzed using analysis of variance (ANOVA, P = 0.05; SAS Institute, 1990). Means among the treatments were separated using the least significant difference test (Steel & Torrie, 1980).

Results and Discussion

Silverleaf whitefly abundance. Silverleaf whitefly abundance was greater on hibiscus than other ornamentals in the 1992 experiment (Fig. 1). In 1993, whitefly population was highly abundant on purple lantana followed by white lantana (Fig. 2). The lowest number of whiteflies was recorded on hibiscus in the second study.

Insecticide efficacy test. Silverleaf whitefly population abundance was high on lantana during the study in 1993. Eggs and nymphal populations were significantly fewer in all insecticide treated plants than in the nontreated plants (Figs. 3a,b). Pupal populations were significantly reduced by lambda cyhalothrin, CS and WP formulations, at 0.06 kg.ha-1 (Fig. 3c). When all development stages were averaged across the season, all insecticide treatments significantly reduced whiteflies in comparison to the nontreated control (Fig. 3d).

Whitefly population abundance was low to medium on lantana during 1994 study. Mean numbers of whitefly populations, both eggs and nymphs, showed a decreasing trend on lambda cyhalothrin (CS) (0.06 kg.ha-1) and Lambda cyhalothrin (WP) (0.06 kg.ha-1) treated plants in the first and fourth samples, although not significantly different from plants treated with the same insecticides at lower rates (Figs. 4a,b). When development stages were averaged across the season, similar results, as in the first and fourth samples, were observed (4c). Soil drench of imidacloprid significantly reduced whitefly in this test.

In the third study on hibiscus, a trend similar to the second study was observed in the control of whitefly using different insecticide treatments (Figs. 5a,b,c,d). In this study imidacloprid also significantly reduced all development stages of silverleaf whitefly on hibiscus.

In the fourth study, imidacloprid and fenoxycarb significantly reduced different development stages of silverleaf whitefly on poinsettia followed by halofenozide, the ecdyson agonist (Fig. 6). Azadirachtin in this study did not differ from the nontreated check in controlling whitefly.

In the fifth study, both granular and flowable formulations of imidacloprid were highly effective in controlling different development stages of silverleaf whitefly (Fig. 7). Fenoxycarb and halofenozide also showed some promise in reducing ($P < 0.05$) this insect pest.

In summary, silverleaf whitefly abundance was highly significant on hibiscus and purple lantana. Imidacloprid was most effective in reducing whitefly on ornamentals followed by fenoxycarb and halofenozide. This information could be of great importance in developing an integrated management program for silverleaf whitefly. Further investigations are warranted to understand silverleaf whitefly abundance on other ornamentals.

Literature Cited

Drees, B. M. 1989. Sweetpotato whitefly management on Texas ornamentals. Ent. Notes 30(6): 1-5.

Diethelm, V. 1990. Whiteflies on gerbera controlled with parasitic wasps. Research results in Switzerland. Gartnerborse und Gatenwelt 90(11): 546-553.

Diraviam, J. and S. Uthamasamy. 1992. Monitoring whitefly, *Bemisia tabaci* (Genn.) on sunflowers with yellow sticky traps. J. Entomol. Res. 16(2): 163-165.

Matsui, M. and T. Nakashima. 1992. Damage to vegetables and ornamental plants by the sweetpotato whitefly and its control in Japan. Japan Pesticide Information 60: 15-18.

Redak, R. A. and J. A. Bethke. 1993. Control of the sweetpotato whitefly on poinsettia using soil treatments summer 1992. Insecticide & Acaricide Tests 18: 338-339.

SAS Institute. 1990. SAS/STAT user's guide, vol. 1. SAS Institute. Cary, N.C.

Seal, D. R. 1993. Effectiveness of different insecticides for the control of sweetpotato whitefly, *Bemisia tabaci* (Gennadius) (Homoptera: Aleyrodidae) on vegetable crops in southern Florida. Proc. Fla. State Hort. Soc. 106:224-228.

Steel, R. G. D. and J. H. Torrie. 1980. Principles and procedures of statistics-a biometrical approach. McGraw-Hill, New York.

Proc. Fla. State Hort. Soc. 107: 226-228. 1994.

INSECTICIDAL CONTROL OF MAGNOLIA WHITE SCALE (FALSE OLEANDER SCALE) (HOMOPTERA:DIASPIDIDAE) ON MAGNOLIA

GARY L. LEIBEE AND KENNETH E. SAVAGE
Central Florida Research & Education Center
IFAS, University of Florida
Sanford, FL 32771

Florida Agricultural Experiment Station Journal Series No. N-01023.

Additional index words. bifenthrin, dimethoate, fenoxycarb, *Magnolia grandiflora, Pseudaulacaspis cockerelli*

Abstract. **Recently bifenthrin and fenoxycarb have become available for use on woody landscape ornamentals. The efficacy of foliar application of bifenthrin and fenoxycarb, and foliar, drench, and stem paint application of dimethoate were compared for control of Magnolia white scale (false oleander scale), *Pseudaulacaspis cockerelli* (Cooley), on southern mag-**

nolia, *Magnolia grandiflora* L. None of the treatments were effective at increasing mortality of mature magnolia white scale. Foliar application of fenoxycarb, bifenthrin, and foliar and drench applications of dimethoate were very effective at preventing the establishment of magnolia white scale on new foliage of magnolia.

Magnolia white scale (false oleander scale), *Pseudaulacaspis cockerelli*, was first found in Florida in 1942 and has become a pest of many ornamental plants grown in Florida (Hamon, 1980). Dekle (1976) referred to this scale as "the most serious economic pest of ornamentals in Florida," and listed about 200 recorded hosts, including southern magnolia, *Magnolia grandiflora*. Magnolia white scale also occurs in Georgia and Alabama, and probably in all of the Gulf states (Johnson and Lyon, 1988). Its rapid distribution has been attributed to movement on infested nursery stock (Hamon, 1980).

Magnolia white scale can be found year round in Florida on the upper and lower leaf surface and stem of magnolia. Besides its unwanted presence, it causes chlorotic spots on leaves that are visible from the upper and lower leaf surface near the point of scale attachment. Heavy infestations can cause leaves to become completely chlorotic and drop off prematurely.

Insecticidal control of scale insects is generally considered most effective when applications are timed to coincide with the presence of the crawler stage. Familiar products containing active ingredients such as diazinon, malathion, acephate, and dimethoate have been recommended for control of scale insects on woody landscape ornamentals. Recently, bifenthrin (Talstar 10 WP, FMC Corp., Philadelphia, Pa.) and fenoxycarb (Precision, Ciba-Geigy Corp., Greensboro, N.C.) have become available for use on woody landscape ornamentals. The purpose of this study was to compare the efficacy of foliar application of bifenthrin and fenoxycarb, and foliar, drench, and stem paint applications of dimethoate (Cygon 2 E, American Cyanamid Co., Wayne, N.J.) for control of magnolia white scale on magnolia (dimethoate is not labeled for use on magnolia).

Materials and Methods

Southern magnolia in 26.5-liter plastic containers were arranged in groups of five so that the distance between stems was about 0.5 m within each group. There was no leaf contact between plants. The distance between each group was about 0.8 m. One group of five plants was used for each treatment. Each plant was considered a replicate. Plants were irrigated (tap water) from overhead with impact sprinklers daily for 20 min at dawn. Rainfall totals for Jan., Feb., Mar., Apr., May, June, and July 1993 were 13.4, 8.4, 8.6, 4.4, 9.9, 6.8, and 6.5 cm, respectively.

Treatments were applied one plant at a time. Each plant was removed from the group, treated and returned, to avoid spray drift onto adjacent plants. Insecticidal treatments were fenoxycarb (Precision 25WP [wettable powder], Ciba-Geigy Corp., Greensboro, N.C.) applied foliarly at 4 and 8 g (a.i.)/100 liters; bifenthrin (Talstar 10WP [wettable powder], FMC Corp., Middleport, N.Y.) applied foliarly at 24 g (a.i.)/100 liters; and dimethoate (Cygon 2E [emulsifiable concentrate], American Cyanamid Co., Wayne, N.J.) applied foliarly at 45 g (a.i.)/100 liters, as a soil drench at 30 g (a.i.)/100 liters, and as a stem paint with undiluted formulation. Foliar sprays were applied with a compressed-air sprayer with a single nozzle. One liter of spray was used to spray all five plants until the upper and lower leaf surfaces were covered and run-off was evident. Tap water and a wetting agent (X-77 [Chevron Chemical Co., Moorestown, N.J.] at 0.63 ml/liter) was used to prepare the foliar and drench treatments. The dimethoate 2E drench treatment consisted of pouring 500 ml of mixture from a beaker evenly over the soil surface in the pot. The foliage did not come into contact with the drench. The dimethoate 2E stem paint consisted of applying undiluted formulation with a 1.5-cm wide, foam, paint applicator around the trunk just below the lowest branches. The width of the dimethoate 2E band was equal to the thickness of the trunk at that location (usually about 1.5 cm). The untreated check was sprayed with water and wetting agent only. Treatments were applied on 31 Dec. 1992, 28 Jan., 12 Mar., 6 May, and 9 June 1993. The first three treatments were applied when only heavily infested, mature foliage was present on the plants. Most of the mature, heavily infested foliage dropped off during Mar., and most plants were leafless during late Mar. and early Apr. The new foliage flushed out during the last two weeks of Apr. and first two weeks of May. The few remaining mature leaves were removed by hand prior to applying the last two treatments.

Plants were sampled on 7 and 22 Jan., 25 Feb., 10 June, and 28 July. Mature foliage was not sampled after the 12 Mar. because much of the foliage had dropped off shortly after application. The percentage of mature scales that were dead was determined on the first three sample dates since numbers of scales were not noticeably reduced by the treatments. A leaf of intermediate age (located equidistant from the top and bottom leaves) was removed and transferred to the laboratory. The armor of 20 mature scales was lifted and the insect underneath was examined with the aid of a binocular microscope. Insects were classified as dead if no movement was detected. On the last two sample dates the number of scales of any size with white armor on four intermediately aged leaves was determined. The last two sample dates were after the old, heavily infested foliage was gone and new foliage was present. At the last sample date the plants were about 1-m tall with stems of 1.5-2.0 cm diameter measured below the foliage.

Table 1. Effects of selected insecticidal treatments on mortality of mature magnolia white scale on magnolia.

Insecticide & rate (g a.i./100 liter)	% mortality (SEM)[z]		
	7 Jan.	22 Jan.	25 Feb.
Nontreated check	20 (15.1) NS	17 (4.6) bc	29 (7.3) b
Fenoxycarb 25 WP foliar 4.0	9 (2.9)	12 (2.5) c	31 (7.2) b
Fenoxycarb 25 WP foliar 8.0	14 (4.3)	19 (7.0) bc	25 (5.9) b
Bifenthrin 10 WP foliar 24.0	20 (7.9)	36 (5.9) ab	49 (8.1) ab
Dimethoate 2 E foliar 45.0	43 (7.5)	46 (4.0) a	54 (8.3) ab
Dimethoate 2 E soil drench 30.0	22 (4.9)	37 (8.9) ab	62 (12.7) a
Dimethoate 2 E stem paint	24 (10.2)	19 (5.6) bc	29 (9.3) b

[z]ANOVA performed on transformed (ARCSIN [SQRT X]) data. Nontransformed means presented. Means followed by the same letter within each column are not significantly different (P = 0.05; Duncan's [1955] Multiple Range Test).

Results and Discussion

On 22 Jan. 1993, dimethoate applied as a foliar spray resulted in the highest mortality of mature scales and was the only treatment with significantly ($P \leq 0.05$) greater mortality than the untreated check (Table 1). On 25 Feb. 1993, dimethoate applied as a soil drench resulted in the highest mortality of mature scales and was the only treatment that resulted in significantly ($P \leq 0.05$) higher mortality than the untreated check. There was a trend toward higher mortality of mature scales with both bifenthrin and dimethoate indicating that these products were acting on the armored stage where fenoxycarb was not. This was not surprising for the fenoxycarb treatments since fenoxycarb is an insect growth regulator with activity only on the immature stages.

Table 2. Effects of selected insecticidal treatments on numbers of magnolia white scale on magnolia.

Insecticide & rate (g a.i./100 liter)	Number of scales per 4 leaves (SEM)[z]	
	10 June	28 July
Nontreated check	30.8 (7.0) a	213.0 (97.6) a
Fenoxycarb 25 WP foliar 4.0	5.0 (2.1) b	3.6 (1.7) c
Fenoxycarb 25 WP foliar 8.0	2.0 (1.2) b	1.0 (0.8) c
Bifenthrin 10 WP foliar 24.0	0.8 (0.5) b	0.0 (0.0) c
Dimethoate 2 E foliar 45.0	0.2 (0.2) b	0.8 (0.2) c
Dimethoate 2 E soil drench 30.0	1.8 (0.9) b	0.2 (0.2) c
Dimethoate 2 E stem paint	24.0 (7.1) a	36.2 (9.3) b

[z]ANOVA performed on transformed (SQRT [X + 0.5]) data. Nontransformed means presented. Means followed by the same letter within each column are not significantly different (P = 0.05; Duncan's [1955] multiple range test).

All treatments were very effective at preventing scale establishment on the new growth except for the dimethoate stem paint (Table 2). However, the dimethoate stem paint did result in significantly ($P \leq 0.05$) fewer scales than in the untreated check on 28 July. Treatment applications made after the new foliage was present were probably responsible for most of the control. However, since scales were present on the stems during the flushing period, insecticide residues from the three previous applications could have contributed to control by preventing the crawlers from migrating from the stem to the new foliage prior to the last two applications.

In conclusion, none of the treatments were considered effective at controlling mature magnolia white scale. However, foliar application of fenoxycarb, bifenthrin, and foliar and drench applications of dimethoate were very effective at preventing the establishment of magnolia white scale on new growth of magnolia.

This difference in efficacy attests to the importance of timing insecticide applications for effective control of scale insects. Fenoxycarb might be preferred over dimethoate and bifenthrin since it is the least toxic to mammals (based on oral LC_{50} [rat]), and is reported to be safe to parasites and predators. However, the convenient and relatively safe method of using a drench could render the differences in toxicity irrelevant. In addition, the systemic nature of dimethoate reduces the problem of incomplete coverage that can occur with foliar application of nonsystemic insecticides.

Literature Cited

Dekle, G. W. 1976. Florida armored scale insects. Fla. Dept. Agr. and Consumer Serv., Div. of Plant Ind. Arthropods of Florida and neighboring land areas. 3:1-345.

Hamon, A. B. 1980. False oleander scale, *Pseudaulacaspis cockerelli* (Cooley) (Homoptera:Coccoidea:Diaspididae). Fla. Dept. Agr. and Consumer Serv. Entomol. Circ. 95.

Johnson, W. T. and H. H. Lyon. 1988. Insects that feed on trees and shrubs. 2nd ed. Comstock Publ. Assn., Ithaca, N.Y.

Proc. Fla. State Hort. Soc. 107: 228-231. 1994.

CONTROL OF *PHYLLOCNISTIS* LEAF MINERS ON ORNAMENTAL CITRUS AND MAHOGANIES WITH BIORATIONAL PESTICIDES: AZADIRACHTIN AND ABAMECTIN.

F. W. HOWARD
Fort Lauderdale Research & Education Center
University of Florida, IFAS
3205 College Avenue
Fort Lauderdale, Florida 33314

Additional index words. Citrus limettioides, Phyllocnistis meliacella, Swietenia mahagoni

Abstract. **Azatin (60 ppm azadirachtin) and abamectin at 0.312 ml/literH_2O were tested for effectiveness against the citrus leaf miner, *Phyllocnistis citrella* Stainton (Lepidoptera: Gracillariidae) on sweet lime, *Citrus limettioides* Tanaka. Azatin was tested against the mahogany leaf miner, *P. meliacella* Becker, on West Indies mahogany, *Swietenia mahagoni* Jacquin. Citrus leaf miners did not complete mines in leaves of the citrus plants treated with Azatin or abamectin. By comparison, 58.3% of the citrus plants in the control group had well-developed leaf miner damage, with a mean of 2.84 leaves with well-developed mines per plant ($P < 0.05$). There were 4 times as many mines in leaves of untreated West Indies mahoganies compared to trees treated with Azatin ($P < 0.01$). Although leaf miners initiated mines in the leaves, the Azatin treatment protected the leaves from being damaged significantly. These results indicate that the azadirachtin and abamectin prevent damage by citrus leaf miners and azadirachtin (abamectin was not tested) prevents damage by mahogany leaf miners when sprayed on leaves prior to oviposition by these insects.**

Biorational pesticides are natural products with low mammalian toxicity. Two such products ar azadirachtin, which is