

ROOT DRENCHES AND TOPICAL INSECTICIDE TREATMENTS FOR CONTROL OF THE LOBATE LAC SCALE, *PARATACHARDINA LOBATA* (CHAMBERLIN)

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Abstract. Chemical treatments were evaluated for control of the lobate lac scale, *Paratachardina lobata* (Chamberlin) (Hemiptera: Sternorrhyncha: Coccoidea: Kerriidae), an invasive polyphagous pest of woody plants in southern Florida. Root drench treatments with imidacloprid applied as Merit 75WP to large Indian laurel trees, *Ficus retusa* L. (Moraceae), at rates of 0.19, 0.38 and 0.76 g of product per centimeter of trunk diameter, were equally effective in virtually eliminating live lobate lac scales within 103 days after applications of treatments. Samples taken 523 days post-treatment indicated that the trees had not become reinfested. Of seven treatments tested as topical applications for reducing the percentage of live lobate lac scales on wax-myrtle shrubs, *Myrica cerifera* L. (Myricaceae), bifenthrin and imidacloprid were highly effective based on sampling at four weeks post-treatment. Organocide (containing fish and sesame seed oils and lecithin) and malathion in combination with paraffinic horticultural oil were moderately effective. In a separate test, bifenthrin formulated as Onyx was highly effective in reducing the percentage of live 1st instars and matures when applied with or without Hasten spreader sticker to infested *Inga edulis* Martius (Fabaceae).

Paratachardina lobata, a scale insect native to India and Sri Lanka (Varshney, 1976), was found for the first time in Florida in August 1999 by personnel of the Florida Department of Agriculture and Consumer Services, Division of Plant Industry (Hamon, 2001). This species infests branches, usually those less than about 2 cm in diameter (Fig. 1). It never occurs on foliage and seldom on larger main stems. It has been observed on 274 species of plants in varying degrees of infestation. Nearly all of its hosts are woody dicotyledonous shrubs or trees; there are rare records on a palm and a conifer. It is a serious pest on many species of woody plants that are important as ornamentals or fruit trees, and on native plants in wild areas that it has invaded. Some of the plant species that are especially susceptible to dense infestations of lobate lac scale include certain native plants, e.g., wax-myrtle (*Myrica cerifera* L.), cocoplum (*Chrysobalanus icaco* L.), buttonwood (*Conocarpus erectus* L.), strangler-fig (*Ficus aurea* Nuttall), myrsine (*Myrsine guianensis* Aublet) Kuntze), red bay (*Persea borbonia* (L.) Sprengel) and wild-coffee (*Psychotria nervosa* Swartz); popular exotic ornamental plants, e.g., black-olive (*Bucida buceras* L.), Indian laurel (*Ficus retusa* L.), Benjamin fig (*F. benjamina* L.); and fruit trees, e.g., lychee (*Litchi chinensis* Sonnerat) and star-fruit (*Averrhoa carambola* L.) (Pemberton, 2005; Howard et al., 2004; Howard, Pemberton and Steinberg, unpublished). Scale insects damage plants directly by sucking



Fig. 1. A branch of wax-myrtle, *Myrica cerifera*, infested with lobate lac scale, *Paratachardina lobata* (Chamberlin).

the juices and thus drawing energy from the plant. Additionally, it is thought that the saliva of many species of scale insects may have phytotoxic properties resulting in significant necro-

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sis. The infestations of lobate lac scale on many plant species become extremely dense and cause branch die-back, and in some species, e.g., wax-myrtle, the death of the entire plant. Other species become only lightly infested, or appear to tolerate dense infestations. In these cases, the honeydew produced by the scale insect accumulates and supports thick crusts of sooty mold on foliage and twigs.

A few species of hymenopterous parasitoids have been reared from lobate lac scales collected in Florida (Schauff, 2005; Howard and Pemberton, unpublished). They are apparently exotic and may have been introduced along with the lobate lac scale, but the rate of parasitism is extremely low (Howard and Pemberton, unpublished). While efforts are being made to identify natural enemies of this scale insect in its native home for importation and ultimate release in Florida (Pemberton, 2003), we are conducting research to provide chemical control options. Lobate lac scale is not a pest in its native home, thus no research has been published on chemical or other control methods for this species. This paper reports results of tests of imidacloprid applied by a root drench method for controlling lobate lac scale on large trees, and topical sprays of insecticides that could serve to control this pest on smaller trees and shrubs.

Materials and Methods

Root drench method. A preliminary test was conducted with a root drench treatment for control of lobate lac scale. Imidacloprid (Merit 75WP, Bayer, Kansas City, Mo.), a chloronicotinyl systemic insecticide, was applied at the rate of 60.7 grams of product per tree to six large Indian laurel trees, each about 80 cm in diameter measured 10 cm above the ground. Three of the trees were in Cooper City, Fla., and three were on the campus of Broward Community College in Davie, Fla. The drenches were applied in April 2002. Pre-treatment and post-treatment counts were made of live and dead scale insects. A few twigs infested with lobate lac scale were sampled each week following treatments and examined for live and dead scale insects to obtain a rough indication of the treatment's effectiveness and to determine an appropriate post-treatment period of days for evaluating the effects of this treatment for this species. The evaluation of chemical treatments on scale insects of most families requires special techniques because they are immobile beyond the first instar. The preliminary experiment provided an opportunity to develop criteria for determining live and dead lobate lac scale insects: In this study they were considered live if probing elicited hemolymph of normal color for this species (deep reddish purple in mature females and second instars; clear in first instars), and dead if desiccated. This sampling procedure indicated that the treatment resulted in maximum mortality of the scale insects six weeks after treatment. Therefore, on the six weeks post-treatment sampling day, five 30 cm-long twigs with at least 20 mature female lobate lac scale insects were randomly selected from each tree. Nearly 100% of the mature female lobate lac scale insects sampled on treated trees were dead, while 70% of those on untreated controls were alive (Howard, unpublished).

Based on these results, a test to compare three rates of imidacloprid (Merit 75 WP) was designed and carried out. A street-side planting of Indian laurel trees was selected in Coral Gables, Fla. Merit 75 WP was applied at rates of 0.19, 0.38 and 0.76 g per cm of trunk diameter measured 10 cm from the ground. The high rate in our test, 0.76 g per cm of trunk

diameter, was the highest rate on the label for application to ornamental trees in the landscape. One-half and one-quarter of this rate were termed moderate and low rates, respectively. The drench method consisted of wetting the ground around the base of the tree within about 50 cm of the trunk with 20 L of water poured from a bucket. After several minutes to allow the water to penetrate the soil, the insecticide was mixed in 20 L of water and poured very slowly on the same surface.

To evaluate the method for use on unusually large trees, one large Indian laurel tree with a trunk diameter of 260 cm and a canopy breadth of about 30 meters was treated with the 0.76 g of product per cm of trunk diameter rate. These treatments were applied on 21 Feb. 2003.

To determine the survivorship of lobate lac scale on the trees prior to and following the treatments, five 30-cm long twigs with at least 20 mature female lobate lac scale insects were randomly selected from each tree on each sample date. A tripod ladder and an extension pruning pole were used to obtain the twigs from as high as 8 meters from the ground. Twenty similar twig samples were taken from the 260-cm trunk diameter tree. Twig samples from each tree were bagged together in Ziploc bags and brought to the laboratory, where lobate lac scale mature females were examined under a stereoscopic microscope. Pre-treatment samples were taken on 13 Feb. 2003, whereas post-treatment samples were taken at 61, 103, 166, 334 and 523 d following treatment.

To evaluate the effect of the treatments on stages other than the mature female, on some sampling dates 20 each of selected additional stages were examined and probed to determine survivorship. The first instars were examined in the samples taken 103 and 523 d post treatment and the first and second instars on 334 d post treatment.

Topical application method. Seven insecticides or insecticide combinations were compared as topically applied sprays for effectiveness in reducing populations of lobate lac scale. The test was conducted outdoors at the Fort Lauderdale Research and Education Center on containerized wax-myrtle plants each about one meter tall and highly infested with lobate lac scale. The insecticides were mixed in tap water. Plants in the untreated control group were sprayed with water alone. The treatments evaluated included:

- 1) A flowable formulation containing 23.4% bifenthrin (Onyx, FMC Corp., Philadelphia, Pa.), a synthetic pyrethroid, applied at the rate of 1 mL/L of water with the addition 1 mL/L of spray adjuvant (Hasten, Wilbur-Ellis, Fresno, Calif.). The adjuvant consists of 100% esterified vegetable oil and non-ionic surfactant as principal functioning agents.
- 2) A flowable formulation containing 1.47% imidacloprid (Advanced Garden Tree and Shrub Insect Control, Bayer Crop Science, Research Triangle Park, N.C.) applied at the rate of 2 mL/L of water.
- 3) An emulsifiable concentrate containing 50% malathion (Malathion Plus, The Ortho Group, Marysville, Ohio), an organophosphate, applied at a 2.6 mL/L of water rate.
- 4) A paraffinic horticultural light oil (Sunspray Ultrafine Horticultural Oil, Control Solutions, Pasadena, Texas) applied at the rate of 9.9 mL/L of water.
- 5) A combination of the malathion and paraffinic oil treatments listed above.

6) A product with 92% fish oil, 5% sesame oil, and 3% lecithin (Organocide, Organic Research Laboratories, Stuart, Fla.) applied at 16 mL/L of water.

7) An emulsifiable concentrate containing 8% acephate (Systemic Insect Killer, The Ortho Group, Columbus, Ohio), an organophosphate insecticide, applied at 11 mL/L of water.

8) An untreated control.

Treatments were applied on 24 May 2004. A hand pump sprayer was used to apply the spray to the foliage and stem surfaces to run-off. The controls were sprayed with water only. To determine the survivorship of lobate lac scale on the plants prior to and following the treatments, five 15-cm long twigs with at least 20 mature female lobate lac scales were selected and pruned from each plant a few days prior to applying the treatments and four weeks following application. There were five plants per treatment. Pre-treatment counts included matures only while both 1st instars and matures were sampled in the 4 week post-treatment counts. Live and dead scale insects were determined using the procedures described above.

Evaluation of bifenthrin and adjuvant. In the evaluation of seven different treatments, the bifenthrin treatment was highly effective, and it was postulated that this may have been at least partly due to the oils in the adjuvant. Therefore a separate test was conducted to compare the effectiveness of bifenthrin alone, bifenthrin plus adjuvant, and adjuvant alone. The test was conducted on lobate lac scale infesting guamo, *Inga edulis* Martius (Fabaceae), growing in 12-liter containers.

The following treatments were evaluated, using the rates for each material and sampling methods as in the above test: 1) bifenthrin (Onyx) alone, 2) bifenthrin plus adjuvant (Hasten), 3) adjuvant alone and 4) untreated control. The treat-

ments were applied on 12 Aug. 2004 and post-treatment evaluations conducted four weeks later.

Means separations were determined using LSD tests.

Results and Discussion

Root drench method. Imidacloprid at all three rates applied as a root drench resulted in complete to almost complete elimination of live lobate lac scales from the large Indian laurel trees (Table 1). Prior to the applications of treatments, the percentages of live mature female lobate lac scales were quite uniform on trees in the experiment, and declined precipitously on trees treated with the imidacloprid root drench at all three rates during the period 61 and 103 d after treatment; the treated trees remained devoid of live mature females through 523 d after treatment, when sampling was discontinued.

There was very low survival of first instars in samples from treated trees collected 103 and 334 d post-treatment, and no survival in samples collected 523 d post-treatment (Table 2). There were no live second instars in samples collected 334 d post-treatment. The small numbers of live first instars present in samples during the post-treatment period may have been moved by air currents from untreated trees in the vicinity. However, these obviously did not develop on the treated trees, as evidenced by the extremely small percentages of live females and second instars in samples from the post-treatment period.

Results on the unusually large tree (260-cm diam) were similar to those in the replicated test. There were no pre-treatment samples from this tree. Sixty-one days after treatment, 41% of females were alive. This percentage declined to 14% at 103 d, 2% at 166 d, and 0 at both the 334 and 523 d post-treatment days.

Since in the replicated treatment, the lowest rate of imidacloprid (0.19 g Merit 75WP/cm trunk diameter) was as effec-

Table 1. Mean percentages of lobate lac scale mature females alive on twig samples from Indian laurel trees treated with imidacloprid (Merit 75WP) root drench at three rates, and untreated controls.

Rate (g Merit/cm trunk diam)	Percentages of live mature females per sample					
	Pre-treatment	61 days post-treatment	103 days post-treatment	166 days post-treatment	334 days post-treatment	523 days post-treatment
0.19	27.6 a	10.7 a	0.3 a	0.0 a	0.0 a	0.0 a
0.38	21.0 a	13.0 a	0.0 a	0.0 a	0.0 ba	0.0 a
0.76	29.0 a	17.3 a	0.6 a	0.6 a	0.0 a	0.0 a
Untreated	21.0 a	12.3 a	29.7 b	5.3 b	14.7 b	25.0 b

Means within a column followed by the same letter are not significantly different ($P < 0.05$ LSD, $n = 100$).

Table 2. Mean percentages of lobate lac scale first and second instars alive on twig samples from Indian laurel trees treated with imidacloprid (Merit 75WP) root drench at three rates, and untreated controls.

Rate (g Merit/cm trunk diam)	Percentages of live mature females per sample			
	103 days post-treatment	334 days post-treatment		523 days post-treatment
	1st instars	1st instars	2nd instars	1st instars
0.19	6.0 a	0.6 a	0.0 a	0.0 a
0.38	0.6 a	0.4 a	0.0 a	0.5 a
0.76	13.3 a	1.3 a	0.0 a	0.0 a
Untreated	70.6 b	25.6 b	36.3 b	79.3 b

Means within a column followed by the same letter are not significantly different ($P < 0.05$ LSD, $n = 100$).

tive as the highest rate (0.76 g/cm trunk diameter), the lowest rate may be preferable for treatments because of its lower cost. However, possibly the effects of a higher rate may last longer (Dr. Marco Toapanta, personal communication). The period during which different rates of imidacloprid are active has not been investigated with lobate lac scale, and may possibly differ with different hosts.

Topical application method. Prior to the applications of treatments the percentages of live mature female lobate lac scales were quite uniform on test plants (Table 3). Topical sprays of imidacloprid and bifenthrin with adjuvant were each highly effective in reducing the numbers of live mature females and first instar lobate lac scales. Organocide and malathion with paraffinic horticultural oil were each highly effective against first instars and moderately effective against mature females.

Evaluation of bifenthrin and adjuvant. Pre-treatment samples indicated an essentially uniform percentage of live first instars and mature females on test plants (Table 4). Post-treatment samples revealed that both bifenthrin alone and bifenthrin with adjuvant resulted in almost no survivorship of lobate lac scale mature females. Adjuvant alone was not highly effective against first instars, although some reduction in live mature females was evident.

Discussion

Prior to the preliminary test with the root drench using imidacloprid, we did not anticipate that it would be effective

because the lobate lac scale is found mostly on woody portions of branches, and imidacloprid is often thought to be translocated primarily to new growth tissue (Dr. Marco Toapanta, personal communication). The results indicated that this chemical may be effective on many other kinds of insects that infest woody tissue.

Likewise, we did not anticipate that bifenthrin would be effective against lobate lac scale, because it is a contact insecticide with no systemic activity, and would not penetrate the scale. Since bifenthrin (as Onyx) is often applied with the adjuvant Hasten, we initially surmised that the insecticide combined with this adjuvant might penetrate the scale. However, the results indicated that the insecticide was effective without the adjuvant. Onyx is a formulation of bifenthrin that incorporates spreader-sticker agents that extend its persistence on woody parts of plants (Ms. Geri Cashion, personal communication), and possibly these enabled the product to penetrate the resinous scale of this insect.

The root drench method with imidacloprid offers an option for controlling lobate lac scale on large trees. Important advantages of this treatment are that root drenches do not result in insecticidal drift, and the treatments would not have to be repeated frequently. The root drench treatment undoubtedly could be modified for treating small shrubs. However, it may often be more convenient to control lobate lac scale on small shrubs, especially when grown in hedges, with topical treatments of insecticides. In this study, bifenthrin and imidacloprid were both highly effective as topical treatments against this scale insect. Probably neither insecticide is highly

Table 3. Mean percentages of lobate lac scale mature females alive on twig samples from wax-myrtle shrubs treated with eight different topical treatments.

Mean percentages and standard deviations of lobate lac scale mature females alive on twig samples from wax-myrtle shrubs treated with seven different treatments.						
Treatments	Rate (mL/L)	Pre-treatment Live females (%)	Four weeks post-treatment			
			Live females (%)		Live first instars (%)	
			Mean	SD	Mean	SD
Onyx + Hasten	1 + 1	56.0	8.1 a	9.3	0.7 a	2.6
Advanced Garden Tree and Shrub Insect Control	2	59.5	10.2 a	13.6	12.7 a	22.5
Malathion Plus	2.6	76.0	52.7 bc	37.9	58.0 b	30.0
Sunspray Ultrafine Oil	9.9	86.0	49.3 bc	27.2	58.7 b	31.4
Malathion Plus + Sunspray Oil	2.6 + 9.9	68.1	24.8 ab	27.1	12.0 a	17.4
Organocide	16	90.0	24.5 ab	16.9	9.0 a	15.5
Systemic Insect Killer (acephate)	11	75.0	63.6 c	27.1	44.7 b	30.0
Untreated		69.8	70.0 c	30.5	80.7 c	19.0

Means within a column followed by the same letter are not significantly different (P < 0.05 LSD, n = 100).

Table 4. Mean percentages of live lobate lac scale mature females and first instars on twig samples from *Inga edulis* treated with bifenthrin (as Onyx), a spray adjuvant (Hasten), and Onyx and Hasten in combination.

Treatment	Rate (mL/L)	Mean percentage live individuals			
		Pre-treatment counts		Post-treatment counts	
		1st instars	Mature females	1st instars	Mature females
Onyx	1	80.0	60.0	0.0 a	0.0 a
Hasten	1	83.3	86.7	55.0 b	5.0 b
Onyx + Hasten	1 + 1	93.3	73.3	0.0 a	0.0 a
Control		70.0	86.7	78.3 c	18.3 c

Means within a column followed by the same letter are not significantly different (P < 0.05 LSD, n = 100).

persistent when applied topically as compared to the imidacloprid drench; therefore, applications would have to be more frequent than with the drench treatment. A moderate degree of control was obtained with Organocide, and also with a malathion and paraffinic oil combination. The Organocide treatment may be more effective if repeated ad-lib, and, because this oil combination is probably not lethal to parasitic insects on contact, could be an appropriate option for some situations once biological control is developed for lobate lac scale.

Lobate lac scale appears to be more easily controlled with certain insecticides than we had anticipated. However, because it is spread widely in southern Florida, attacks a large array of plant species, and is invading natural areas, chemical control of this scale insect is only a short-term solution. Ultimately, biological control is the only viable long term option for controlling lobate lac scale.

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