SECTION 4
ENTOMOLOGY

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Pest Management Strategies for Azalea Lace Bug

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Virginia

Nature of Work: Azalea lace bugs are the major insect pest of both commercially grown and landscape azaleas. The feeding injury results in a chlorotic appearance to the foliage that can lead to premature leaf drop. The lace bugs overwinter in the egg stage, located ususally along the mid-vein. Hatching begins in early April in Virginia. Populations of nymphs were monitored in April of both 1991 and 1992. Treatments were applied when a majority of nymphs had reached the third instar.

The first study utilized two-year old azaleas, cv. Delaware Valley White, heavily infested with azalea lace bug nymphs.Six treatments of four plants each were used in the study, and are listed in Tables 1-3. The plants were approximately 1 m (3 feet) tall, and planted in size 400 containers (I gallon). Plants were irrigated daily with overhead sprinklers, and were located in full sun. Pre-treatment counts were taken on each plant on April 22, 1991, by counting the number of nymphs and adults over a 30 second period. Treatments were applied the same day as the pre-treatment counts. Granules were evenly distributed in the top one inch around the base of the plant, the media of which was loosened with a garden tool. Sprays were applied to runoff using a Co^2 sprayer at 30 psi. Water was applied to the untreated check. Counts were taken at 1, 7, 28, and 63 days after treatment in the manner identical to the pre-treatment counts. Counting ceased at 200 for each replicate, and was listed as that number.

In the second study, two-year old azaleas, cv. George Tabor, also heavily infested with azalea lace bug, were used to evaluate treatments for control. Plants were in size 300 containers (3/4 gallon). Pre-treatment counts were taken April 23, 1991 and identical treatments applied later that day. Methodology was identical to the prior study.

In 1992, the study was repeated using azaleas, cv. Girards Rose. Pre-treatment counts were taken on April 29, 1992, and the treatments applied later that day. Except for the dates, techniques were identical to the 1991 study. Counts were taken 2, 7, 28, and 43 days after treatment in the manner previously described.

Results and Discussion: The results indicate rapid control with the liquid formulations, with the granular material effective 7 days after application. Once active, Orthene 15G was effective through the 28 day counts. Nearby plants were heavily infested with azalea lace bug leading to re-infestation once degradation had occurred.

Table 1.- Mean numbers of azalea lace bug nymphs and adults on Delaware Valley White azaleas, 1991.

	DAT (days after treatment)				
Treatments	0	1	7	28	63
Orthene 15G I.0gm	118.8*	98.8b	I.0b	0.5c	7.8c
Orthene 15G 2.0gm	123.8	78.8bc	0.3b	0.0c	13.5c
Orthene 15G 3.0gm	117.5	42.8cd	0.3b	0.3c	9.0c
Orthene 75SP 0.3 lbs	118.8	37.5cd	1.3b	17.8b	51.3a
Tame 2.4EC 0.21bs	127.5	8.0d	4.5b	46.3a	64.0a
Check	154.0	154.0a	152.5a	9.0bc	32.3b

*Means within columns followed by the same letter do not differ significantly, Duncan's multiple range test (5% level).

Table 2.- Mean numbers of azalea lace bug nymphs and adults on George Tabor azaleas, 1991.

	DAT (days after treatment)				
Treatments	0	1	7	28	63
Orthene 15G I.0gm	200.0a	200.0a	3.0b	0.8c	13.8b
Orthene 15G 2.0gm	195.0a	185.0a	1.5b	0.3c	7.3b
Orthene 15G 3.0gm	177.5a	155.0a	2.0b	0.0c	4.8b
Orthene 75SP 0.3 lbs	150.0b	64.0b	I.0b	11.8b	54.0a
Tame 2.4EC 0.21bs	137.5b	11.5b	2.0b	33.8a	44.5a
Check	200.0a	200.0a	175.0a	9.5b	42.3a

*Means within columns followed by the same letter do not differ significantly, Duncan's multiple range test (5% level).

Table 3.- Mean numbers of azalea lace bug nymphs and adults on Girard Rose azalea, 1992.

	DAT (days after treatment)				
Treatments & rate	0	2	7	28	43
Orthene 15G 0.2gm	182.5ab	186.3a	0.0c	13.5c	14.5bc
Orthene 15G 0.4gm	180.0ab	115.0b	0.0c	2.8c	9.5bc
Orthene 15G 0.8gm	188.8ab	57.0c	0.0c	2.0c	5.3c
Orthene 15G 1.4gm	193.8a	5.5c	0.0c	1.5c	2.3c
M-Pede 2%	200.0a	43.8c	37.0b	78.5b	21.0b
Check	146.3b	157.5ab	158.8a	123.5a	48.0a

*Means within columns followed by the same letter do not differ significantly, Duncan's multiple range test (5% level).

Evaluation of Bagworm Control Strategies, 1991

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Virginia

Nature of Work: The bagworm, *Thridopteryx ephemeraeformis* (Haworth), is a polyphagous defoliator that prefers evergreen species as hosts. Arborvitae, Leyland cypress and juniper are highly susceptible; however, many species of deciduous and evergreen ornamentals are also prefered hosts. Bagworms occur throughout the eastern U. S., and are found as far west as Texas and as far north as New York. Severe defoliation often results, which may cause death of the host.

Larvae hatch beginning in late May to early June (depending on spring temperatures) from the bags in which females had lived and oviposited the previous year. The larvae usually remain on the host, but can be carried for short distances by wind on silk threads. The larvae begin constructing bags composed of silk threads and bits of foliage shortly after hatching, and the bags increase in size as the larvae grow, reaching 2 inches in length at maturity. The male moth leaves the bag and mates with the female, the latter remaining in the bag. The bagworm has only one generation a year, and overwinters as eggs in the bag.

When practical, light infestations of bagworm can be controlled by hand-picking. Chemical control of bagworm is effective in early summer when the larvae are small, but declines in effectiveness as the larvae become large. Six insecticide treatments and an untreated check were evaluated for control of the bagworm on July 5, 1991 Insecticides were applied to field-grown Leyland Cypress, *Cupressocyparis leylandii,* approximately 6 meters high located at the Hampton Roads Agricultural Experiment Station in Virginia Beach, VA. Infested areas of trees were sprayed to runoff (approximately 0.5 liters per tree) with a CO_2 sprayer at 30 psi. Three days after application, 15 bagworm larvae were collected from each of three replicates per treatment. Survival was determined by counting the number of live larvae 7 days post-treatment. Temperature at time of treatment was 86°F and plants were irrigated 3 times per day for 60 minutes (approximately 1 inch of water per day) using an overhead sprinkler system.

Results and Discussion: The results indicated that Talstar and Tame provided excellent control. CGA-237218 is a microbial insecticide, *Bacillus thuringiensis,* var. *kurstaki/aizawai,* and control after such a short interval was not expected to be on the level of the pyrethroid materials Talstar and Tame. No phytotoxicity was observed.

Table 1. - Evaluation of bagworm survival with selected insecticides, 1991.

Treatment and	lb(ai) per 100 gal.	Mean bagworm survival
Talstar 80F	0.06	0.0a*
Tame 2.40 EC	0.1**	0.3a
Tame 2.40 EC	0.1	1.3a
CGA-237218 50 WP	0.5	10.7bc
CGA-237218 50 WP	1.0	8.0b
CGA-237218 50 WP	2.0	7.3b
Check	-	13.0c

*Means followed by the same letter are not significantly different (p=0.05, DMRT).
**Formulated in 1990.

Chemical Control of Azalea Lace Bug

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Nature of Work: Azaleas continue to be one of the primary nursery crops produced in South Alabama. The azalea lace bug, Stephanitis pyrioides (Scott), is one of several common economic pests which attacks both nursery and landscape azaleas. This insect is often found year-round, but greatest abundance occurs in the warmer parts of the year. Lace bugs are very mobile insects which are commonly found on the lower leaf surface. Injury is from sap extraction producing a chlorotic spotting on the upper leaf surface. Upon turning the leaf over, numerous cast skins and circular black fecal spots are usually present.

Historically, the azalea lace bug has not been difficult to control. These efficacy tests were conducted with lace bug infested azaleas obtained from a local nursery with a history of control problems.

Test 1 evaluates several relatively new materials or formulations along with a couple of industry standards. Rhododendron x ‘Treasure’ growing in 3 gallon containers of an amended pine bark/peat moss medium were treated with a single foliar spray to all leaf surfaces until run-off. No spray adjuvants were included. Treatments were replicated and plants placed under 47% shade cloth completely randomized. Evaluation was conducted 7 days after treatment using a modified beat-sheet method to count live adult lace bugs.

Test 2 evaluates the efficacy of a pre-plant incorporation of Orthene 15G as a preventative treatment. R. x 'Christmas Cheer' liners were potted in trade gallon containers of an amended pine bark/peat moss (3:1 v/v) medium. Orthene 15G was pre-plant incorporated at several different rates into the media. Treatments were replicated and plants randomized in close proximity to azaleas heavily infested with lace bugs.

Results and Discussion: Test 1, seven days after treatment application, good control was observed with all materials tested when compared to the untreated check (Table 1). These include two formulations of Talstar, Dycarb 76W, Mavrik 2F, Margosan O, Orthene 75S and Diazinon AG-500.

In Test 2, pre-plant incorporation, lace bug feeding damage was observed within 36 hours after treatment on most plants. At the first evaluation (7 DAT), little difference in lace bug numbers was observed, however considerably less feeding damage was observed with the foliar applied treatment (Table 2). This treatment was included as a standard control measure. Twenty-one days after potting/application, the two highest rates of Orthene 15G as well as the Orthene 75S foliar spray provided control (Table 2). The plants receiving the foliar spray had the least amount of feeding damage. No phytotoxicity was observed in either test.

In summary, these two tests indicate that a number of labeled insecticides provide good azalea lace bug control when properly applied. Orthene 15G may also prove useful in the future.

Table 1. Chemical Control of Azalea Lace Bug

Treatment	Products/100 gal.	Mean Live Lace Bug Number
Talstar 10 WP	12.8 oz.	3.5 a *
Talstar 80 g/l F	15.3 fl oz	0.5 a
Dycarb 76W	16 oz	0.3 a
Mavrik Aquaflow 2F	5 fl oz	2.3 a
Morgasan 0 0.3%	80 fl oz	3.0 a
Orthene 75S	10.6 oz	0.5 a
Diazinon AG-500	16 fl oz	1.8 a
Control	- - - - -	43.3 b

*Mean seperation within columns by DMRT, p = 0.05.

Table 2. Preventative Treatment for Azalea Lace Bug

Treatment	Product/yd^3	Mean Live Lace Bug Number 7 DAT	21 DAT
Orthene 15 G	.11 lb	2.5	12.3
Orthene 15 G	.23 lb	3.3	12.3
Orthene 15 G	.45 lb	4.0	5.3
Orthene 15 G	.66 lb	3.0	3.3
Orthene 75 S*	1 lb/100 gal.*	2.3	0.8
Untreated Check	- - -	5.5	17.5
LSD @ .05		4.0	5.9

*Foliar Spray

Evaluation of Four Insecticides for Sweet Potato Whitefly Control on Greenhouse Poinsettias

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Nature of Work: The sweet potato whitefly (SPWF), Bemisia tabaci Gennadius was first a problem in Florida poinsettias in 1986 and since then has become a major pest on greenhouse ornamentals nationwide. Tank mixes of pyrethroid insecticides and Orthene (acephate) provide for excellent control, but routine use of these treatments may produce strains of whitefly that have resistance to both groups (classes) of insecticides (1). Switching formulations or classes of insecticides will help prevent resistance. It was the purpose of this study to document the effects of a new nitro guanidine insecticide, Merit (Mobay Corp., Kansas City, MO) and a carbamate numbered compound, A1417 (Uniroyal Chem. Co. Inc., Middlebury, CT) on efficacy of SPWF control and phytotoxicity to Supjibi and V-14 poinsettias. Treatments included A1417 at 0.25 and 0.50 lbs ai per 100 gallons with and without surfactant (0.25% Aquagro) and Merit at 0.20 lbs ai per 100 gallons with surfactant. Effects of these treatments were compared to Orthene/Tame (0.50, 0.50 lbs ai/100 gal.) tank mix with surfactant and an untreated check. All treatments were applied as a foliar spray with a CO_2 sprayer.

Treatments were applied twice to poinsettia varieties (Supjibi, V-14) planted in 6.5 inch pots; once when breaks were 4.0 inches in length (November 3, 1991) and again when bract color was noticeable (December 1, 1991). Phytotoxicity ratings and insect counts (eggs, nymphs) were made two weeks after each insecticide application. Insect counts were made on the 3rd and 5th leaf of five plant replicates of each poinsettia variety (20 leaves). Insect counts were made prior to initial treatment applications.

Results and Discussion: None of the insecticide treatments or application rates caused any pyhtotoxic symptoms on Supjibi or V-14 poinsettia variety. Nymphal populations of SPWF were significantly reduced by all insecticide treatments as compared with the check treatment (Table 1). Percent nymphal population reductions of 47 to 76% were accomplished with insecticide and surfactant treatment combinations. The systemic insecticide treatments of Merit (nitro guanidine) and Orthene/Tame (organophosphate, pyrethroid) were the only treatments to significantly reduce egg populations. Egg population reductions of 57 to 66% were obtained with these insecticide treatments. The systemic action of these insecticides actually weakened or killed the adult whiteflies as they were feeding and mating so as to reduce the number of eggs laid.

Significance to Industry: The results indicate that A1417 (carbamate), Merit (nitro guanidine), and Orthene/Tame (organophosphate, pyrethroid) provide excellent control of SPWF with no phytotoxicity to Supjibi and V-14 poinsettia varieties at the rates and application frequency tested. The systemic activity of Merit and Orthene/Tame insecticide treatments provide superior levels of SPWF suppression.

Literature Cited

1. Drees, B., W. Pianta, and J. Daniel. 1990. Sweet potato whitefly treatment evaluations. The Texas Nurseryman 21 (9):22-24.

Table 1. Effect of insecticide and surfactant on sweet potato whitefly egg and nymphal populations (average 20 leaves) on poinsettias (V-14, Supjibi) two weeks after insecticide application.

Insecticide		**Oct.** 24[z]	November 19 (percent reductions in parenthesis)			December 14 (percent reductions in parenthesis)		
(Ib- ai/100 gal)	**Surfactant**	**Total**	**Eggs**	**Nymphs**	Total	**Eggs**	**Nymphs**	**Total**
A1417	+	138aY	71 a	75bcd	146bc	82a	47bc	130bc
(0.2)			(12)	(62)	(47)	(0)	(55)	(26)
	-	96a	105a	105b	210b	64ab	55b	118bc
			(O)	(46)	(24)	(11)	(47)	(33)
A1417	+	126a	64ab	79bcd	143bc	53bc	38bc	91 cd
(0.5)			(21)	(60)	(48)	(26)	(63)	(48)
	-	138a	76a	92b	168b	75ab	57b	132b
			(6)	(53)	(39)	(0)	(45)	(25)
Merit	+	113 a	28 b	49 d	77 c	31 cd	26 c	56 ed
(0.2)			(65)	(75)	(72)	(57)	p5)	(68)
Orthene/Tame	+	104 a	27 b	63 cd	89 c	26 d	25 c	51 e
(0 5,0.5)			(66)	(68)	(68)	(64)	(76)	(71)
Check	-	136a	81 a	196a	276a	72ab	104a	176a

zInsect count made prior to initial insecticide application.

yMeans within columns followed by the same letter are not significantly different at the 5% level using LSD.

Phytotoxicity of Talstaro 10WP Surface Applied and Preplant Incorporated to Selected Cultivars of Succulent and Woody Ornamental Plants

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Nature of Work: Among the many toxicants evaluated for use as a quarantine treatment to prevent imported fire ant (IFA), Solenopsis invicta Buren and Solenopsis richteri Forel, infestations in nursery stock, one of the most promising is bifenthrin formulated as Talstar® 10WP (FMC Corp., Philadelphia, PA). Data suggests exceptional residual activity against IFA for this synthetic pyrethroid insecticide at a number of rates of application and use patterns. Although a significant amount of data has been gathered concerning the effect of bifenthrin on IFA, no data exists as to its potential phytotoxic effect on nursery stock. As part of our continuing evaluation of bifenthrin, tests were undertaken at the Mississippi Agricultural and Forestry Experiment Station at Poplarville, MS, to determine if bifenthrin can have phytotoxic effects on containerized plants.

Three different tests were conducted. Plants were selected on the basis of local availability, popularity among commercial growers and a previous history of phytotoxic responses to insecticides. All plants in Tests I and II were potted in 3-quart containers in a commercial growing medium (Strong-Lite®) manufactured by Strong-Lite Products Corporation of Pine Bluff, Arkansas. All plants were maintained in a greenhouse under normal horticultural practices.

In each test an experimental unit consisted of one containerized plant per plot with seven blocks per cultivar in a randomized complete block design. As a check, an identical number of plants in each test were transplanted into pots containing untreated potting medium. Mean fresh shoot weights for all plants were subjected to analysis of variance and Duncan's new multiple range test at the $P<0.05$ level (2).

Test 1: On 15 August 1990, 17 selected cultivars of succulent and woody ornamentals were treated with two rates of Talstar 10WP applied as a drench in 17 oz water/3 quart container. Applications were made at rates of 100 ppm (IX) and 300 ppm (3X). Seven replications per cultivar/ treatment were established. An untreated check was included by applying 17 oz of water to each container. Plants were sacrificed 70 days post-treatment. Shoot weights were obtained by severing the plants at the growth medium surface. Shoots and roots were visually evaluated as follows:

1. Plants healthy, not different from the untreated check.
2. Slight yellowing, wilting, or other mild symptoms such as marginal chlorosis.
3. Symptoms more severe, leaf drop or necrosis.
4. Severe stunting, abnormal leaf drop or necrosis.
5. Plant dead.

Test II: On 23 January 1991, 15 selected cultivars of succulent and woody ornamental plants were treated with two rates of Talstar 10WP surface applied as a dry powder "over-the-top". Applications were made at rates of 100 ppm (IX) and 300 ppm (3X). Seven replicates per cultivar/treatment were made. Sufficient amounts of water, 17 oz, were then applied to saturate the growth medium in each container. Plants were sacrificed 90 days post-treatment. Fresh shoot weights were measured as described in Test I.

Test III: Nine selected cultivars of succulent and woody ornamentals were transplanted from liners into standard industry 2-gallon pots containing media into which Talstar 10WP had been incorporated at 100 ppm (IX) and 300 ppm (3X) on 16 August 1991. Talstar was incorporated into the growth medium by blending in a 3-cubic foot capacity concrete mixer for 30 minutes. Plants were sacrificed 181 days after planting and fresh shoot weights were measured.

Results and Discussion: Test I. None of the 17 cultivars tested displayed any significant differences in mean shoot fresh weights between the treatments and the untreated check (Table 1). Visual inspections of shoots and roots indicated no detrimental effect among treatments.

Test II. No significant decrease in shoot fresh weight was obtained, nor were growth abnormalities observed among shoots and roots of the test plants used in this test. Impatiens at the IX and 3X rate treatment rates and Rosmarinus officinalis (rosemary) at the 3X treatment rate showed some enhanced top growth (Table 2).

Test III. No phytotoxic effects were noted among the cultivars tested. Some enhanced top growth was noted in both Rhododendron sp. and Juniperus sp. at the IX rate and in Portulaca oleraceae and Magnolia michellia at the IX and 3X rates (Table 3).

There were no phytotoxic effects to any of 29 cultivars to Talstar 10WP applied as a drench, "over-the-top" or preplant incorporated. Some enhanced top growth was noted among Portulaca oleraceae and Maqnolia michellia at the IX and 3X rates and Rhododendron 'eriocarpum' and Rhododendron 'Formosa' in the incorporation test. Enhanced growth also occurred in the drench trial with Impatiens 'New Guinea' and R. officinalis displaying significant differences at the IX and 3X rates, respectively.

Significance to Industry: Chlorpyrifos is presently the only insecticide registered for quarantine use against IFA. Recent revelations regarding chlorpyrifos' rapid loss of efficacy has led to severe restrictions to its use (1). The Imported Fire Ant Laboratory is constantly seeking and evaluating new products to control the spread of IFA. Talstar 10WP is currently in the process of being registered as a quarantine treatment material and 24C registrations have already been awarded in 10 of the 11 quarantine states.

Literature Cited

1. Imported Fire Ant Program Manual, M301.81 (Revised July 1990). USDA-APHIS-S&T, 29 pp.

2. Duncan, D.B. 1955. Multiple Range and Multiple F Tests. Biometrics 11:1-42.

Table 1. Relative Phytotoxicity of Bifenthrin (Talstaro IOWP) Applied as a Drench to Selected Succulent and Woody Ornamental Plants, Test I.

	Shoot Fresh Weight [1/]		
Cultivar	check	IX	3X
	——g——		
Succulents:			
Aqeratum Houstonianum 'Blue Puffs'	236.0a	258.3a	245.6a
Beqonia semperflorens	688.1a	667.7a	726.1a
Caladium sp.	162.9a	147.8a	160.8a
Coleus Blumei 'Red Wizard'	370.0a	352.2a	318.9a
Firmiana simplex	77.5a	82.5a	75.5a
Hibiscus sp.	136.5a	126.9a	129.6a
Impatiens Wallerana 'Blue Pearl'	248.3a	266.9a	273.5a
Woody Ornamentals:			
Rhododendron 'Carror'	88.0a	81.4a	84.6a
Rhododendron 'eriocarpum'	153.1a	149.3a	170.7a
Rhododendron 'Sunglow'	84.4a	88.9a	81.8a
Rhododendron 'Wakaebisu'	94.9a	85.5a	93.6a
Ilex #4878 'China Girl'	57.7a	63.1a	62.4a
Ilex crenata 'Compacta'	55.7a	54.5a	56.8a
Ilex cornuta 'Bufordi'	40.4a	38.9a	41.2a
Ilex latifolia	56.5a	61.8a	56.la
Ilex vomitoria 'Schilling'	57.4a	61.7a	58.0a
Prunus carolinianum	84.la	84.9a	93.3a

[1/] Means within cultivars followed by the same letter are not significantly different at the 5% level according to Duncan's multiple range test (P<0.05).

Table 2. Relative Phytotoxicity of Bifenthrin (Talstar® 10WP) Surface Applied as a Powder to Various Succulent and Woody Ornamental Containerized Plants, Test II.

Cultivar	Shoot Fresh Weight [1/] check	IX	3X
		g	
Succulents			
Beqonia semperflorens 'Whiskey'	425.la	425.7a	418.la
Hibiscus varigatus	114.2a	103.9a	103.8a
Impatiens 'New Guinea'	225.5b	255.6a	237.7a
Rosmarinus officinalis	74.0b	67.lb	82.9a
Scindapsus aureus	158.la	156.0a	160.8a
Woody Ornamentals:			
Rhododendron 'Carror'	90.0a	90.4a	87.6a
Rhododendron 'eriocarpum'	119.1a	119.3a	114.7a
Rhododendron 'Formosa'	116.9a	117.5a	109.6a
Rhododendron 'Sunglow'	94.4a	95.9a	98.8a
Ilex cornuta 'Avery Island'	57.7a	51.la	61.4a
Ilex crenata 'Compacta'	50.7a	47.5a	47.8a
Ilex x attenuata 'Fosteri'	28.4a	28.9a	30.2a
Ilex latifolia	59.5a	48.8a	55.la
Ilex vomitoria 'Schilling'	58.4a	57.7a	67.0a
Prunus carolinianum	62.la	61.9a	59.3a

[1/]Means within cultivars followed by the same letter are not significantly different at the 5% level according to Duncan's multiple range test (P<0.05).

Table 3. Relative Phytotoxicity of Bifenthrin (Talstar® 10WP) Preplant Incorporated Into Media to Various Succulent and Woody Ornamental Containerized Plants, Test III.

Cultivar	Shoot Fresh Weight [1/] check	IX	3X
		g	
Succulents			
Brassaia actinophylla	179.9a	167.6a	180.0a
Scindapsus aurea	187.la	182.0a	196.3a
Vinca minor	274.5a	252.2a	253.9a
Portulaca oleraceae	386.8b	489.9a	518.la
Woody Ornamentals			
Rhododendron 'eriocarpum'	68.3b	84.4a	72.0b
Rhododendron 'Formosa'	58.7b	79.9a	61.lb
Ilex crenata 'Compacta'	32.2a	29.6a	29.6a
Magnolia michellia	67.lb	75.9a	74.7a
Juniperus 'Shore Juniper'	13.2b	18.4a	15.6b

Means within cultivars followed by the same letter are not significantly different at the 5% level according to Duncan's multiple range test (P<0.05).

Early Season Paint-On Application of Orthene 75 S™ Aphid Control on Crape Myrtle

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Nature of Work: At the 1989 SNA Research Conference the senior author reported on a preliminary procedure whereby Orthene 75 S (acephate) in a 3:1 and 4:1(v:v ratio) water slurry could be painted on the trunks of seedling crape myrtle, *Lagerstroemia indica* trees for control of the crape myrtle aphid, *Sarucallis kahawaluokalan (Tinocallis kahawaluokalan)* Doughty et al 1989.

High populations of aphids feeding on crape myrtle can cause physical damage to leaves and new shoots (Doughty, et al 1992). Aphids have piercing - sucking mouth parts and by inserting their proboscis into plant tissue, they remove cellular sap. With high populations sticky "honey dew" secretions adhere to leaves, branches and objects below the canopy (Odenwald and Turner 1987). Sooty mold, caused by the fungi *Capnodium sp.,* grows on these sugary secretions causing the leaves, branches and lower objects to be covered by a black film which could significantly reduce the photosynthetic capacity of the plants.

Our objective was to take advantage of the systemic nature of Orthene 75 S™ by applying paint-on concentrations at three rates directly to the trunk to determine if aphid populations could be controlled.

One hundred and six seedling crape myrtle trees, ranging in caliper from 1/8 inch (3.18mm) to 1/4 inch (6.35mm) at 6 inches (15.24 cm) above soil line, were planted in two rows on 3 foot centers (0.91m) on February 27, 1986 at the LSU Hammond Research Station, Hammond, LA.

On April 10, 1986, 70 trees were subjected to a randomized complete block design with 5 blocks and 14 plants per block.

Treatments consisted of banding Orthene 75 S™ with either a 3:1 or 4:1 v/v ratio of Orthene 75 STM and water slurry completely around the trunk at 2 inches (5.08 cm) from soil line. The band width was determined by the mean caliper of the seedlings used which was approximately 1/5 inch (4.76mm). A camel hair brush was cut to deliver a 1/5 inch band around each trunk. The 3:1 or 4:1 Orthene 75 S™ trunk surface area rate was increased simply by doubling or tripling the diameter width of the band (2x or 3x respectively, **Table 1).** Control plants were banded only once at diameter width with a clean brush and water.

On June 6,1987 the same 70 trees were again subjected to the same treatments but the trunk calipers had increased to a mean of 0.94 inch (23.82mm). A camel hair brush was cut to deliver a 0.94 inch band. The time required for banding all treatments was less then one minute per tree.

Aphid population counts were taken at random from the top and each quadrant of each tree. A total of 10 leaves were examined for both nymph and adult aphids.

Treatment means for experimental data were compared statistically at the P < 0.05 level using Dunnett's One-tailed T test after being transformed on a log scale for normalized standard error and distribution.

Results and Discussion: The early 1986 results were mixed because of such low overall aphid populations. Of the total number of plants containing aphids, the control plants had the highest aphid populations before treatments (Fig. 1). Many of the treated plants had no aphid populations at the beginning of the experiment and consequently developed few if any populations after treatments.

Treatments A (1xd.3:1) and B (1xd.4:1) had higher populations in the week following treatments, 4.67 and 2.5 aphids respectively, but with low overall populations this could easily have been the result of transitory aphid activity.

The early 87 data provided even more information (Fig. 2). By June 10 the total aphid population was still small [6 (C, control), 46.8 (A, 1xd. 3:1),11.1 (B, lxd. 4:1), 17.3 (J, 2xd. 3:1), 19.3 (K, 2xd. 4:1), 19.0 (R, 3xd. 3:1) and 14.6 (S, 3xd. 4:1)]. After treatments the populations dropped to almost zero in all treated plants and ranged from 4.2 to 7.8 aphids on the control plants which was significant until July 17. Good control was observed in all treatments for over 30 days. On July 17 populations began to rise on all plants but the treatment with the highest Orthene 75 S™ concentration and most diameter banding (S, 3xd. 4:1) did not rise as high as the others. On July 22 and 27 an upward trend in populations was evident indicating that Orthene 75 S™ was loosing its effectiveness but not significantly so (Pr>F =0.0001). Treatments K(2xd. 4:1), R(3xd. 3:1) and S(3xd. 4:1) significantly prevented the populations from rebuilding as rapidly as treatments A(1xd. 3:1), B(1xd. 4:1), C(control) and J(2xd. 3:1).

From June 10 to July 9, there was 237.24 mm (9.34 in) of rainfall at the Hammond Research Station. Since the control aphid population was small on June 10 (6) it remained nearly constant until July 17 where along with the treated plants, the population began to rise. Rainfall possibly caused sufficient Orthene 75 S™ to leach into the soil and be root absorbed thus preventing very high aphid populations until July 17.

Significance to the Industry: This paint-on application of Orthene 75 S™ appears to be absorbed directly into the crape myrtle trunk and possibly roots thus reducing aphid populations for up to approximately 3 to 4 weeks without phytotoxicity. This method also is a quick and easy method of crape myrtle aphid control as well as ecologically safer than spraying.

As a result of our work, the Valent Corporation accepted and gained formal acceptance of this procedure from the Environmental Protection Agency (E.P.A.) on April 14, 1992 and will include it on all labels of Orthene 75 S™ (Orthene Tree, Turf and Ornamentals, OTTO) printed after April 14, 1992 for use on crape myrtle.

Table 1. Orthene 75 S™ concentrations and band width of treatments used in early 1986 and 1987.

A = band 1 time the diameter (IX) of 3 Orthene 75 S : 1 water		(3:1)
B = IX	of	(4 1
C = Control		
J = band 2 times the diameter (2X)	of	(3:1)
K = 2X	of	(4 1)
R = band 3 times the diameter (3X)	of	(3:1)
S = 3X	of	(4:1)

Early 1986 Aphid Data

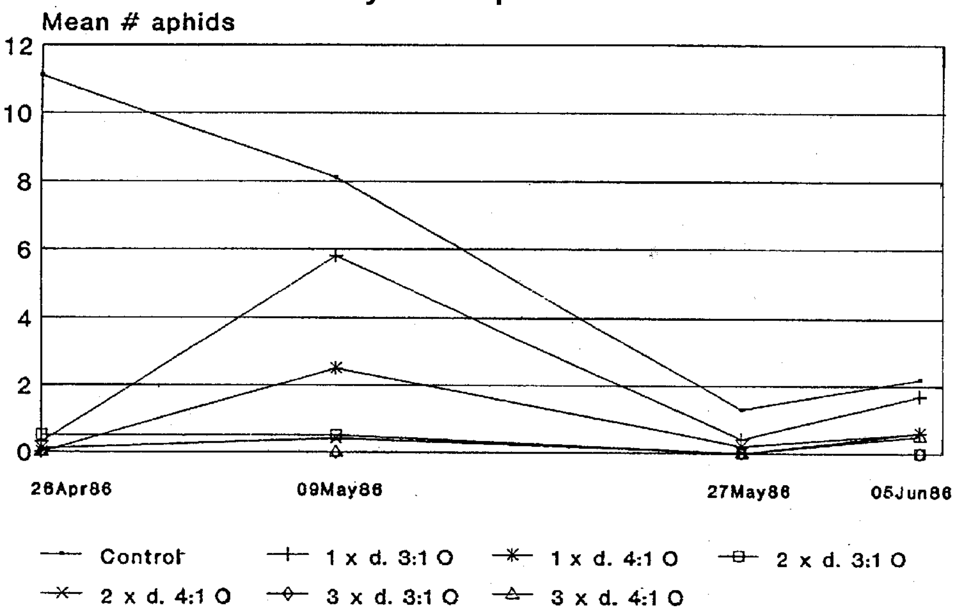

Fig. 1: Early 86 aphid populations before treatments April 26 and aphid counts taken after treatments. A, B, C, J, K, R, S May 9, 27, and June 5.

[z]NS and ** indicate not significant or significance at the 0.01 level when comparing control with the average of treatments.

Early 1987 Aphid Data

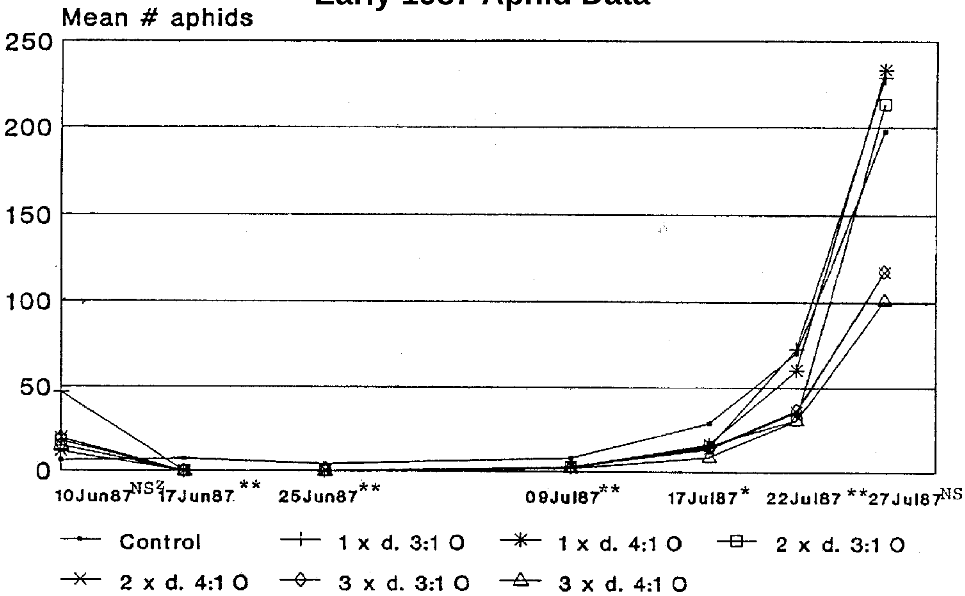

Fig. 1: Early 87 aphid populations before treatments June 10 and aphid counts taken after treatments. A, B, C, J, K, R, S. June 9, 17, 22, and 27.

[z]NS and ** indicate not significant or significance at the 0.01 level when comparing control with the average of treatments.

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Suitability of 'Natchez' vs. 'Carolina Beauty' Crapemyrtle Cultivars as Hosts for the Crapemyrtle Aphid

David R. Alverson and R. Ken Allen
South Carolina

Nature of Work: The popularity of crapemyrtle, Lagerstromia spp., arises from its attractiveness and versatility in Southern environments, as well as its relative freedom from insect and disease pests. Its primary insect pest, the crapemyrtle aphid, Tinocallis kahawaluokalani (Kirkaldy) (CMA), often renders trees in nurseries and landscapes unsightly because of the black sooty molds that grow on honeydew excretions, and infested plants may defoliate prematurely.

The biology and bionomics of the CMA have been described recently (Alverson and Allen, 1991, 1992). Field observations by researchers and nurserymen have indicated that there are manifest differences between cultivars in host susceptibility and suitability (R. F. Mizell 1992, unpublished). Suitability implies that the potential host provides a satisfactory environment for the successful growth and development of the aphid, and that the host plant does not react defensively against the pest (Lowe 1973). The objective of this research was to evaluate the suitability of two nursery standard crapemyrtles representing the older L. indica ('Carolina Beauty') and more recent L. indica X L. fauriei ('Natchez') cultivars.

Leaf and aphid specimens from 'Natchez' and 'Carolina Beauty' were collected from a nursery field near Easley, SC, and returned to the laboratory for detached leaf studies. Leaves were held in environmental chambers at 26°C with a photoperiod of 14:10 (L:D) on water agar plates as described by Reilly and Tedders (1990). Development of neonate nymphs, fecundity and longevity were recorded as described by Alverson and Allen (1992). A preference test was established on water agar plates using two 1.25 in^2 leaf discs, one of each cultivar, tangent to opposite sides of a 0.5 in^2 square of filter paper. Fourth instar aphids collected from each cultivar were placed in separate plates directly onto the filter paper with an orientation that favored neither cultivar. Adult preference and subsequent production and movement of offspring were recorded daily for each of 100 plates. Mean comparisons were made by ANOVA (Statview 512II).

Results and Discussion: Table 1 provides a comparison of adult longevity and fecundity on detached leaves of both cultivars. Though significant differences were detected in longevity and total fecundity per female aphid, the host suitability advantage was realized on 'Natchez'. This seems in conflict with most field observations of low infestation levels normally found on 'Natchez' in SC, but is consistent with observations of infestation levels in FL (Mizell, unpublished). Both cultivars appear adequately suitable for CMA survival and reproduction.

Preference tests on detached leaf discs indicated no distinct difference between cultivars. Initial preferences by fourth instar/adult aphids collected from 'Natchez' trees, selection ratio for 'Natchez':'Carolina Beauty' was 17:10, and for aphids collected from 'Carolina Beauty', selection ratio was 15:8 in favor of 'Natchez'. The 65% preference for 'Natchez' leaf discs is not sufficient to rule out selection as random. All adults tended to stay on the leaf disc on which they originally settled, indicating suitability of either cultivar. Movement by adult females occurred only when aphid density increased as a result of nymph production. For aphids which settled initially on the 'Natchez' discs, adults moved to the 'Carolina Beauty' discs when disc density reached 20 (+ - 1) aphids, and those which settled initially on 'Carolina Beauty' moved to 'Natchez' discs when density reached 14 (+ - 2) aphids. There was no statistical difference in the number of aphid offspring produced during the course of the preference experiment.

Significance to Industry: In nursery field situations, it is common to observe greater infestation levels on some cultivars than others, and thus to assume that one cultivar is more resistant to the CMA than another. Selections of 'pest resistant' cultivars should be based on replicated research experimentation, both in the field and in the laboratory. These tests show that there is no difference in the host suitability of two cultivars about which such assumptions have been made. Expressed differences often seen in nurseries may be the result of selection, but both 'Natchez' and 'Carolina Beauty' are suitable hosts for the CMA.

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Table 1. A comparison of adult Tinocallis kahawaluokalani longevity and fecundity on leaves of 'Carolina Beauty' and 'Natchez' crapemyrtle cultivars. (n = 60)*

Cultivar	Adult longevity	$\bar{X}$ daily fecundity	$\bar{X}$ total fecundity
Carolina Beauty	12.8 a	4.4 a	60.9 a
Natchez	19.1 b	4.0 a	77.1 b

* Means followed by the same small case letter are not significantly different; longevity in days; fecundity in number of offspring per female.

Control of Sweetpotato Whitefly, Bemisia tabaci, on Container Grown Hibiscus

Michael L. Williams and Jimmy Stephenson
Alabama

Nature of Work: In Alabama, growers of ornamental plants may encounter several species of whiteflies, but four species cause most of our problems. Out-of-doors, the citrus whitefly is our most common whitefly pest. It causes problems most frequently on gardenia and ligustrum. In greenhouses and the interior plantscape, the greenhouse whitefly, bandedwinged whitefly and sweetpotato whitefly cause most of our problems. Of these four species, the sweetpotato whitefly, Bemisia tabaci, is the most troublesome and most difficult to manage.

The first confirmed identification of sweetpotato whitefly in Alabama was from a greenhouse in the Mobile area. In Alabama, it has now spread as far north as Decatur in the interior environment. Supposedly, the sweetpotato whitefly cannot overwinter outdoors above 30 degrees north latitude, but in greenhouses and the interior environment it has become established as far north as Buffalo, New York. Primary hosts in Alabama have been poinsettia, hibiscus, and gerbera daisy, but its known host range includes over 500 plants in 74 families.

Potential for damaging crops in the State is great because research has shown sweetpotato whitefly to be more difficult to control than either citrus whitefly or greenhouse whitefly. It has an amazing ability to tolerate pesticides, adapt to new host plants, and reproduce rapidly. Sweetpotato whitefly resistance is broadbased, spanning at least four classes of insecticides organochlorines, organo phosphates, carbamates, and pyrethroids. It is believed that the resistant strains we are now combating are a result of intense pesticide exposure on cotton, especially to the pyrethroid insecticides. Resistance in some populations of sweetpotato whitefly has been documented at the 54 - fold level.

Southern growers are desperate for answers. Some have abandoned tried-and-true products and application methods labeled for use against sweetpotato whitefly and are turning to products and application methods that are illegal - only in the hope of trying to get a grip on the pest after legal products and application methods have failed. In the interior environment, the arsenal of pesticides available for use against sweetpotato whitefly is limited. Because of human exposure problems, materials with high mammalian toxicity and long residual activity cannot be used in the interior environment. For this reason, we have been evaluating both traditionally used and new materials for use against this pest in greenhouses and shadehouses.

In 1991 we evaluated nine pesticides and/or pesticide combinations for control of sweetpotato whitefly on container-grown Chinese hibiscus growing in the greenhouse. Test materials were applied 19 and 25 August to 40 plants growing in three gallon containers which were heavily infested with whiteflies. The foliar sprays were applied to run-off using hand held compressed air sprayers. Care was taken to thoroughly cover undersides of leaves. Granular materials were sprinkled on the soil surface and watered in. Efficacy of materials tested was evaluated 7 and 14 days post-treatment.

Results and Discussion: In tests conducted in 1991, best results were obtained with combinations of Tame 2.4 EC + Orthene 75 S and Orthene 75 S + Sunspray Ultrafine Spray Oil. Both combinations provided 100% control of sweetpotato whitefly infesting hibiscus after two applications applied at seven day intervals (Table 1). No phytotoxicity was observed.

The sweetpotato whitefly problem in Alabama, at present, is confined to ornamental plants in the greenhouse and interior plantscapes in office complexes and shopping malls. Very likely, we will soon be facing the same situation that Arizona, California, and Florida are presently encountering — movement of these resistant populations to vegetable and other crops outdoors. We must therefore continue to seek means of controlling sweetpotato whitefly in these reservoir populations in the interior environment.

Significance to Industry: The pesticide combinations, soap and oil sprays evaluated in this test provided good to excellent control and offer additional materials to use in rotation with other pesticides to help control and manage pesticide resistance in sweetpotato whitefly populations.

Table 1 . Sweetpotato whitefly control on hibiscus, 1991.

Treatment[1]	Rate	Mean % Mortality[2] 7 DAT	14 DAT
Tame 2.4 EC	0.20 lb AI/100 gal	31 c	42 d
Orthene 75 S	0.25 lb AI/100 gal	29 c	47 d
Tame 2.4 EC + Orthene 75 S	0.20 + 0.25 lb AI/100 gal	80 a	100 a
Orthene 15 G	I.Sgm./3 gal pot	44 bc	76 abc
Orthene 75 S + Sunspray Oil	0.25 lb AI + 2 gal/100 gal	72 ab	100 a
Talstar 10W	0.20 lb AI/100 gal	44 bc	55 cd
Talstar 80F	0.20 lb AI/100 gal	38 c	64 bcd
Attack Soap	4 gal/100 gal	68 ab	76 abc
Avid 0.15 EC	8 oz/100 gal	39 c	84 ab
Untreated	—	22 c	12 e

[1]Treatments applied 19 and 25 Aug. 1991. 2 Mortality determined 25 Aug. and [2] Sep. 1991, DMRT (P=0.05).

Life history of the Walnut Scale on Flowering Dogwood in Tennessee

P. L. Lambdin and J. F. Grant
Tennessee

Nature of Work: In eastern Tennessee, flowering dogwoods, *Cornusflorida L.,* are one of the more popular ornamentals planted to enhance the aesthetic beauty of residential areas. The walnut scale, *Quadraspidiotus juglansregiae,* has been collected from more than 87 species of fruit and ornamental trees including flowering dogwoods in the United States (Kosztarab 1963, Dekle 1976). The walnut scale was reported to have three generations per year in Missouri (Hollinger 1923), two or more generations in Ohio (Kosztarab 1963) and Kentucky (Gordon and Potter (1988), and univoltine in Maryland (Stoetzel 1975). The objective of this study was to determine the development of the walnut scale on dogwood in Tennessee.

Data were obtained (1988-1990) from scale insect populations on 6 flowering dogwoods 2 to 3 m in height on the University of Tennessee Knoxville campus, and from 24 saplings 1 to 1.5 m in height and 12 saplings 14 to 19 cm in height grown under greenhouse conditions. Three twig samples, ca. 10 cm long, were collected weekly during 1988 and 1989 and biweekly in 1990. Walnut scale specimens were removed, processed, mounted on slides and examined microscopically to determine developmental stage. Number of generations per year was monitored by transferring 100 newly-emerged crawlers to each of 12 uninfested host plants.

Results and Discussion: The walnut scale is a bivoltine species that overwinters as second instar males and females (Fig. 1). Most second instar females molted into adults by the third week of March. Prepupal males were present from the first to the third week in March. Pupal males were present from the second through the fourth week in March. Upon emergence from mid-March to early-April, the ephemeral adult males immediately began to seek out and fertilize adult females. Females (n=100) deposited an average of 34 (3 - 52) pale-yellow eggs over a 10-14 day period which may account for overlapping generations.

The mobile crawlers emerged from late-May until the fourth week of June. Crawlers were negatively phototrophic and generally settled on the underside of older limbs and branches. Heaviest infestations on dogwood trees (n=6) occurred on branches in the lower 1/3 to 1/4 region of the tree. All crawlers had developed into second instars by the second week of July. Adult females were primarily present from mid-July through mid-September, although a few survived until the end of September. The male prepupal stage was present the second and third weeks of July while the pupal stage was present from the third week in July through the first week of August. Adult males emerged from the third week of July through the second week of August. Egg laying females were found from mid-August through September. Most crawlers had developed into second instars by mid- to late-October.

Significance to Industry: Dogwoods are one of the more popular ornamentals produced by nurserymen in Tennessee. Control of scale insects is difficult due to the development of a protective, waxy covering over their bodies that thickens with age. The two most appropriate time periods to control the walnut scale through the application of insecticides are late-May through June and early-August through late-October. Control efforts directed at the susceptible adult males in mid-March to early-April and late-July to mid-August may also prove effective.

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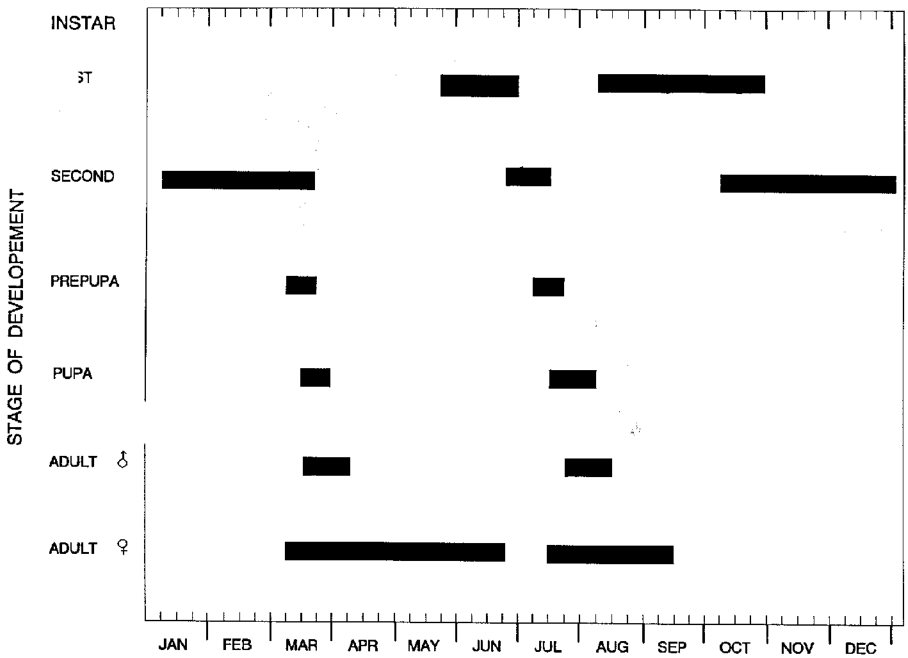
Fig. 1. Seasonal incidence of different stages of the walnut scale, *Quadraspidiotus juglansregiae,* on dogwood in Tennessee.



Area-Wide Distribution of Rhinocyllus conicus (Coleoptera: Curculionidae) Against Musk Thistle in Tennessee

Jerome F. Grant and Paris L. Lambdin
Tennessee

Nature of Work: Musk thistle, Carduus thoermeri (Weinmann), was introduced into the United States from Europe more than 100 years ago (1,5). Classified as a noxious weed, this Compositae is an important pest in nurseries, pastures, unused farmland, suburban residences, and along highway and railroad right-of-ways, and unkept ditchbanks in Tennessee.

Musk thistle infests thousands of hectares of land and has become increasingly important to efficient agricultural production and land management in Tennessee. Chemical control of musk thistle in nursery fields is sometimes difficult because of the many different types of plants grown in a typical commercial nursery production system. Other tactics, such as hoeing, are labor intensive and time consuming.

Because of the difficulties involved in the area-wide management of musk thistle, a cooperative, multi-year biological control program, using plant-feeding weevils, was initiated by the University of Tennessee and the Tennessee Department of Transportation (3). The initial objective of this research program concentrated on the introduction, release, and establishment of an introduced plant-feeding weevil [the head weevil, Rhinocyllus conicus Froelich (Coleoptera: Curculionidae)] into all thistle-infested counties in eastern and middle Tennessee. Head weevil larvae feed within the plant buds and reduce the number of viable seeds.

Results and Discussion: The head weevil was released at ca. 132 thistle-infested sites in 37 counties in eastern and middle Tennessee during 1989, 1990, 1991, and 1992 (Fig. 1). Releases of head weevils were concentrated in these areas of the state because of abundant populations of musk thistle. Colonies of head weevils are well-established at the oldest release sites, and at several of these sites, 10 to 30 eggs per bud have been observed. After dissection, well developed larvae were found within infested buds. In several instances, larvae were found within the stem about 2.5 to 5.0 cm (1 to 2 inches) below the bud. Dispersal of head weevil has been documented in Tennessee as adults and/or eggs have been found about 1.9 to 6.2 kilometers (3 to 10 miles) from the original release sites.

Significance to Industry: This type of biological control program has been successful in other states, e.g., Virginia and Maryland, and, combined with other management tactics, has reduced infestations of musk thistle in these areas. For example, adult head weevils were released in Virginia in the spring of 1969, and by 1975, had reduced musk thistle in the release area by 95% (4). Populations of head weevils are currently maintained at several reservoir sites in eastern Tennessee (2). Individuals will be collected from these reservoir sites annually and transferred to thistle-infested nursery fields. As population densities of the head weevil increase in Tennessee, they should impact on seed proliferation and plant density. As fewer seeds are available for dispersal and fewer plants are present, the annual monetary and labor input for management of musk thistle also should diminish.

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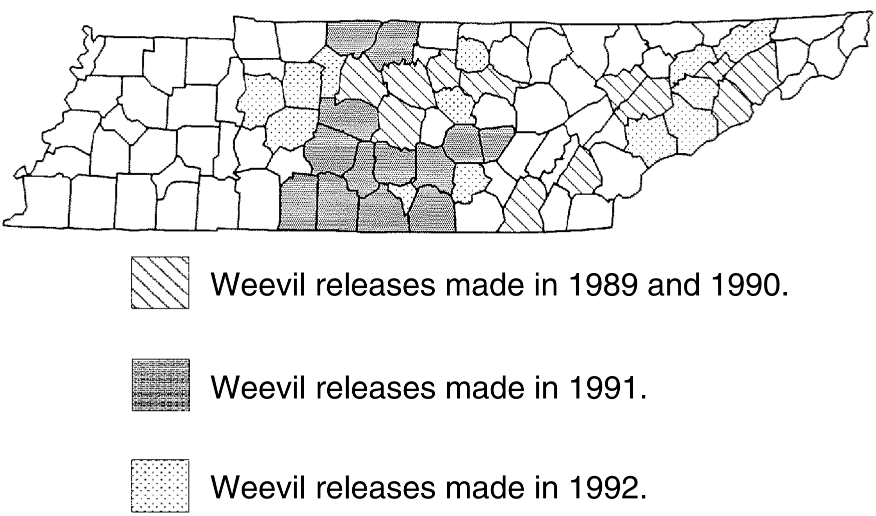
Figure 1. Locations of sites where the head weevil, <u>Rhinocyllus</u> <u>conicus,</u> was released during 1989, 1990, 1991, and 1992 in Tennessee.



The Arthropod Fauna in Detritus in Fraser Fir Stands

David N. Hughes, Paris L. Lambdin and Jerome F. Grant
Tennessee

Nature of Work: Fraser fir, *Abies fraseri, is* a southern Appalachian endemic species restricted to high elevations with the largest remaining tracts occurring in the Great Smoky Mountains National Park (GSMNP). As the elevation increases above 1365m. Fraser fir becomes the most dominant component of the 132 or so vascular plant species present within the region.

Migration of exotic pests into the GSMNP can adversely upset the natural balance of the arthropod fauna as well as have a significant impact on other species, both plant and animal. Presently, a serious threat to Fraser fir stands exists from massive infestations of the Balsam woolly adelgid, *Chermes piceae* (Ratz.) (Hays et.al. 1978). The loss of the Fraser fir could be potentially devastating to the numerous arthropod species that are restricted to Fraser fir habitats. As a result, a study was initiated by the National Park Service and University of Tennessee to determine the occurrence and population densities of arthropod species of the GSMNP. The objectives of this study were: (1) to determine the arthropod fauna in Fraser fir environments in the GSMNP, (2) and to determine the seasonal abundance and distribution of selected arthropod species associated with Fraser fir.

Arthropod specimens from each of three study sites (located at Mt. Buckley, Mt. Sterling, and Mt. LeConte) consisting of Fraser fir stands in the GSMNP were sampled and monitored from 31 May 1991 to 29 February 1992 with the primary field collections made from June through October. Collections during the remaining months were made as permitted by weather. The study site at each of the three locations consisted of 25 trees that were divided into five subplots, each consisted of five trees. Also, arthropods from areas adjacent to the test sites were randomly sampled.

Detritus-dwelling arthropod specimens were collected (biweekly at sites on Mt. Buckley and monthly at sites at Mt. Sterling and Mt. LeConte) using a combination of methods including: pitfall traps, handpicking, and Berlese traps. Pitfall traps (minimum 1/tree) were placed at random in the soil within the perimeter of the foliage of the test tree.

Three detritus samples from each test site were collected and returned to the lab where they were placed into Berlese funnels to collect the arthropod specimens. The specimens were then placed into ethanol filled vials for storage. The three vials of arthropods representing collections from each detritus sample for a given time period were initially processed by gross sorting of specimens. then separated into identified taxa, and placed into 3 dr. vials. Data recorded for each specimen consisted of: the number of speclmens/site/date, habitat parameters (stand age and density) and elevation.

Results and Discussion: Of 84 samples, 19 have been sorted. All specimens from 15 samples have been identified and catalogued. Detritus-inhabiting arthropods represented 11 taxa (class or order) at Mt. Buckley. Although only 9 taxa have been identified from Mt. LeConte at this time, additional representatives should be identified as more samples are processed (Table 1). From those specimens processed, ca. 97% were mites, both predaceous and scavenger, and Collembola. Some 14 species of mites representing 13 families have been identified from detritus samples obtained at three Fraser fir sites. Eight species of Collembola have been identified. Of the fauna sampled, several predaceous taxa representing major arthropod groups were present. One pseudoscorpion species was found at each of the three sites. Collections of detritus-dwelling arthropods will continue in 1992 to assess the populations common to Fraser fir environments. Cumulative data for the arthropod species collected will be compared and analyzed to evaluate seasonal trends of the various species.

Significance to Industry: These data will be useful to growers by providing a better understanding of the interrelationships among the arthropods and Fraser fir. As such, this information may assist to increase the use of Fraser fir as an ornamental throughout the region. Because the adelgid normally attacks mature trees, the need for replacement seedlings for future plantings may be provided by nurserymen.

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Table 1. Arthropod Composition in Fraser Fir Detritus, 1991.

SITE/TAXA	June	July	August	Sept.	October	Percent
Mt. Sterling						
Acari	1147*	891	2789	1205	1752	74.42
Collembola	341	783	362	194	508	21.20
Coleoptera	35	33	27	2	—	0.94
Diptera	4	5	11	63	45	1.82
Hymenoptera	—	3	2	—	—	0.05
Psocoptera	—	—	—	—	—	0.01
Chilopoda	13	2	6	—	—	0.02
Diplopoda	1	1	3	—	—	0.05
Diplura	—	1	4	—	—	0.05
Pseudoscorpiones	9	2	13	1	—	0.24
Araneae	2	—	—	—	—	0.02
Mt. Buckley						
Acari	2514	3283	3510	2275	2644	80.00
Collembola	796	963	694	173	283	16.00
Coleoptera	84	27	21	6	27	0.93
Diptera	12	100	93	101	2	1.74
Hymenoptera	2	1	2	—	3	0.05
Psocoptera	—	—	—	—	—	0.00
Chilopoda	7	2	5	—	17	0.18
Diplopoda	—	—	—	—	2	0.01
Diplura	—	—	2	1	—	0.02
Pseudoscorpiones	—	2	4	—	12	0.10
Araneae	—	—	—	1	3	0.02
Mt. LeConte						
Acari	1092	3236	4519	3120	1511	73.29
Collembola	881	909	1240	677	645	23.66
Coleoptera	40	37	14	17	13	0.59
Diptera	10	47	55	262	41	2.10
Hymenoptera	—	2	—	—	—	0.01
Psocoptera	—	2	—	—	—	0.01
Chilopoda	1	20	1	3	—	0.13
Pseudoscorpiones	13	10	—	5	1	0.15
Araneae	2	1	1	1	—	0.03

*Total numbers of specimens obtained per month.

Natural Resistance of Birch, Cherry and Crabapple Taxa to Feeding by Adult Japanese Beetle

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Nature of Work: Since introduction into the United States, early in this century, the Japanese beetle *(Popillia japonica* Newman) has become a destructive pest throughout much of Eastern North America. Although this insect is known to have preferences for certain host plants, there has been little research on variations in beetle preference for host plants within specific genera. The purpose of this study was to evaluate a range of plant taxa, within taxa of birch, cherry, and crabapple for susceptibility and possible resistance to Japanese beetle feeding.

Three separate experimental plots were established, one for each genus of plants studied. Individual plots were arranged in randomized complete block designs, located at the Mountain Horticultural Crops Research Station in Fletcher, N.C.

Crabapple plot. Three replicates of 33 taxa of flowering crabapples (Table 1) were planted over the period of March 1990 to March 1991. Trees were planted in rows spaced 6.1 m (20 ft) apart, with 4.6 m (15 ft) between trees within rows.

Cherry plot. Eight taxa of flowering cherries (Table 2) were planted in April 1991, in a plot approximately 100 m (330 ft) from the crabapple plot. Trees were planted in rows spaced 6.1 m (20 ft) apart, with 3.6 m (12 ft) between trees within rows.

Birch plot. Nine taxa of birch (Table 3), with seven replicates, were grown in 19 liter (#7) containers, outdoors, on a gravel bed located approximately 0.4 km (0.25 mi) from the cherry and crabapple plots.

Injury ratings. Two observers visually rated each tree for foliage injury during the period of July 15 to July 19, 1991. The rating system was based on an 11 point scale corresponding to feeding injury (skeletonization) from 0 to 100 percent, in 10 percent increments. The ratings from both observers were averaged, adjusted using an arcsine transformation, and subjected to an analysis of variance and separation of means by LSD (4). Statistical differences among means were determined on the transformed data; percentage data are presented for ease of interpretation.

No choice feeding. Four taxa, two resistant and two susceptible, were selected for further testing in a no choice feeding study. On July 17, 1991, nylon mesh netting was used to enclose the terminal portion of one well-lit branch (with similar leaf areas) from each of three trees of the four taxa. Ten beetles of unknown age and sex were released into each cage. Damage was evaluated after 1 week.

Results and Discussion: Average feeding injury on flowering crabapples ranged from 0% for several taxa to as high as 83% for 'Red Splendor' (Table 1). Eighteen of the taxa had minor injury with ratings of s 14% skeletonization, with none of these ratings being significantly greater than0%. The ranking of these taxa based on percent feeding injury was similar with the ranking for 21 of the same taxa evaluated at an experimental plot in Raleigh, N.C. (Dr. D.M. Benson, personal communication), with one exception. In the Raleigh plot, M. *floribunda* was found to have substantial injury (2.5 on a 5 point scale), while the same species had no injury in our evaluation. Feeding injury among the flowering cherries varied from 46% for 'Akebono' to 93% for P. *sargentii* (Table 2). Although there were significant differences among taxa in the amount of injury sustained, none of these plants were sufficiently free of injury to warrant selection of taxa resistant to Japanese beetle. Of the birches evaluated, *B. jacquemontii* was the only taxa that had significant injury from Japanese beetles, with a mean skeletization of 16% (Table 3). The number of beetles found at the birch plot may have been less than at either of the other two plots resulting in low injury ratings for many of the species. Reports by Ladd (3) and Fleming (2) indicate that *B. populifolia* and *B. pendula* are fed on extensively under certain conditions. Our results do, however, identify *B. jacquemontii* as a preferred host plant compared with the other taxa of birch evaluated. Observations made by the senior author in nurseries in N.C. support the findings that *B. jacquemontii* is a favored host and can be completely skeletonized, while other birches are less effected .

Evaluation of the feeding response of beetles caged on branches of selected *Malus* taxa was conducted to evaluate the degree of antixenosis among these plants under conditions where the beetles had no choice of host plants. Despite the presence of the enclosures, beetles continued to feed extensively (>40 % skeletonized) on the two cultivars, 'Liset' and 'Radiant', observed to be preferred in the early evaluation (Table 4). The feeding response of beetles on the two taxa found to be resistant showed that the beetles would feed extensively on *M. hupehensis* (50% skeletonized), but did little damage to *M. baccata* 'Jackii' (1% skeletonized). Although there was little overall injury on the leaves of *M. baccata* 'Jackii', there were signs of feeding on 40% of the leaves, suggesting that beetles began to feed on leaves but found them unpalatable.

Preference of the beetles for various taxa under field conditions depends first on the ability of the beetle to locate/choose a host and secondly on palatability. Ahmad (1) found that Japanese beetles rely to a large degree on olfactory senses for locating host plants. In fact, many plants that are rarely attacked by the beetle, such as ginkgo *(Ginkgo biloba),* will be fed-on if the leaves are coated with juice pressed from cherry leaves (5). In the case of the crabapple taxa evaluated, it appears as though some taxa are more attractive to Japanese Beetle than others. Although *M. hupehensis* showed little injury in the initial field evaluation, the beetles fed extensively on it when they were enclosed with its foliage, suggesting that this plant may not have extensive injury in the field because it attracts fewer beetles. In the case of *M. baccata* 'Jackii', however, beetles refrained from feeding even under the caged conditions. These results suggest that *M. baccata* 'Jackii' is less palatable to the insect.

Significance to Industry: With increasing limitations on the use of pesticides in nursery and landscape settings, there is a need for more information on landscape plants that are naturally resistant to insect pests. This research explored the degree of preference of Japanese beetles for selected taxa of crabapple, cherry and birch. Results demonstrate that considerable variation exists in the preference of adult Japanese beetles for different taxa within the *Malus* and *Betula* genera, suggesting that natural resistance to feeding by this insect is a useful selection criterion.

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Table 1. Feeding preference of Japanese beetle among 33 taxa of flowering crabapple *(Malus* spp. *).*

Taxa	Common/trade name	Leaf area skeletonized (%)^{z}
M. baccata Borkh. 'Jackii'	Siberian	O
M. hupehensis Rehd.	Tea	O
M. floribunda Siebold	Japanese	O
'Branzam'	Brandywine	O
'Louisa'	'Louisa'	O
'Strawberry Parfait'	'Strawberry Parfait'	O
'Golden Raindrops'	'Golden Raindrops'	O
'Mazam'	Madonna	1
'Hargozam'	Harvest Gold	1
M. sargentii Rehd.	Sargent	1
'Silver Moon'	'Silver Moon'	1
'Ormiston Roy'	'Ormiston Roy'	2
' Baskatong '	' Baskatong'	2
'Candy Mint'	'Candy Mint'	2
'Molazam'	Molten Lava	3
'Glen Mills'	'Glen Mills'	4
'Mary Potter'	'Mary Potter'	7
'Narragansett'	'Narragansett'	14
M. x *zumi* Rehd. 'Calocarpa'	Redbud Crab	17
'Sutyzam'	Sugar Tyme	21
'Callaway'	'Callaway'	21
'Donald Wyman'	'Donald Wyman'	23
'Pink Princess'	'Pink Princess'	28
'Robinson'	'Robinson'	32
'White Angel'	'White Angel'	33
'Snowdrift'	'Snowdrift'	33
'Doubloons'	'Doubloons'	33
'Sinai Fire'	'Sinai Fire'	36
'Adams'	'Adams'	45
'Sentinel'	'Sentinel'	52
'Liset'	'Liset'	77
'Radiant'	'Radiant'	78
'Red Splendor'	'Red Splendor'	83
		LSD 0.05 = 14

^{z}Values are means (n=3).

Table 2. Feeding preference of Japanese beetle among taxa of flowering cherries *(Prunus spp.).*

Taxa	Common/trade name	Leaf area skeletonized (%)[z]
P. x yedoensis Matsum. ‘Akebono’	‘Akebono’ Yoshino	46
P. serrulata Lindl. ‘Kwanzan’	‘Kwanzan’ Japanese	48
Px yedoensis ‘Afterglow’	‘Afterglow’ Yoshino	55
P. serrulata ‘Tai Haku’	‘Tai Haku’ Great White	73
P. serrulata ‘Mt. Fuji’	‘Mt. Fuji’ Japanese	76
P. subhirtella Miq. ‘ *Autumnalis Rosea’*	‘Autumnalis Rosea’ Autumn Flowering Higan	82
P. x incamp ‘Okame’	‘Okame’	89
P. sarDentii Rehd.	Sargent	93
	$LSD_{0.05}$=24	

[z]Values are means (n=3).

Table 3. Feeding preference of Japanese beetle among nine taxa of birch *(Betula spp.).*

Taxa	Common name	Leaf area skeletonized (%)[z]
B. papyrifera Marsh.	Paper	0
B. platyphylla var. *japonica* Hara’Whitespire’	‘Whitespire’ Japanese	0
B. platyphylla var. *szechuanica* Rehd.	Szechuan	0
B. populifolia Marsh.	Gray	0
B. pendula Roth.	European	0
B. ermanii Cham.	Erman’s	0
B. nigra L.	River	1
B. nigra’Heritage’	‘Heritage’ River	1
B. jacquemontii Spach.	Himalayan	16
	$LSD_{0.05}$=	4

[z]Values are means (n=7).

Table 4. Feeding response of Japanese beetles caged on btanches of four crabapple taxa for one week.

Taxa	Leaves fed upon (%)[z]	Leaf area skeletonized (%)
Resistant		
M. baccata 'Jackii'	40 a	1 a
M. hupehensis	100 b	50 b
Susceptible		
'Liset'	89 b	47 b
'Radiant'	79 b	42 b

[z]Means (n =3) within columns followed by the same letter are not significantly different, $LSD_{0.05}$.

Insect Problems and Insecticide Effectiveness as seen by Nursery Growers in the Southeast

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Nature of Work: In November 1990, the EPA requested the USDA Extension Service to conduct a biologic and economic assessment of Dursban and Diazinon. The purpose of the assessment was to describe the benefits of these compounds and their usages in agricultural production and the economic ramifications of their discontinued use. We were contacted to conduct this assessment for ornamental and sod production in the United States.

A questionnaire was developed to address insecticide/acaricide usage, pest occurrence, effectiveness of pesticides against pest, use of alternatives to conventional pesticides, phytotoxicity associated with chemical application, and method of application for pest management. The American Association of Nurserymen was contacted and with their cooperation the questionnaire was distributed to their membership. Questionnaires were distributed to l,115 nurseries and 217 or 19% were returned. In this paper we will report on a portion of the information gathered in this study and all data will be based on the sample collected and will not be expanded to reflect the total industry.

Results and discussion: There is not any consistent data on the current value of the nursery production industry. The 1988 Census of Horticultural Specialties (1) reports the total sales for nursery plants and plant material to be $1.23 billion while a 1987 HRI (2) report gave $1.781 billion for total sales in the nursery industry. In our survey of 217 growers we obtained a total gross sales of $147 million in the Southern Region and $479 million for the Nation.

Nurserymen reported using 35 different active ingredients for insecticides/acaricides. Of the ten active ingredients receiving most of the usage, four were acaricides (Table 1). In general, most growers report good to very good control of various pest groups by these insecticides/acaricides (Table 2). Of the major pests reported, mites were the most difficult to manage. Two materials (Dursban and Logic) were used extensively in the south for control of fire ants. Growers estimated losses of 31% in the Southern Region and 36% of gross sales for the nation as a result of insect and mite pests. At least one half of the top ten active ingredients are either being removed from the ornamentals market or are under close examination and could be removed.

There has been a trend to rotate pesticides for control of pests. There were 73% (south) and 67% (nation) of the growers that reported that they rotate pesticides and 32% (south) and 27% (nation) that combine pesticides in a tank mix. Thirteen percent (south) and 14% (nation) report using nonchemical, along with chemical, methods for managing their pest populations.

Significance to Industry: The industry is cognizant of the fact that they need to reduce their resistance problem and nurserymen are looking at methods of reducing chemical dependency. Pest control is becoming more difficult and the approach to management of pest is changing. We must look at new methods of growing to reduce pest incidence, be conscience of cultivar susceptibility to pests in selecting plant material, and support the development of alternatives to traditional chemicals for pest management.

Table 1. The ten insecticides/acaricides used the most by growers and the pests they were used against.

	Pounds of Active Ingredients					
Compound	Wood Boring	Foliage Worms	Feeding Beetles	Sucking Insects	Mites	Soil Borne
Sevin	233	7,325	4,813	525		52
Orthene	64	1,636	5,189	1,482	2,718	176
Ornamite					12,453	
Dursban	336	67	21	160	38	7,284
Pentac				44	5,693	
Kelthane					5,240	
Logic						4,388
Vendex					3,828	
Lindane	1,514	13		101		128
Disyston	231	435		74	35	227

Table 2. Current Level of Control by Pest Groups for Ten Major Use Insecticides/Acaricides for Their Major Usage.

	Current Control Level[a]					
Compound	Wood Boring	Foliage Worms	Feeding Beetles	Sucking Insects	Mites	Soil Borne
Sevin	4.0	4.2	4.4	3.9		
Orthene		3.8	4.0	4.1	3.6	
Ornamite					3.6	
Dursban	3.6					3.9
Pentac					3.9	
Kelthane					4.1	
Logic						3.6
Vendex					3.8	
Lindane	3.8					
Disyston	3.8	5.0				2.0

[a]Control Level: 5=excellent, 4=very good, 3=good, 2=fair, 1=poor, 0=none.

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Evaluation of Azalea Lace Bug Control Strategies

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Nature of Work: Azalea lace bugs, *Stephanitis pyrioides* (Scott), are the most serious pests of cultivated azaleas in the eastern United States (2). Infested foliage appears stippled or bleached from above as a result of activity of nymphs and adults feeding on the underside of the leaves. Effective control strategies for the azalea lace bug that minimize adverse effects on natural enemies co-occurring on these widely planted ornamentals are needed.

One hundred 'Hershey Red' azaleas were planted in a ten by ten design on eight foot spacing in October, 1991. Plants were infested with adult azalea lace bugs collected from landscape plantings on five separate dates in November, 1991 and April, 1992. A heavy infestation was achieved on these experimental plants. Nine registered or experimental products were compared with an untreated control in a randomized compete block design with ten replications. Application of materials was made with a CO_2 powered backpack sprayer equipped with a meter jet gun. All materials were applied on June 16, 1992. Products and rate of formulation/ 100 gallons were as follows: Tempo 2 1.3 oz, Turcam 76WP 6 oz, Orthene 75S 5.3 oz, Cygon 2E 33.8 oz, NTN 33893 1.5 oz, Avid 0.15EC 8 oz, 3% azadirachtin 84.4 oz, Volck Oil 84.4 oz, Safer's Soap 84.4 oz.

Plots were evaluated one week post-treatment. Number of nymphs and adults per two terminals per plant were compared using a least significant difference test following a significant analysis of variance. Plants treated with Safer's soap, Volck oil, Avid, and azadirachtin were retreated on June 29, 1992. All plots were again evaluated on June 30 as previously described.

Results and Discussion: Initial application with Tempo, Turcam, Orthene, Cygon, and NTN 33893, provided effective reduction in azalea lace bug populations throughout the two week sampling period (Figures 1 & 2). There was no difference in number of nymphs or adults in plots treated with these materials at one week post-treatment (Figure 1). Avid provided an intermediate level of control at this time.

Numbers of azalea lace bugs one week post-treatment following the initial application were unacceptably high in plots treated with soap, oil, or azadirachtin. However lace bug occurrence in these plots following a second pesticide application at two weeks was significantly reduced (Figure 2). Lace bug population reduction ranged from 83-100% in comparison with the untreated control during the second evaluation.

Significance to the Industry: Optimal timing for azalea lace bug control occurs early in the spring after all the overwintered eggs have hatched at approximately 301 degree days above a base temperature of 11.2°C=52.2°F (1). When control efforts must be undertaken later in the season, mixed populations of eggs, nymphs, and adults will be present. Under these conditions, as represented in this study, a variety of materials applied with appropriate coverage and timing will effectively manage the azalea lace bug.

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Figure 1. Azalea lace bug mortality, June 23, 1992.

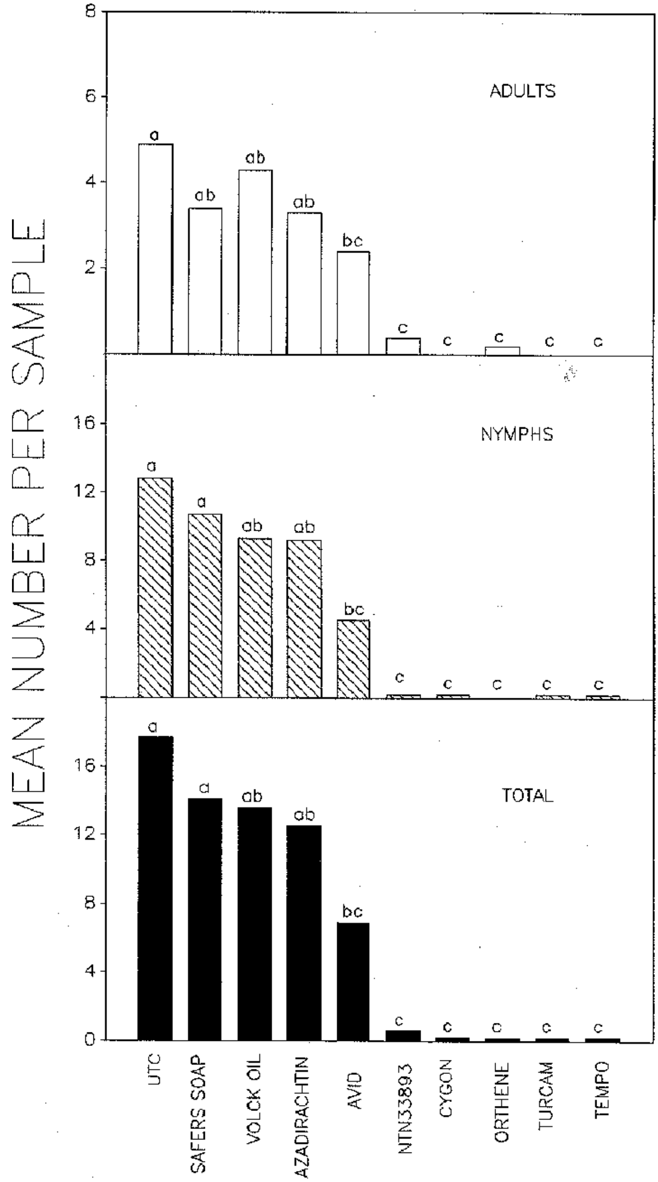

Figure 2. Azalea lace bug mortality, June 30, 1992.