BIOAG PROJECT FINAL REPORT

TITLE: Spatial and temporal dynamics of attracting green lacewings to synthetic lures in apple orchards for pest suppression

PRINCIPAL INVESTIGATOR(S) AND COOPERATOR(S): Vincent P. Jones and Conor O'Leary (graduate student)

KEY WORDS: *plant volatiles, biological control, insect behavior*

ABSTRACT: We found spatial effects of the lures were limited to <3.3 m from the source tree. Flight activity around the lures was highest at dawn and dusk, with 86 and 90% of activity observed for *Chrysoperla carnea* and *Chrysopa nigricornis*, respectively. Flight activity at other times of the day or night was relatively uniformly spread out. Evaluation of population growth between trees with lures and control trees showed that the percentage of infested shoots grew faster on control trees compared to trees with either a squalene or AMP lure. These results demonstrate the feasibility of this approach and justify further experiments to evaluate the operational factors necessary for commercial adoption.

PROJECT DESCRIPTION

This project focused on some critical knowledge gaps in the use of plant volatiles as attractants for manipulating natural enemy spatial distributions in agricultural systems to augment biological control in areas with large pest populations. Our research had three different objectives: (1) determine the spatial range over which synthetic lures attract of two different lacewing species (*Chrysopa nigricornis*, and *Chrysoperla carnea*); (2) determine the daily activity patterns of the two most common lacewings present in the apple agro-ecosystem; (3) to investigate whether short term use of the lures can increase biological control of woolly apple aphid (WAA).

OUTPUTS

- ***Work Completed:***

Objective 1. We used in-field video recording to evaluate how activity patterns of two lacewing species varied at different distances from two different lures. The first lure was a single component squalene lure that attracts primarily the lacewing *Chrysopa nigricornis*, while the second lure was a three component lure consisting of Acetic Acid, Methyl Salicylate, and 2-phenyl ethanol (AMP lure) that attracts *C. nigricornis* and *Chrysoperla carnea*. Both species of lacewings responded similarly to each lure and demonstrated that activity around the lure reached the orchard average by 3.3m away from the tree with the lure present. The short attraction range is a good finding in that attraction is fairly limited and would have minimal effect on natural enemies at a larger scale which could result in pest outbreaks if the range of attraction were too great.

Objective 2. Activity around the lures was primarily around sunrise and sunset (≈55 and 35% of the total), with the remaining activity evenly distributed in the night and day. Behavior around the lures was not observed to the extent needed because the experimental setup used sticky panels under the lure (so the species specific response could be determined) and behavior after landing was not available. We are currently using our extramural funding (from Washington Tree Fruit Research Commission) to follow up on this objective with a newly hired person who will be doing more video-based monitoring this coming summer to clarify the behavior around the lures.

Objective 3. We randomly selected 24 trees separated by >60m in a large orchard with both WAA and lacewings present. The trees were randomly assigned to receive either a blank lure (control), a lure containing squalene or an AMP lure. For each tree, we performed a 3-minute visual count for lacewing eggs and each egg mass was marked so that it would not be recounted. We also selected 10 shoots per tree and evaluated whether the shoots were infested with WAA to determine the average percentage of shoots infested. In addition, we examined 10 additional randomly selected shoots from the same tree,

counted the number of colonies per shoot and followed those over a six-week period. After the six-week period, the entire experiment was broken down and set up again, and run an additional 4 weeks. We found that final proportion of shoots infested on the trees with the squalene lure was 55% lower than the control trees and the ratio of green lacewing egg masses to WAA colonies was 1.7 fold higher. The trees with the AMP lures showed similar responses, with 40% lower infestation and 1.6-fold higher ratio of green lacewing eggs masses to WAA colonies. These data showed that not only do lacewings oviposit more in the vicinity of the lures, but that WAA colonies are suppressed compared to those on control trees. While our data show that we can suppress WAA colony establishment and growth, they have not shown that we can reduce high populations. We will be following up with that possibility this summer with our external funding.

- **Publications, Handouts, Other Text & Web Products:**

1. O'Leary, C. 2015. Application of synthetic HIPV lures to augment biological control of *Eriosoma lanigerum* (Homoptera: Aphididae) in WA apple orchards. Entomology non-thesis MS scholarly review and research report. 37 pp.
2. Jones, VP and C. O'Leary. 2016. Evaluating plant volatiles for augmenting biological control. Progress Report for Washington Tree Fruit Research Commission Grant CP-15-101.

- **Outreach & Education Activities:**

1. Jones, VP and C. O'Leary. 2016. Evaluating plant volatiles for augmenting biological control. WA Tree Fruit Res. Commission Crop Protection Meetings. 15-minute Presentation. Jan. 27. Wenatchee, WA
2. Jones, VP and C. O'Leary. 2016. Evaluating plant volatiles for augmenting biological control. WA Tree Fruit Res. Commission Crop Protection Meetings. Poster Presentation. Jan. 27. Wenatchee, WA.
3. Jones VP, U Chambers, C Baker, T Melton, C O'Leary. 2016. Using multiple approaches to enhance biological control in tree fruit: Simulation, field studies and behavioral components. Invited Symposia Talk. Pacific Branch of the Entomological Society, 3-6 April. Honolulu, HI.

IMPACTS

- **Short-Term:** The short-term impacts are primarily from filling data gaps and showing the feasibility of the approach of using synthetic plant volatiles to aggregate natural enemies and increase spatially limited biological control. This work will form the basis of the new experiments that will further refine the parameters needed to use the techniques at larger scales.
- **Intermediate-Term:** Our grant from the research commission will allow us to perform more studies to clarify the best way to use the technology and to examine its strengths and weaknesses.
- **Long-Term:** The goal over the next 5 years, first and foremost, will be to further explore and define phytochemical-insect interactions in apple and other agricultural systems. The finer details of utilizing this technique to our advantage remain exceedingly complex, but our work should simplify the process. Research that continues to study and improve our understanding of methods to enhance biological control will be important for developing the most stable IPM programs. Perhaps more importantly, the lures work independently of the cropping system and, since the target NEs are generalist predators that are found in a wide range of crops in the western U.S., our data will have much broader applicability than to apples alone. Thus, our long-term goal is to advance luring technology throughout U.S. agriculture, identifying more NE-lure interactions and promoting lure-based biocontrol as another tool in the farmer's IPM program

ADDITIONAL FUNDING APPLIED FOR / SECURED: Jones, VP and C. O'Leary. Evaluating plant volatiles for augmenting biological control. Washington Tree Fruit Research Commission. $110,066 (2015-2016).

GRADUATE STUDENTS FUNDED: Conor O'Leary (MS Dec. 2015) Department of Entomology.

RECOMMENDATIONS FOR FUTURE RESEARCH: We are currently following up with funding from the WTFRC some of the remaining issues with the research already done. We expect to have those gaps filled by the end of 2016 season. The biggest issues are: (1) Determining behavior around the lure and its effects on biological control, and (2) whether we can knock down high populations using the lures. The first issue will be investigated using a different set up with the in-orchard video cameras where the lacewings will not be captured as they get close to the lures (previous setup) and we have started the setup in the last month and will continue throughout the summer. The second issue will also be evaluated in multiple ways including sampling to compare before and after population levels and also to use video observations of WAA colonies on trees with lures or not. We expect to be able to quantify how much more predation occurs on lured trees versus control trees and how population density changes over time with the different treatments.