N O T E

Integration of Insecticides with the Natural Enemy *Chrysoperla carnea* (Stephens) for Management of Azalea Lace Bug (Hemiptera: Tingidae)[1]

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Azaleas (*Rhododendron* L. spp.) are among the most popular and widely cultivated ornamentals worldwide. The azalea lace bug, *Stephanitis pyrioides* (Scott), is a major cosmopolitan tingid species attacking azaleas and can cause significant economic damage (Klingeman et al. 2001, J. Econ. Entomol. 94: 1187 - 1192).

Relatively few specific parasitoids and predators have been reported from tingids (Wheeler et al. 1975, Ann. Entomol. Soc. Am. 68: 1063 - 1068; Gordh and Dunbar 1977, Florida Entomol. 60: 85 - 95; Henry et al. 1986, Proc. Entomol. Soc. Wash. 88: 722 - 730). The nymphs are notably free of parasitism or predation (Neal and Schaefer 2000, Pg. 85 - 138 *In* Heteroptera of Economic Importance, CRC Press). Secretions from bristles covering their bodies may have a role in deterring predators (Neal 1988, Proc. Entomol Soc. Wash. 90: 52 - 54). However, some natural enemies have been reported to attack *S. pyrioides*, e.g., the mymarid egg parasitoid *Anagrus takeyanus* Gordh recovered from eggs of *S. pyrioides* (Braman et al. 1992, J. Econ. Entomol. 85: 870 - 877; Balsdon et al. 1993, J. Environ. Hortic. 11: 153 - 156; Balsdon et al. 1996, Environ. Entomol. 25: 383 - 389); the Japanese mirid *Stethoconus japonicus* Schumacher, an aggressive obligate predator of *S. pyrioides* (Henry et al. 1986, Proc. Entomol. Soc. Wash. 88: 722 - 730); the mirid *Rhinocapsus vanduzeei* Uhler, the green lacewings *Chrysoperla carnea* (Stephens) and *C. rufilabris* (Burmeister) (Braman and Beshear 1994, Environ. Entomol. 23: 712 - 718; Shrewsbury and Smith-Fiola 2000, J. Environ. Hort. 18: 207 - 211; Stewart et al. 2002, Environ. Entomol. 31: 1184 - 1190) and various spiders (Shrewsbury et al. 2004, Int. J. Ecol. Environ. Sci. 30: 23 - 33).

Several contact and systemic insecticides are labeled for lace bug control. Early-season treatment can help prevent further generations from developing (Neal and Schaefer 2000). This can reduce insecticide use and, thereby, plant protection costs. Alternative methods like use of botanicals (Wedge et al. 2009, Nat. Prod. Comm.

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4: 123 - 127; Tabanca et al. 2010, Nat. Prod. Comm. 5: 1409 - 1415) and insecticidal soaps (M-Pede®) or horticultural oils (Sparks et al. 2002, CAES Bull. 1102, Univ. of Georgia, Athens) are also reported to be effective in controlling lace bug populations.

Integration of chemical control with biological methods was addressed in one study where parasitoid emergence by the mymarid wasp *A. takeyanus* was not affected by any of the insecticides, among which acephate proved to be the most cost-effective and provided long-term suppression (Balsdon et al. 1993). This indicates a possibility of integrating this or other natural enemies with chemical control for effective lace bug suppression. Integrating augmentative release of *C. carnea* larvae into azalea lace bug management programs also was found to be feasible (Shrewsbury and Smith-Fiola 2000).

The objective of the present study was to evaluate the effectiveness of selected insecticides, in conjunction with a commercially available natural enemy (*C. carnea*) in suppressing the azalea lace bug. *Chrysoperla carnea* are voracious predators often found in association with *S. pyrioides* in landscape situations and they have been demonstrated to prey on *S. pyrioides*. They are also readily available from commercial suppliers (Leppla, N. C. and K. L. Johnson. 2011. IPM-146 (IN849), UFL IFAS, Entomology and Nematology).

Azalea plants (n = 120) of the susceptible variety 'Girard's Rose' were used in the study and were planted with pecan trees as the overstory on the UGA Griffin Campus (Griffin, GA). They were irrigated as necessary to prevent wilt. Pesticides were not used on the plants prior to the study. At the beginning of the study (June 2010), the plants were healthy and free of lace bugs. An *S. pyrioides* colony was established from field-collected specimens and periodically replenished using adult azalea lace bugs collected from natural populations found near Griffin, GA. The colony was housed in 1.0-m^3 screen cages in an insect rearing facility on the campus. The colony was reared on several cultivars of evergreen azaleas under conditions of 27 ± 1°C and a photoperiod of 14:10 (L:D) h.

Test plants were infested with azalea lace bugs from the colony. A branch with sufficient green foliage (100 - 150 leaves) was selected on each of the test plants and enclosed in a sleeve cage (BugDorm®, BioQuip Products Inc., Rancho Dominguez, CA). Ten male and 10 female adult lace bugs were then transferred into the sleeve cages using a brush or by tapping the tube. Releases were made on 8, 9 and 10 June 2010. Nymphs were observed 3 wks later. Nymphs in each sleeve cage were counted on 6 July 2010. To facilitate ease of application of treatments, plant branches were color coded with different colored flagging tape. On 7 July 2010, the spray materials were applied to the branches in the sleeve cages using a meter jet gun (TeeJet Technologies, Springfield, IL) with a CO_2 sprayer. Each sleeve cage was removed from the branch before spraying and replaced after the foliage was dry. The insecticides acephate and imidacloprid, an insecticidal soap (M-Pede®), horticultural oil (Suffoil), a biopesticide (Tick Ex containing *Metarhizium anisopliae* (Metsch.) Sorokin.) and a water check were chosen as the treatment materials. These were each applied individually as well as in combination with green lacewing larvae, giving a total of 12 treatments. The treatments and rates of formulation used for 400 ml of spray fluid were as follows: acephate (Orthene Turf, Tree and Ornamental 75 WSP) (119.83 mg), imidacloprid (Merit 75 WP) (26.65 mg), soap: M-Pede® (Potassium salts of fatty acids 49%) (6 ml), oil: Suffoil-X (Petroleum Oil 80%) (5.99 ml), biopesticide (Tick Ex *Metarhizium anisopliae* Strain 52 11%) (0.908 ml), water, acephate (119.83 mg) + 10 green lacewing larvae, imidacloprid (26.65 mg) + 10 green lacewing larvae, soap: M-Pede® (6 ml) + 10 green lacewing larvae, oil: Suffoil (5.99 ml) + 10 green lacewing larvae, biopesticide: Tick Ex (0.908 ml) + 10 green lacewing larvae, and water + 10 green lacewing larvae. The treatments were applied in a randomized complete block design with ten replications.

Two days later (10 July 2010), 10 *C. carnea* larvae were released in the sleeve cages according to the treatment schedule. The *C. carnea* larvae were purchased from Bio-Serv Corp., Frenchtown, NJ, and were received in cut pieces of corrugated cardboard with silkscreen glued to either side. Each cell of the corrugated cardboard contained a single larva which was moved to an individual diet cup (30 ml) with a moist filter paper disc and maintained at 15°C until release into the sleeve cages on the azalea plants. Post-treatment counts of both nymphs and adults were taken on 13 July 2010, six days after spraying. For the final counts the treated branches along with their sleeve cages were clipped off the plants and transported to the laboratory where the counting was done.

Data (pre-treatment counts of nymphs, the only stage at the time, and post-treatment counts of nymphs and adults) were subjected to analysis of variance (ANOVA) using the general linear model procedure (SAS Institute 2003, SAS Institute, Cary, NC). Means were separated using Fisher's protected least significant difference (LSD) test. Data were square-root transformed prior to analysis. Means presented

Table 1. Mean number of azalea lace bugs per terminal prior to and after insecticide application alone, or with the addition of green lacewing larvae (GLW)

Treatment	Pre count (nymphs)	Post count (nymphs)	Post count (adults)
Acephate	14.1 a	1.8 ab	0.5 c
Imidacloprid	16.56 a	0.22 b	0.0 c
Soap	17.3 a	3.2 a	1.5 bc
Oil	7.71 a	5.14 a	6.43 a
Tick Ex	16.4 a	1.3 ab	1.5 c
Water	9.44 a	3.11 a	3.44 ab
Acephate + 10 GLW	14.0 a	0.44	0.0 c
Imidacloprid + 10 GLW	15.0 a	4.2 a	1.5 bc
Soap + 10 GLW	10.38 a	0.13 b	0.87 c
Oil + 10 GLW	7.71 a	1.29 ab	2.0 bc
Tick Ex + 10 GLW	9.7 a	1.7 ab	0.9 bc
Water + 10 GLW	10.38 a	2.5 ab	5.62 a
F	0.78	2.01	3.46
P	0.6625	0.0355	0.0004

Means in the same column bearing different letters are significantly different ($P < 0.05$)

herein are back-transformed data. Orthogonal contrasts compared water controls with all other treatments, with green lacewings compared with without green lacewings, and synthetic organic insecticides to alternative treatments.

There were no significant differences among pre-treatment counts (Table 1). Significant differences among treatments were observed for both lace bug adults and nymphs in the post-treatment counts (Table 1). Treatments imidacloprid, acephate + green lacewing, and soap + green lacewing resulted in significantly lower numbers of lace bug nymphs relative to the water control. These same 3 treatments plus treatments acephate and biopesticide (*Metarhizium*) also significantly reduced number of adults in comparison with the water control.

Orthogonal contrasts showed that the water controls were significantly different from other treatments ($P = 0.0021$), and also that the treatments that using synthetic organic insecticides (acephate, imidacloprid, acephate + green lacewing and imidacloprid + green lacewing) were significantly different from alternative treatments ($P = 0.0026$). Green lacewing larvae in general did not contribute significantly to control ($P = 0.6614$). Among individual treatments, however, application of insecticidal soap (nymphs) and oil (adults) benefited by the addition of the predaceous green lacewing larvae (Table 1).

In the present study, we found that acephate, imidacloprid and insecticidal soap combined with green lacewing larvae offered the best control of lace bugs. The single applications of soap, oil or biopesticide (*Metarhizium*) alone, however, were not as effective as the synthetic organic insecticides. The feasibility of integrating natural enemies with chemical control for effective lace bug suppression merits further research, especially in open field situations.