SECTION 4
ENTOMOLOGY

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Control of Sweetpotato Whitefly with Insect Growth Regulators in the Greenhouse

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Nature of Work: The Sweet Potato Whitefly, *Bemisia tobaci* (Gennadius), is a major pest of greenhouse-grown crops in the United States. Control of these pests with conventional chemical insecticides can be very difficult and expensive. The whitefly developes resistance to insecticides quickly (1), and growers are usually encouraged to rotate materials to avoid this problem (2). One approach has been to rely on "alternative" materials, such as insecticidal soaps, horticultural oils, and insect growth regulators, early in the crop cycle and save the more effective (and often more toxic) materials for later when the plants are bigger and closer to market and control is more critical. Unfortunately, this means that the grower applies materials that are generally less effective at a time when plants are smaller and the whiteflies are most vulnerable. The question posed in this study was whether insect growth regulators could prevent sweetpotato whitefly from colonizing new growth of two host plants, poinsettia *(Euphorbia pulcherrima)* and hibiscus *(Hibiscus rosa-sinensis),* after routine pruning was performed to stimulate branching in young plants.

Materials tested were kinoprene (Enstar II), fenoxycarb (currently registered as Logic/Award fire ant bait and Torus flea control), and Margosan-O, an extract of the neem tree. Bifenthrin (Talstar 10WP) was used as the "conventional" treatment for comparison. Rates applied are listed in the tables. Enstar was applied alone and tank-mixed with Sunspray Ultrafine Oil at 1% of the finished solution.

The experiment was run twice. The first application was made using poinsettias (V-14) in 6 in. pots with 4-5 leaves that had been pinched 3 days before. Treatments were replicated 10 times with individual plants acting as replications. The second run used small hibiscus in 1 gal pots that had been pruned the previous week, with 5 replications per treatment. All plants in each run had low-level sweetpotato whitefly infestations. At each treatment, plants were sprayed to run-off using a hand-held compressed air sprayer. Timing of applications was the same for both runs. Initial application was made on a Monday and the plants were retreated twice at 7 day intervals for a total of 3 applications.

Pretreatment samples were collected immediately prior to initial application of test materials by picking at random 20 (poinsettia run) or 50 (hibiscus run) leaves from the test plants. These leaves were taken to the laboratory and all 2nd and 3rd instar immatures were counted under a stereomicroscope. On the third day following the last treatment of each run (17 days after initial application), one new growth leaf and one older leaf was removed from each plant and the 2nd and 3rd instar immatures were counted. An additional set of new growth samples was collected from the hibiscus 7 days after the first sample date (10 days after the last application). Data were analyzed by ANOVA and means separated by LSD.

Results and Discussion: The addition of horticultural oil to the Enstar treatment did not improve control in either test. Only fenoxycarb produced significant reductions in whitefly infestation levels on poinsettia compared to untreated controls, and then only new growth infestation levels were affected (Table 1). This is in striking contrast to the results from the hibiscus test, where all treatments produced significant reductions in whitefly populations on new growth leaves (Table 2). The results were so different that a second set of new growth samples was taken from the hibiscus to confirm the counts. Again, all treatments except Margosan-0 were significantly lower than the untreated controls.
There was no effect in either test on whitefly infestation levels on older leaves, which were present and infested prior to initial application. This was not unexpected since insect growth regulators do not kill the insects immediately, but rather interfere with molting and prevent the pests from completing development. These materials are usually more effective if applied early in the life cycle, as with those whiteflies hatching from eggs laid on new leaves during the experiment.

Significance to Industry: Although there is some ambiguity in these results, it is encouraging to find that insect growth regulators can be used to prevent infestation of young plants by sweetpotato whitefly, allowing the grower to save those effective insecticides that are still available for the later stages of the production cycle when coverage is more difficult to obtain and control is crucial. This tactic should also help avoid the problem of insecticidal resistance developing in local populations of this important pest.

Literature Cited:

1. Dittrich, V., S. Uk, and G.H. Ernst. 1990. Chemical control and insecticide resistance of whiteflies. pp. 2-63-285 In D. Gerling (ed.), Whiteflies: their bionomics, pest status and management. Intercept Ltd., U.K.

2. Price, J.F., D. Schuster and D. Short. 1986. Managing sweetpotato whitefly. Greenhouse Grower. December 1986:55-57.

Table 1. Sweetpotato whitefly control on poinsettia.

Treatment	Rate/100 gal.	Mean Immatures/Leaf (Std. Dev.)* New Growth	Old Growth
Enstar II	5 oz.	15.6 (24.1)a	28.4 (36.0)a
Enstar II + 1% UFO	5 oz.	16.5 (21.8)a	21.4 (14.8)a
Fenoxycarb	5.3 oz.	20.2 (31.0)a	22.6 (33.16)a
Fenoxycarb	10.7 oz.	7.6 (12.0)a	25.2 (29.07)a
Fenoxycarb	21.4 oz.	2.5 (4.3)b	38.2 (22.14)a
Margosan-O	3 pts.	9.7 (12.0)a	14.8 (35.7)a
Talstar	12 oz.	31.8 (28.5)a	51.8 (36.9)a
Control		16.9 (13.3)a	21.4 (19.8)a

Pre-treatment mean = 5.9, SD = 11.11, N = 20 new growth leaves
*Means in the same column followed by the same letter are not significantly different (LSD, P = 0.05).

Table 2. Sweetpotato whitefly control on hibiscus.

Treatment	Rate/100 gal.	Mean Immatures/Leaf (Std. Dev.)* 1st Week		2nd Week
		New Growth	Old Growth	New
Enstar II	5 oz.	12.2 (20.3)a	10.2 (7.3)a	4.4 (9.3)a
Enstar II + 1% UFO	5 oz.	18.0 (27.2)a	2.8 (5.7)a	0.6 (1.3)a
Fenoxycarb -	5.3 oz.	1.4 (2.0)a	1.8 (1.6)a	2.2 (2.9)a
Fenoxycarb	10.7 oz.	11.6 (l9.1)a	10.2 (10.1)a	2.6 (5.8)a
Fenoxycarb	21.4 oz.	3.8 (8.5)a	3.6 (4.0)a	1.8 (2.5)a
Margosan- O	3 pts.	2.0 (3.39)a	6.2 (9.0)a	9.8 (11.7)ab
Talstar	12 oz.	4.4 (5.9)a	3.8 (4.5)a	5.6 (6.8)a
Control		82.0 (87.5)b	3.2 (3.0)a	28.2 (41.7)b

Pre-treatment mean = 5.5 pupae/leaf, SD = 9.77, N = 50 leaves
*Means in the same column followed by the same letter are not significantly different (LSD, P = 0.05).

Integrated Pest Management Program for a Native Plant Production Nursery Operation

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Nature of Work: Use of Integrated Pest Management (IPM) programs in commercial ornamental nursery production is now an accepted practice (1). The majority of the plant species and cultivars in production are the traditional woody and herbaceous omamentals used for landscaping purposes (1,3). Little IPM work has been done in conventional or wet culture production systems that are concerned with the production of native and wetland species of woody ornamentals, grasses and aquatic plants for wetlands mitigation.

Many of the native plant materials, especially wetland species, are either not listed on pesticide labels or the specific insect and/or disease pest that attack them are not listed. These include herbaceous wetland species such as *Peltandra virginica* (Arrow arum), *Polygonum densiflorum* (Dense-flower smartweed) and Sagittaria latifolia (Duck potato), woody shrubs like *Cephalanthus occidentalis* (Buttonbush) and *Iva frutescens* (High-tide bush) and trees such as *Aralia spinosa* (Devil's walking stick).

Concentration of these plant materials in a production system can result in the appearance of insect and disease pest species at damaging levels normally not found in their native settings. There is a need to develop specific pest control methods for the plant material in question with the emphasis on finding the most environmentally sensitive techniques to mitigate and control the pest damage to the plants while maintaining saleable quality(2).

In 1992 a pilot IPM program was initiated at a native plant nursery on the Eastern Shore of Maryland. Weekly scouting of the plant material was done at the nursery operation to develop baseline data on insect and diseases present and the time of appearance. In addition to the weekly scouting, Trece' pheromone traps for Nantucket Pine Tip Moth (*Rhyacionia frustrana*) and Lilac/Ash Borer (*Podosesia syringae*) were used to determine emergence dates. In 1993, the monitoring program has been expanded to two scoutings a week and addition of pheromone trapping for European Pine Shoot Moth (*Rhyacionia buoliana*). To correlate degree days with pest emergence, a maximum - minimum thermometer and a Omnidata Model TA51 Biophenometer were placed in the nursery and temperatures and accumulated degree days were recorded.

Results and Discussion: Prior to 1992, pest control in the nursery was effected through the use of general cover sprays and calendar timed sprays with limited success. Scouting the nursery on a consistent schedule has afforded the opportunity to identify, record and where necessary, control specific insect and disease problems before they spread to an entire block of material. As a result of the use of the IPM program, the use of cover and calendar timed sprays was discontinued.

Biorational spray materials such as dormant and summer oils and soaps were substituted when appropriate as replacement for organo-phosphate and carbamate insecticides. As compared to previous years, the nursery increased the effectiveness of its control of Nantucket Pine Tip Moth in Loblolly pine seedlings and Lilac/Ash Borer in Green Ash by 80 per cent. In many instances pest control was either not necessary or was done by spot treatment of insecticides or fungicides, physical removal of the problem (hand picking of insects or diseased leaves), or by removal of the infested plant material. In some instances the presence of natural biological controls, such as lady beatles (Coccinellidae sp.) was noted and left to control insect problems such as aphids.

Some of the disease problems identified on the plants, such as *Phytophthora sp*. and *Botryosphaeria dothidea* on *Lindera benzoin* (Spicebush) and Northern Bayberry (*Myrica pennsylvanica*), were the result of cultural practices. Attempts were made to control these problems through proper irrigation techniques and examination of the container mix being used rather that the use of fungicides.

A preliminary computerized record keeping system using “DBASE IV" was developed. Data from the records of the nursery manager will be entered to provide a file on each plant species, insect and disease problems, pest id and emergence or appearance times, spray programs and effectiveness. This program will enable the nursery manager to have a historical record of insect and disease patterns in the nursery and control programs that were used. Degree day data and insect counts will be entered into a computer program that will provide a model to predict insect pest emergence in the future.

Significance to the Industry: The long term trend in the nursery industry is the continued loss of the use of a number of specialty pesticides because of re-registration costs and government regulation. In addition, the industry is faced with increased public scrutiny over chemicals used to control pests in the nursery. There is also an environmental trend to accelerate the use of native plant material in the landscape and in the reclamation or mitigation of natural upland sites and fresh and tidal wetlands. As a result, the demand for the production of native plant species not normally found in the trade is increasing. The nursery industry is being challenged to produce these new materials with their unique pest management problems. IPM programs will help the industry deal with production problems while producing saleable and viable native and wetland plant materials under the current and future chemical and regulatory restraints.

Literature Cited:

1. Higgenbotham, Julie S. 1993. Pest Control. Am. Nurs. 177(12):70-77.

2. Raupp, M.J., C.S. Koehler and J. Davidson. 1992. Advances in Implementing Integrated Pest Management for Woody Landscape Plants. Annu. Rev. Entomol. 37:561-85.

3. Studebaker, Dan W. 1992. Practical IPM. Am. Nurs. 176(7):41-55.

Management of Pine Bark Adelgid with Imidacloprid

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Nature of Work: The pine bark adelgid, *Pineus strobi* (Hartig), one of 11 adelgid species on conifers in the U.S., is an insect pest commonly found on eastern white pine *Pinus strobus* (2). It feeds on the trunk, the underside of branches and on new growth but not the needles of white pine (1). Adelgids overwinter on the trunk of the tree as late stage immatures and then begin feeding and secreting large amounts of a woolly substance during the first warm days of spring. As spring continues, the females complete development and lay eggs. Crawlers then emerge which mature to another apterous generation. These apterous forms reproduce parthenogenetically throughout the season (2,4).

Christmas tree producers in Georgia have reported increased incidence of adelgid infestations in white pine Christmas trees. Control with common contact insecticides is ineffective due to the the presence of the protective woolly wax masses produced by these insects.

A test was initiated with imidacloprid (1-[(6-Chloro-3pyridenyl)methyl]-N-nitro-2-imidazolidinimine), a new chemistry systemic insecticide reported to be effective on aphids and whiteflies (3). Control of adelgids was attempted with the 240 gram/liter (2 lb AI/gal) formulation of imidacloprid.

The experiment was designed to compare a soil drench treatment to a foliar spray. In addition, a fall application timed to reduce the population just before entering the winter dormant period and a spring application timed to coincide with the first activity and population increase in the spring were evaluated. Each treatment plot contained two rows of 10 trees each with a border row between each plot. Each block of treatments was replicated 6 times in a randomized complete block design.

The foliar spray treatments were applied with a sprayer operated at 50 p.s.i. and sprayed to run-off. The foliar application rate was 0.003% solution of active ingredient (40 ml formulation/100 gallon). The drench treatments were applied within the dripline and around the base of the trunk of each tree. Two drench rates of 3 and 6 ml of formulation per pint of water per foot of tree height were tested.

The population was determined by using a rating scale of O to 9 based on the amount of waxy material present indicating adelgid activity. The ratings were: O = no wax, 1-3 very little wax, 4-6 = quantities of wax that may require treatment, and 7-9 = quantities of wax that if not treated would result in death of the tree. In addition, activity within the waxy deposit was determined by collecting five 10 cm (4 in) lengths of twigs with waxy material from trees which had an initial rating of 5 or more. These twigs were washed in a 70% ethyl alcohol solution and the number of adelgids recorded.

Results and Discussion: Imidacloprid reduced pine bark adelgid populations based on a waxy fluff rating scheme and live adelgid count method used to evaluate test plots (Table 1). The untreated check plots exhibited a continued adelgid population growth through the winter of ’92 and the spring of ’93. The imidacloprid plots treated in the fall remained somewhat stable with marked rating reduction by May ’93. In addition, live adelgid counts indicate a significant population reduction of adelgids from fall application.

Spring applications provided a reduction of adelgid incidence. The spring treatments were applied against an exploding population and require more time for effectiveness to be expressed.

Significance to Industry: Imidacloprid is new chemistry currently being considered by EPA for national registration. The availability of an insecticide for the control of pine bark adelgid would allow management of this pest and an increase in profits by Christmas tree growers. It would also be applicable to adelgid pests of other Christmas tree species and pines grown in production nurseries.

Literature Cited:

1. Doane, C.C. 1961. Taxonomy and biology of *Pineus strobi* (Hartig) and P. *coloradensis* (Gillette) (Homoptera: Adelgidae). Can. Entomol. 93: 553-560.

2. Johnson, W.T. and H.H. Lyon. 1988. Insects that feed on trees and shrubs. 2nd ed. Cornell Univ. Press, Ithaca, N.Y.: 76-77.

3. Oetting, R.D. and A.L. Anderson. 1990. Imidacloprid for control of whiteflies, *TrialeurodeS vaporariorum* and *Bemisia tabaci,* on greenhouse grown poinsettias. Brighton Crop Prot. Conf.-Pests and Diseases 1990,1: 367-372.

4. Raske, A.G. and A.C. Hodson. 1964. The Development of *Pineus strobi* (Hartig) (Adelginae, Phylloxeridae) on white pine and black spruce. Can. Entomol. 96: 599-616.

Table 1. Control of Adelgids on White Pine Christmas Trees with Drench and Foliar Application of Imidacloprid.

	1992			1993			
	Infestation Rating[2]		Live Adelgids per 5 Stems	Infestation Rating[3]			Live Adelgids per 5 Stems
Treatment[1]	Sept.	Nov.	Nov.	Feb.	May	June	May
Check	1.64	2.35	20.00±11.7b	3.30	4.46	3.42	103.20±105.6a
drench 3ml/ft 9/17/92	2.29	2.60	0.00±0.00c	2.61	0.59	0.53	22.9±18.6b
drench 6ml/ft 9/17/92	1.93	2.11	0.00±0.00c	2.07	0.36	0.34	22.80±17.6b
foliar 40ml/100gal 9/25/92,3/30/93	2.07	2.43	1.54±1.40c	2.75	1.01	1.03	34.70±28.1b
drench 3ml/ft 3/1/93	1.87	2.68	27.36±17.50a	3.68	2.63	1.35	95.20±129.7a
foliar 40ml/100gal 3/30/93	2.16	2.99	30.92±18.30a	3.64	3.22	1.56	91.40±74.4a

[1]Six Reps per treatment, all drench treatments applied at given rate in one pint of water per foot of height. Foliar to run-off (0.25 pint/tree).

[2]Adelgid infestation rating 0 to 9 scale with 0 as no visible evidence and 9 as excessive waxy fluff covering stems and trunk.

[3]Rating 0 to 9 scale based on presence of waxy fluff on periphery with attention to new growth and first 10 cm inside new growth with 0 as no visible evidence and 9 as excessive development.

Imported Fire Ant Baits: A Review of Their Use in Applied Research/Demonstration Plots in Georgia, 1989-1992

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Nature of Work: Imported fire ants (IFA), *Solenopsis invicta* Buren and *Solenopsis richteri* Forel continue to spread through the southeastern United States. IFAs are currently found in all counties in Florida, Alabama and Louisiana; the majority of counties in Mississippi, Georgia, and South Carolina; the southern portions of North Carolina, Tennessee, Arkansas and Oklahoma; and the eastern half of Texas. Nurserymen located in IFA infested areas that ship containerized or balled and burlapped plant materials to noninfested areas must comply with IFA quarantine regulations. Quarantine regulations for the IFA-Free Nursery Program require the following: visual survey of the nursery twice monthly for IFA colonies; the incorporation of bifenthrin (Talstar®) into potting media; plants received into the nursery from sources other than IFA free nurseries must receive topical application, a drench or immersion treatment with an approved insecticide prior to shipping; and application of an approved fire ant bait in and around the perimeter of growing areas every six months (1).

In 1989 through 1992 twelve field trials were conducted in Georgia to evaluate the efficacy of broadcast treatment of fire ant baits in controlling populations of the red imported fire ant. Products evaluated in these trials include fenoxycarb (Award® and Logic® Fire Ant Bait, Ciba-Geigy Corp., Greensboro, NC) and hydramethylnon (Amdro®, American Cyanamid Co., Princeton, NJ). Baits were evaluated as individual broadcast treatments, treatments where two baits were applied in combination, the baits in combination with broadcast treatments of granular chlorpyrifos, and the baits in combination with individual mound drenches of diazinon, chlorpyrifos (Dursban®) or isazophos (Triumph®).

Plot design, application techniques, and evaluation of product efficacy were similar for the trials. Plots were located in permanent pastures (10 trials), a golf fairway (1 trial), and a grass air strip (1 trial) in nine counties in Georgia. In each trial test plots and untreated checks were arranged in a completely randomized block design with a minimum of 3 replicates per treatment. All plots were 0.5 to 1 acre in size with either circular 0.10 or 0.25 acre efficacy subplots located within each plot. All bait and broadcast granular insecticide treatments were made using a Herd GT-77 granular applicator (Herd Seeder Co., Logansport, IN) mounted on an All Terrain Vehicle. Mound drenches were made using 2 gallon buckets and slowly pouring one gallon around the perimeter and one gallon on the top of each mound. Efficacy of treatments was based on observation for colony mortality within subplots at intervals of 4, 8, and 24 weeks posttreatment. In several trials 12, 16 and 52 week evaluations were also made.

Results and Discussion: Table 1 presents the range and average percent reduction in number of active fire ant mounds in plots treated with baits containing fenoxycarb and hydramethlynon in nine trials conducted in Georgia in 1989-1992. Bait containing hydramethlynon provided more rapid control than baits containing fenoxycarb. Hydramethlynon bait averaged greater than a 70 percent reduction in number of active mounds within 4 to 8 weeks of broadcast application compared to less than a 42 percent reduction in number of active mounds for fenoxycarb baits within the same time period. However, baits containing fenoxycarb suppressed fire ant populations for a longer period of time than hydramethylnon baits. In all trials, evidence of IFA reinfestation was apparent within 24 weeks in hydramethylnon treated plots. No evidence of reinfestation in fenoxycarb plots was recorded during the 24 week period.

Table 2 presents percent reduction in number of active fire ant mounds tests where fenoxycarb and hydramethylnon baits were tested as individual applications (1.3 and 1.0 lbs/A respectively), as a combined treatment (one application of 0.75 lbs/A of each product), and as a combination of the two baits applied in two applications at 30 day intervals. Results indicate that one application of hydramethlynon and fenoxycarb baits applied in combination reduced fire ant populations by 90% within 8 weeks and held populations at that level until the test was terminated (24 weeks). Single applications of either hydramethlynon or fenoxycarb or treatment with both products in two separate applications was not as effective as a single application of the two products combined.

Results of trials evaluating the efficacy of bait treatments followed by broadcast application of chlorpyrifos are presented in Table 3. When used in combination, baits and granular chlorpyrifos reduced fire ant populations by 100 percent within 12 weeks. Treated plots were reinfested with IFA within one year.

Results of a trial evaluating the efficacy of a broadcast treatment of fenoxycarb bait followed in one week with treatment of individual mounds with drenches of either isazophos, diazinon or chlorpyrifos are presented in Table 4. The combination of bait application with individual mound drenches was effective in reducing IFA population by at least 75 percent within 8 weeks of treatment. Populations of fire ants remained suppressed by 85 to 100 percent at the 24 week evaluation.

Significance to Industry: Nurserymen located within much of southeastern United States must meet IFA quarantine regulations to ship nursery stock to non-infested IFA areas. The evaluation of bait application programs provides nurserymen with information on economical and efficacious means of controlling IFA populations in and around plant production areas.

Literature Cited:

1. Imported Fire Ant Program Manual, M301.81. USDA-APHIS-S&T, 29 pp.

TABLE 1: Range and average percent reduction in number of active fire ant mounds in plots treated with IFA baits containing fenoxycarb and hydramethylnon. Field trials were conducted in Georgia, 1989-1992.

TREATMENT[1] (#trials)	Range (Average) %Reduction in Active Fire Ant Mounds at Indicated Week			
	(4)	(8)	(16)	(24)
hydramethylnon (6)	64-100 (73.7)	66-92 (76.7)	78-85 (81.5)	35-83 (64.7)
fenoxycarb (9)	+4.5-54 (33.7)	18-62 (41.9)	36-78 (57.0)	56-78 (71.4)
check (9)	0-12 (7.06)	+6-14 (6.46)	+75-58 (+2.3)	20-36 (30.5)

[1]hydramethylnon (Amdro®) and fenoxycarb (Award® or Logic®) applied at a rate of 1.0 to 1.5 lbs/A.

TABLE 2. Percent reduction in number of active fire ant mounds in plots treated with fenoxycarb and/or hydramethylnon IFA baits. Field trials conducted in Morgan County Georgia, 1989.

	% Reduction in Number Active Fire Ant Mounds at Weeks Indicated	
Treatment[1]	(8)	(24)
hydramethylnon	66.6	83.3
fenoxycarb	62.5	56.2
hydramethlynon + fenoxycarb	90.0	90.0
hydramethlynon + delayed fenoxycarb	66.6	55.0
fenoxycarb + delayed hydramethylnon	90.4	61.9
Check	8.3	+75

[1]hydramethylnon (Amdro®) applied at 1 lb/A; fenoxycarb (Logic®) applied at 1.3 lbs/A; hydramethylnon + fenoxycarb treatment applied at .75 lbs Amdro® + .75 Logic®/A; hydramethylnon + delayed fenoxycarb treatment applied at 1.0 lb Amdro®/A followed in 30 days with 1.3 lbs. Logic®/A; fenoxycarb + delayed hydramethylnon treatment applied at 1.3 lbs Logic®/A followed in 30 days with 1.0 lbs Amdro®/A.

TABLE 3. Percent reduction in number of active fire ant mounds in plots treated with broadcast application of fire ant baits followed by a broadcast treatment with granular chlorpyrifos.

Treatment[1] (# trials)	% Reduction in Active Fire Ant Mounds at Week Indicated			
	(4)	(8)	(12)	(52)
(A) fenoxycarb (2) + chlorpyrifos	86	90	100	35
(B) hydramethylnon (1) + chlorpyrifos	95	90	100	15
(C) check (2)	20	46	26	26

[1]Rates were as follows:
(A) Logic® 1.25 lb/A followed 10 days later by Dursban® 2.5 G at 1 lb AI/A.
(B) Amdro® 1.1 lb/A followed 10 days later by Dursban® 2.5G at 1 lb AI/A.

TABLE 4. Percent reduction in number of active fire ant mounds in plots treated with broadcast application of fenoxycarb followed by individual mound drenches.

Treatment[1]	% Reduction in Active fire ant mounds at the week indicated		
	(4)	(8)	(24)
fenoxycarb + isazophos	57.1	85.7	85.7
fenoxycarb + diazinon	75.0	75.0	100
fenoxycarb + chlorpyrifos	53.8	92.3	92.3
check	7.1	14.2	35.7

[1]Treatment rates were as follows:
fenoxycarb (Award®) applied at 1.5 lbs/A; isazophos (Triumph®) applied at 0.5 ml/2 gallons water/mound; diazinon (2E) applied at 1 oz/2 gallons water/mound; chlorpyrifos (Dursban® 4E) applied at 0.5 oz/ 2 gallons water/mound.

The Liriope Scale, Pinnaspis caricis Ferris: Its Recognition, Biology and Management

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Nature of Work: A two year taxonomic evaluation of a scale insect population occurring on Liriope spp. and allied genera of liliaceous turf plants (Mondo spp., Ophiopogon spp. and Rhodea spp.) was undertaken in the fall of 1991. This population, consisting exclusively of females, has posed taxonomic ambiguities since its recognition and description in 1956 (1). The liriope scale is one of the most injurious insect pests of commercially grown lilyturf plants. Heavy infestations yield chlorotic spotting and foliar necrosis. The unisexual liriope scale, Pinnaspis caricis Ferris, is virtually indistinguishable from the bisexual fern scale, Pinnaspis aspidistrae (Signoret). Due to extreme morphological similarities exhibited by the females, many consider the two populations to be the same species (2). We have compared both populations for similarities and differences in biology, ecology and morphology.

Results and Discussion: In the southeastern United States, there are 3 to 4 overlapping generations of liriope scale occurring annually. Adult females overwinter in the protected basal leaf sheaths of the host plant. During warmer seasons living scale insects can be observed on all surfaces of the liriope blade, however, greatest concentrations are still found in the blade sheaths. Egg production is constant, being greatest in the months of March-April and July-August. Though crawlers are observed all year, primary hatches and crawler dispersal occur in April-May and again in August-September. This aspect of the liriope scale's biology yields optimum target periods for control of this insect. The first instar, which is the only mobile stage in the life cycle, is most vulnerable. Crawlers are slow moving, unable to firmly grip plant surfaces and lack the protective scale cover of later instars.

Reciprocal host plant transfer studies were conducted in 1992 to determine if reproductive mode and observed differences were host plant induced. During periods of crawler activity, container grown liriope plants were exposed to fern fronds infested with fern scale; conversely, boston ferns were subjected to blades of liriope infested with liriope scale. Controls were also established to determine if the chosen transfer technique would prove successful. All transfer tests were conducted for a duration of four weeks. Crawlers were allowed to move onto the new host plants without any manipulation of individual insects. Past research efforts indicate that crawlers are intolerant and prone to injury when individually manipulated (3). It was determined that liriope scale would easily transfer to liriope plants and that fern scale would readily transfer to ferns. In contrast, liriope scale populations failed to develop on fern and fern scale populations failed to develop on liriope, thus indicating host plant specificities within each group.

Based on preferred hosts and host plant origins it is probable that the natural distribution of the fern scale is tropical IndoAsia and Indo-Australia while that of the liriope scale is coastal China, Japan and Korea. Geographic and climatic tolerances of each population differ; the bisexual fern scale exists as an outdoor pest only in tropical and sub-tropical zones and in more temperate climates it is restricted to indoor and greenhouse conditions. In contrast, the liriope scale is able to survive and overwinter in much cooler climates as it can survive temperatures well below freezing.

One lady beetle species and a chalcidoid wasp parasite constitute the observed natural enemy complex of the liriope scale. The twenty spot lady beetle was observed to feed on mobile crawlers in early spring but showed no interest in settled insects. Parasitoids were observed all months of the year. Parasitoids overwinter as pupae within the body of the host scale insect. Late second and third instar scale insects are the only stages parasitized. The fern scale population was also parasitized by a chalcidoid wasp, but it has not yet been determined if the parasitoids affecting both populations are members of the same species or closely related types.

Morphological analysis of adult females from both populations has revealed little basis for separation, however, first instars can be differentiated morphologically. Morphological differences accompanied with biological and ecological differences suggest that both populations are distinct species.

Significance to Industry: Clarification of taxonomic questions yields understanding; increased understanding, particularly with regards to the biology and ecology of pest organisms, may allow for more economically efficient and ecologically sound control and management practices. In addition, clarification of host plant associations allow us recognition of crops most likely to be affected by outbreaks of these pest species. We discovered that cultural practices such as heavy irrigation and fertilization during crawler production can greatly decrease infestations. In the future, management of this insect may be accomplished using a combination of cultural practices, natural enemies and controlled chemical applications.

Literature Cited:

1. Ferris, G.F. 1956. Two Species of Diaspididae new to the Hawaiian fauna (Homoptera: Coccoidea). Hawaiian Entomol. Soc. 16:212-213.

2. Nakahara, S. 1979. Pinnaspis caricis, New synonym of Pinnaspis aspidistrae (Homoptera: Diaspididae). Proc. Entomol. Soc. Wash. 81(1):31

3. Werner, W.H.R. 1931. Observations on the life-history and control of the fern scale, Hemichionaspis aspidistrae Sign. Papers Mich. Acad. Sci. 13:517-541.

Natural Enemies of the Common Bagworm: Life History of the Pyralid Dicymolomia julianalis in Tennessee

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Tennessee

Nature of Work: The bagworm, *Thyridopteryx ephemeraeformis* (Haworth), is one of only two or three species of economically important bagworm. Native to the United States, larvae of this bagworm can be devastating pests of woody ornamentals throughout much of the South (4). Natural enemies, through their feeding on the bagworms, may reduce damage caused by bagworms and help to keep densities of bagworms in “check.”

Several reports have documented *D. julianalis* as a predator and parasite of the common bagworm (5). *D. julianalis* is believed to consume bagworm eggs and occasionally feed on the living larva or pupa, although Balduf (2) concluded that the pyralid is a scavenger which crushes and eats the eggs while preparing hibernacula. Little information is known about the basic lifecycle and host interactions of the pyralid *D. julianalis*, however. Several reports suggest that the larva feeds on a variety of organisms, which include musk thistle (7), cat-tails (1,3) and bagworms (2,5). This range of food sources (which takes it from parasitoid/predator to plant eater to scavenger) is considered to be an unusually diverse diet.

The goal of our research was to determine the lifecycle, ecological interactions, and feeding habits of *D. julianalis* and other predator/parasites on the common bagworm. Bagworm cases were collected biweekly from numerous sites throughout Tennessee from November to

June and monthly from July to October from 1991 to 1993. Most of the collection sites were areas that had never been treated with pesticides. The bagworms, which were in the overwintering egg stage, were taken to the laboratory, dissected and examined for parasites and predators.

Results and Discussion: Among the parasites recovered from bagworm cases were several species of Hymenoptera (i.e., *Itoplectes conquistor*, several braconid species and several members of Chalcidoidea), numerous mites and the pyralid *D. julianalis*. In fact, larvae of *D. julianalis* were found in more than 10% of the bagworms. Eggs of *D. julianalis* were probably deposited on bagworms between September and November, as bagworms collected in late November contained early-instar pyralid larvae (Figure 1). Bagworms collected in April and May contained empty *D. julianalis* pupal cases, suggesting that emergence of adult *D. julianalis* from bagworm cases occurred primarily during these months.

Significance to Industry: Bagworms can be a significant pest of evergreens in nurseries and landscapes. Therefore, the incorporation of a biological control strategy, such as one which uses the pyralid *D. julianalis*, may help to limit the losses caused by the common bagworm, especially in the urban landscape.

Literature Cited:

1. Allyson, S. 1981. Description of the last instar larva of the cabbage webworm, Hellula Roqatalis (Lepidoptera:Pyralidae), with a key to larvae of North American species of Hellula Guenee. Can. Entomol. 113:361-364.

2. Balduf, W.V. 1937. Bionomic notes on the common bagworm, Thyridoteryx ephemeraeformis Haw., (Lepid., Psychidae) and its insect enemies (Hym., Lepid.). Proc. Entomol. Soc. Wash. 39:169-184.

3. Claassen, P.W. 1921. Typha Insects: Their Ecological Relationships. Cornell Univ. Ag. Exp. Station, Memoir 47:457531.

4. Johnson, T.W. and H. Lyon. 1988. Insects that Feed on Trees and Shrubs, Second ed., Cornell University Press, Ithaca, NY.

5. Kaufmann, T. 1985. Dicymolomia lulianalis (Lepidoptera:Pyralidae) as an endoparasite of the bagworm, Thyridopteryx ephemeraeformis (Psychidae): Its relation to host, life history and gonad development. Pan-Pac. Entomol. 61:200-209.

6. Powell, S.D. 1991. Insects and Arachnids Associated with Musk Thistle, Carduus thoermeri, in Tennessee, M.S. Thesis, Univ. of Tennessee, 51 pp.

7. Powell, S.D, J.F. Grant and P.L. Lambdin, 1992. Incidence of Dicvmolomia iulianalis (Lepidoptera: Pyralidae) on musk thistle in Tennessee. J. Entomol. Sci. 27:209-216.

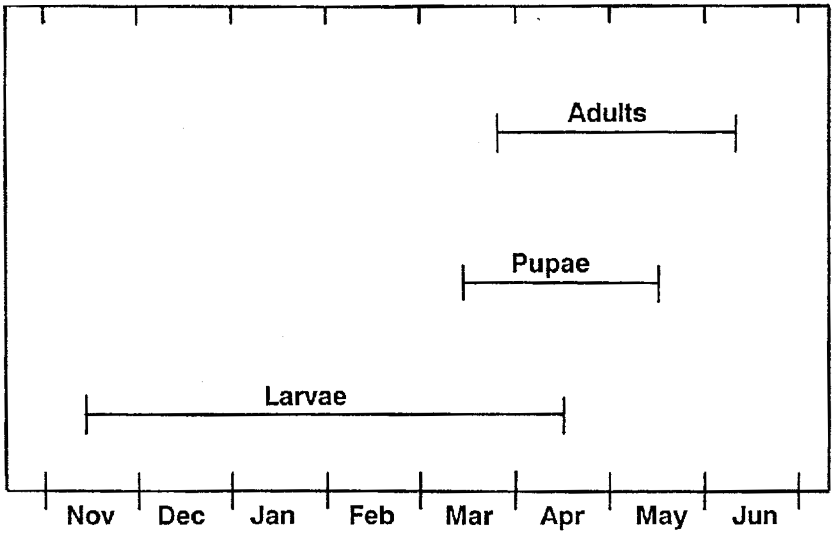

Figure 1. Seasonal incidence of larvae, pupae and adults of Dicymolomia julianalis on bagworm.

Preliminary Investigations of Arthropod Species Diversity in a Northern Red Oak Seedling Seed Orchard

R. Chris Stanton, Jerome F. Grant, Paris L. Lambdin, Larry R. Barber, and Scott E. Schlarbaum
Tennessee

Nature of Work: In 1987, a 13-year progeny test on northern red oak, Quercus rubra L., initiated by the Tennessee Valley Authority within the Cherokee National Forest, was converted to a seedling seed orchard by the U.S.D.A. Forest Senice. The primary purpose of the orchard is to produce acorns for reforestation efforts (1). However, acorn production in this orchard is low compared with the number of flowers produced in the spring. Over two, two-year reproductive cycles (from flower emergence to acorn maturity), the numbers of flowers, lst-year acorns, and mature acorns declined (ca. 77 to 96%) compared to initial flower densities. Few studies on insect diversity have been conducted in deciduous seed orchards. Past studies have shown that oaks harbor insects with the potential to damage developing acorns. Thus, a two year research project was initiated in 1992 to determine the insect community on northern red oaks and to assess if production losses could be attributed to insects. Our objectives were to: 1) document the biodiversity of insect species present in northern red oaks, 2) monitor seasonal incidence and abundance of species, and 3) identify any insects that could be associated with production losses.

The orchard (16.2 acres) lies approximately 30 miles from Elizabethton, in upper east Tennessee, at an elevation of ca. 1980 ft. (1). All seedlings are ca. 20 years old, ranging from 10 to 30 feet tall and 2 to 8 inches dbh. Insect sampling was conducted every 2 weeks from April to October 1992 on individual trees of five genetic “families” chosen on the basis of their past acorn production.

On each sampling date, plastic tarps were placed on the ground beneath each tree’s entire canopy. Next, the canopies were thoroughly sprayed with Asana XL®, a synthetic pyrethroid insecticide, from a bucket truck. After 3 to 4 hours, dead insects that had fallen onto the tarps were suctioned into containers using a modified Dustbuster® vacuum. Samples were then taken to the laboratory where they were sorted, labelled, and identified. These same sampling procedures will be repeated from March through October 1993.

Results and Discussion: In 1992, 13,052 individuals were collected from northern red oaks. Most (ca. 99%) of the specimens were members of only six orders (Table 1). The Asiatic oak weevil, Cyrtepistomus castaneus (Roelofs), and an oak treehopper, Platycotis vittata (F.), were found in large numbers, comprising 32 and 6%, respectively, of all insects collected. Both insect species have the potential to severely damage both the flowers and the mature acorns (1). The Asiatic oak weevil was present from late June to October and populations peaked during July. P. vittata were present from mid April to October. Densities of Asiatic oak weevil and P. vittata varied among genetic "families"; densities among these families will be compared statistically after the completion of the second year of this study.

This research will help to further define the diversity, abundance, and seasonality of insect species in the northern red oak seedling seed orchard. Insects associated with acorn production losses will be identified. More detailed studies of specific insects will be initiated to provide a better understanding of the effects of these pest species on northern red oak flower and acorn production.

Significance to Industry: The goal of this research is to develop pest management strategies to limit losses to insects and to improve acorn production in a northern red oak seedling seed orchard. This information will provide a sound insect database for use by orchard managers working with oaks and other deciduous tree species. Information on insect abundance, seasonality and impact on mast production also will be beneficial to producers who grow other oak species.

Literature Cited:

1. Schlarbaum, S.E., J.L. McConnell, L.R. Barber, R.A. Cox, J.F. Grant, P.P. Kormanik, T. La Farge, P.L. Lambdin, S.W. Oak, C.K. Proffitt, J.R. Rhea, and T. Tibbs. 1993. Research and Management in a Young Northern Red Oak Seedling Seed Orchard. Proceedings of the 1993 Tree Improvement Conference, In Press.

Table 1. Composition of taxa collected from northern red oaks, Elizabethton, TN, 1992.

Insect Order	% of Total Number Collected*
Coleoptera	42.4
Homoptera	20.8
Hymenoptera	20.2
Diptera	11.4
Hemiptera	2.0
Orthoptera	2.0
Other	1.2

*13,052 individual insects were collected.

1991 Periodic Cicada Damage in Kentucky Nurseries

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Kentucky

Nature of Work: The individual life cycle of the periodical cicada is long but relatively simple. The adults usually emerge between late April and early June. Just before emergence, the cicadas burrow to the soil surface. Following emergence, the adults move immediately to any convenient vertical object and shed their last nymphal skin. They leave empty brown skins, which have split down the back, lying all about. After struggling out of the pupal skin, adult cicadas rest on that site for several hours until their bodies and wings have expanded and are dry and hard.

Male cicadas then congregate in very large numbers in nearby tree tops and “sing.” They produce this high-pitched, shrill mating call by vibrating membranes on the underside of their first abdominal segment. The loud “singing” is what most often alerts people to the presence of this insect. After mating, the females disperse to lay their eggs. They prefer grape-vines, oak, hickory, apple, peach and pear trees for egg laying. They first slit the bark and then insert a row of eggs into the wound. The eggs hatch in six to eight weeks. The nymphs fall to the ground and burrow down to the root system where they stay for the next 13 (or 17) years. Damage occurs as they use their piercing-sucking mouthparts to feed on the roots.

During July, 1991 a survey of 150 licensed Kentucky wholesale nurseries was conducted in order to determine the extent of cicada damage to salable landscape plants that year. The survey was stimulated by the desire to know the extent of damage for planning educational and research programs and to provide an estimate of the economic losses within the region as they relate to the possibility of recovering losses through governmental disaster relief or tax deductions. Occurrences of periodic cicada broods are expected in Kentucky in 1995, 1998 and 2000.

Results and Discussion: Of the 82 responding firms, 50 reported no damage, 14 reported light damage, 5 reported moderate damage and 13 reported heavy damage. The 32 nurseries reporting damage incurred income losses totaling over $2,000,000 in 1991 due to nonsalable plants. The degree of damage varied between nurseries within a county or area.

Not all plant materials on all nurseries were damaged. Forty-seven percent of the plant holdings on heaviliy damaged nurseries that were intended for harvesting during the fall of 1991were being held until the fall of 1992. Smaller plants scheduled for harvesting during the fall of 1993 are projected to be delayed until 1994. Those nurseries reporting damage on sizable acreage averaged $325,000 of 1991 income loss on an average of 163 acres (Table 1). These firms reported hiring additional labor for the purpose of spraying and pruning damaged plants.

Plants in the following genera were reported being most heavily damaged: *Acer, Amelanchier, Betula, Cercidophyllum, Cercis, Cornus, Craetagus, Euonymus, Fraxinus, Gleditsia, Ilex, Juniper, Liquidambar, Malus, Platanus, Prunus, Pyrus, Quercus, Syringa, Tilia, Viburnum* and *Zelkova*. How can this damage be corrected? One respondents comment: "*I recall from previous cicada attacks that damaged twigs which do not break off or which are not removed by pruning never grow normally, and will always be weak.*"

A disaster loss is a loss which is attributable to a disaster occurring in an area which the President of the United States later says is entitled to federal assistance. Specific disaster areas are announced in the Federal Register as they are determined. Kentucky nursery owners pursued the possibility of filing for a disaster loss through state and federal routes but were unable to have this insect damage classified as a natural disaster.

The possibility of claiming a casualty loss against income for tax purposes was also considered. A casualty loss is the complete or partial destruction of property resulting from an identifiable event of a sudden, unexpected, or unusual nature. But progressive deterioration from a steadily operating cause, and damage from normal processes, aren't casualties. The fact that the damage could have been foreseen or might have been prevented with due care doesn't bar treating the event as a casualty. The IRS generally denies a casualty loss deduction for loss of trees, shrubs, etc., as the result of insect attacks, disease, or fungus spread by beetles, insects, worms, etc. However, the Tax Court allowed a casualty loss deduction in a case of damage by pine beetles, even where it took up to 30 days for a tree to die after a beetle attack. This ruling has little significance to nurseries classified as agriculture and that claim no inventory. Since there is no inventory until the plants are saleable, there is no inventory loss from the insect attack.

Significance to the Industry: Data on county/area damage from cicada were required to pursue possible avenues for recovering financial losses. Avenues pursued for recovering losses were unsuccessful. The survey revealed the justified need for state, regional, and/or federal research efforts toward discovering economical and environmentally sensitive control of periodic cicada.

Table 1. Respondents reported influence of cicada damage on wholesale nursery production acreage. (Nursery responses were averaged in each category.)

Damage Level	Nursery Size	Spraying Costs ($)	Pruning Costs	Income Loss ($)	Employee Increases	Delayed Harvest	Time Delay
(A)		($)		(No.)	(%)	(Yr.)	
Heavy	163	3,725	26,300	325,000	8	47 47	fall 92 fall 94
Heavy	8.5	3,362	3,235	28,417	1	64 50	92 fall 93
Moderate	15.2	1,866	1,370	5,933	1	34	fall 92
Light	7.1	23	172	211	0	5	fall 92

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Rearing of Chilocorus kuwanae, is it Practical?

Peter B. Schultz
Virginia

Nature of Work: The inoculative release of *Chilocorus* kuwanae, a coccinellid predator of euonymus scale, into Virginia in 1988 resulted in establishment and natural spread to a number of locations throughout the region. Surveys conducted in 1991 around the initial release at the Hampton Roads Agricultural Experiment Station (HRAES) indicated *C. kuwanae* had established in residential landscapes 10 miles from the point of release. Similar results are reported from those southern states where releases were made. Concurrent with the publicity surrounding such an effort, a demand for the beetles arose from urban gardeners through Cooperative Extension personnel for releases in their areas.

Mass rearing of *C. kuwanae* was then begun at HRAES using two procedures, laboratory rearing and field collection. Laboratory rearing offers the benefits of controlled conditions, but is more labor intensive in terms of insect care. Rearing the predator requires rearing prey, and the diet for the prey, in this case winter squash. We reared the *C. kuwanae* on San Jose scale as an alternative to euonymus scale, because of the ease of mass rearing this insect (and the inability of rearing euonymus scale). San Jose scale rearing procedures are relatively simple, but require a year-round supply of winter squash. We grew our own squash, and in the process, evaluated 10 cultivars of squash in 1992 to ascertain which would be best for scale rearing purposes, i.e. longevity in cold storage, scale population suitability, handling. Four different environmental areas were required for the laboratory rearing procedure. A cold storage area held at 50°F, a darkened room with trays for rearing scale on squash, shoe-box sized ventilated crisper-like cages for rearing *C. kuwanae* on the scale, an area with lighting from above to collect scale crawlers for transfer to squash for later use. The same cooler could be used for short-term storage of *C. kuwanae* adults reared on the scaleinfested squash. Once all the conditions and space requirements were in place, the time spent on the rearing was approximately 10 hours per week, with an additional 5 hours per week during squash harvesting. Harvested squash were dipped in a 1% bleach solution and a fungicide solution to improve storage. Squash were stored at 50° F, and moved to room temperature as needed. Scale crawlers were dusted on squash, and after several generations, *C. kuwanae* adults were introduced to propagate the predator. Progeny were collected, and stored at 50°F for release.

An alternative technique is the field collection from urban gardens or a field insectary. A field insectary was established by planting several cultivars and species of euonymus, artificially infesting the area with euonymus scale, and later *C. kuwanae*. The objective of this program is to have *C. kuwanae* available for harvest and relocation by Cooperative Extension personnel.

Results & Discussion: Field insectaries require field maintenance, but fewer manhours than laboratory colonies. While there is control regarding pruning or insecticide usage, there remains the possibility of scale population fluctuations due to weather and parasites. There is also a wasp parasite of C. *kuwanae* that has been collected in both Virginia Beach and Raleigh, NC. Its impact appears minor at this time. Collection from urban gardens with scale infested plants is the most economical, as the only expense is in the travel to survey and collect *C. kuwanae.* Collection from urban gardens has elements of risk in the property owner may decide to renovate the landscape or spray insecticides, thereby elminating the predators. Problems of weather and parasites could also occur.

Laboratory rearing for distribution is not practical, and *C. kuwanae* collections from either urban gardens or a field insectary would fill the demand at lowest cost. Laboratory rearing is an excellent method to introduce biological control concepts to school groups, but not as a cost-effective biological control program.

Comparison of Mortality of an Early and Late Instar Defoliator with *Bacillus thuringiensis*

M. A. Coffelt and P. B. Schultz
Virginia

Nature of Work: Integrated pest management (IPM) strategies are the method of choice for controlling major pests in the urban landscape. A component of IPM is biorational pesticides, which are selective materials that have low toxicity to users and non-target species. A widely used biorational pesticide is *Bacillus thuringiensis,* which selectively kills caterpillars. This material has historically been used against early instar or small sized caterpillars and effective control has been documented (5). Rainfall has been shown to decrease effectiveness (4). Use of *Bacillus thuringiensis* against late instars or larger sized caterpillars is an important consideration in IPM programs.

A serious defoliating caterpillar, the orangestriped oakworm *(Anisota senatoria* J. E. Smith), has caused widespread damage throughout southeastern Virginia since 1985 (3). Control methods that use IPM strategies have been effective (1) and widely accepted (2). Moths emerge from overwintering pupae in late June and are present throughout July. Mated pairs are found on grass blades, low bushes, or tree trunks. Yellow eggs are oviposited throughout July on leaf undersides in masses of 200-700. Eggs are deposited on terminal twigs of lower branches 6-10 feet above ground. Gregarious green-yellow larvae skeletonize leaves, while black fifth instars consume entire leaves except the main vein.

Defoliation occurs in late August to September. During September, larvae seek suitable habitats and burrow 3-4 inches in the soil and pupate. There are one (June-August) and possibly two (SeptemberDecember) generations a year, depending on location (3).

Studies were conducted at an oak plot located at the Hampton Roads Agricultural Experiment Station in Virginia Beach, Virginia. Three rates of CGA-237218, *Bacillus thuringiensis,* var. *kurstaki/ aizawai* were applied to 15-25 ft. pin oaks, *Quercus palustris,* on 30 July, 1992, to control early first instar *A. senatoria.* Diazinon and water were also applied to trees. Triton 1956 spreader sticker was used with the treatments. Five treatments and four single tree replicates of each treatment were used. Pretreatment counts of gregarious early instars were conducted before treatment. Gregarious caterpillar groups and surrounding foliage were sprayed to runoff utilizing a CO_2 compressed air sprayer at 30 psi. The number of live caterpillars was determined seven days posttreatment (6 August).

Temperature at time of treatment was 90°F and rainfall was 1.42 inches between 30 July and 6 August. The same treatments were applied on 19 August, 1992, against late instar (fourth and fifth) *A. senatoria* caterpillars with three single tree replicates of each treatment. Pretreatment counts of late instars were done before treatment application and trees were sprayed to runoff. The number of live caterpillars was determined six days post-treatment (25 August). Temperature at time of treatment was 81°F and rainfall was 0.28 inches between 19 and 25 August.

Results and Discussion: The three rates of CGA-237218 provided excellent control of early first instars compared to diazinon and the water check (Table 1). However, there were no significant differences between treatments for late instars. The CGA-237218 treatment at the lowest rate gave the best control, but the high standard error of the mean (SEM) indicated these data were quite variable. Late instar *A. senatoria are* difficult to control with insecticides because of their tough cuticle and large size (2.5 inches when mature).

Significance to Industry: Strategies that emphasize IPM and control of early instar caterpillars with a biorational like *Bacillus thuringiensis* will be effective. Attempts to control late instar caterpillars with CGA-237218 will not be effective. As is true for many caterpillars, control of *A. senatoria* should be done in the early instars.

Literature Cited:

1. Coffelt, M. A. & P. B. Schultz. 1990. Development of an aesthetic injury level to decrease pesticide use against orangestriped oakworm (Lepidoptera: Saturniidae) in an urban pest management project. J. Econ. Entomol. 83:2044-2049.

2. Coffelt, M. A. & P. B. Schultz. 1991. Citizen attitudes toward orangestriped oakworm: Impact, control, host aesthetics, and IPM practices. J. Arboric. 17:298-302.

3. Coffelt, M. A. & P. B. Schultz. 1993. Population biology of orangestriped oakworm (Lepidoptera: Saturniidae) in southeastern Virginia. J. Entomol. Sci. 28:218-229.

4. Schultz, P. B. & M. A. Coffelt. 1986. Defoliators of woody ornamentals: Their biology and control. Amer. Nurseryman 164:79-85.

5. Schultz, P. B. & M. A. Coffelt. 1991. Evaluation of bagworm control strategies, 1990. Proc. SNA Res. Conf. 36:188-189.

Table 1. Survival of orangestriped oakworm caterpillars, 1992.

Treatment	lb(ai) per 100 gal.	Percent Survival±SEM Early instars	Late instars
CGA-237218 50WP	0.50	0.0±0.0 c *	46.2±27.1 a
CGA-237218 50WP	0.75	2.9±1.6 c	100.0±0.0 a
CGA-237218 50WP	1.00	0.0±0.0 c	89.0±4.7 a
Diazinon AG500	0.50	74.1±7.1 b	93.1±4.1 a
Water Check	--	89.7±2.7 a	100.0±0.0 a

* Means within columns followed by the same letter are not significantly different (P>0.05: Student-Newman-Keuls test).