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Junwei Zhu
Iowa State University

Rick Exner
Iowa State University

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Biological control of the soybean aphid in organic and sustainable soybean production systems

Abstract

Predatory insects and parasitoids can be used to suppress soybean aphid populations. This project explores the development of bio-based insect lures to enhance the efficacy of biological control of soybean aphids.

Keywords

Entomology, Biocontrol and Integrated Pest Management, Organic production practices and comparisons

Disciplines

Agriculture | Entomology



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Biological control of the soybean aphid in organic and sustainable soybean production systems

Abstract: Predatory insects and parasitoids can be used to suppress soybean aphid populations. This project explores the development of bio-based insect lures to enhance the efficacy of biological control of soybean aphids.

Question & Answer

Q: Can strategies such as biological control be used to suppress the infestation of soybean aphids?

A: Yes, it can be used not only by organic soybean growers who currently lack efficient control methods, and also can be helpful for conventional growers to reduce the use of pesticide applications, which ultimately increases the yield.

Background

The soybean aphid is an invasive species that has the potential to seriously affect U.S. soybean production. It is now found in 20 states and three Canadian provinces. In 2005, an estimated 10 million acres of soybeans were treated with chemicals to combat soybean aphid outbreaks. Current soybean aphid management tactics rely heavily on synthetic insecticides which also kill beneficial insect predators and parasitoids that might help control the aphid outbreaks. Furthermore, some studies suggest that insecticides may not be entirely effective, and soybean aphid populations can rebound after application. This project studied whether under certain conditions, insect predators can effectively suppress soybean aphid populations.

Approach and methods

Objective 1: Train Practical Farmers of Iowa cooperators to recognize the soybean aphid and its natural enemies,

to understand the importance of plant and crop diversity for these beneficial insects, to recognize their seasonal biology, and to conduct standard sampling. At farm field days from 2003 to 2005, workshops were held to describe the biology and ecology of soybean aphids and predators, the importance of habitat diversity for natural enemies, ways that farmers can enhance reservoirs of those beneficial insects, and the sampling procedures developed to detect aphid infestations at early stages in soybean fields.

Objective 2: Establish on-farm research and demonstration sites. At selected PFI cooperators' farms, eight 1/2-acre plots were established to test two replicates of four treatments. The treatment regimens were: control (no treatment), the placement of nine newly formulated attractant lures with additional semiochemical added, spraying of three strips with sugar water, and a combination of the new lures with the sugar water spraying. The number of aphids and predators was assessed twice weekly.

Objective 3: Test the efficacy of enhanced levels of biological control via applications of attractant lures. Three- to five-acre soybean fields were established on selected PFI cooperators' farms. Since early results showed that sugar water did not increase the predation or suppress the soybean aphid population significantly, only two treatments were used: the control (no treatment) and the placement of newly formulated lures (three to five per acre) that attract predators and parasitoids to the experimental fields. The numbers of predators and pests were checked each week, and farmers weighed the beans harvested from each field to determine the effects of treatments on yields.

Principal Investigator:

Junwei Zhu
Entomology
Iowa State University

Co-investigator:

Rick Exner
ISU Extension and Practical Farmers
of Iowa Farming Systems
Coordinator

Budget:

\$32,706 for year one
\$27,000 for year two
\$31,050 for year three

Objective 4: Develop a monitoring kit using soybean-associated semiochemicals (kairomones) to predict initial soybean aphid population density.

Objective 5: Share the results of the project through the Practical Farmers of Iowa (PFI) network via their field days, newsletter, web site, and annual meetings.

Results and discussion

During the field seasons from 2002 to 2005, eight predatory insects and parasitoids were observed attacking soybean aphids on soybean plants. Among them were the 7-spotted lady beetle, multicolored Asian lady beetle, and two lacewing species. Other insects were syrphids, aphid midges, a fly species whose larvae attack soybean aphids, and the insidious flower bug. Mummies of (aphid) parasitic wasps also were found in soybean-infested fields. Their presence suggests that they can play important roles in reducing the population density of soybean aphids. Relatively high numbers of four of these predatory insects were found in traps baited with some compounds of methyl salicylate, which became a major ingredient of the attractant lures developed for the project.

In collaboration with an Iowa-based biotech company, MSTRS Technologies, Inc., the researchers developed two beneficial insect attractant lure dispensers using the EPA-registered semiochemical dispensers. Identified beneficial insect attractant compounds were formulated inside a modified polyethylene bag embedded with UV/photo-protected membranes. The release rate of the beneficial attractant compound is controlled by using different loading and permeability of the plastic membranes comprising the bags' outer envelopes. The lures were replaced every three weeks to ensure their effectiveness.

Field trials conducted in soybean fields owned by PFI members in Decorah, St. Ansgar, and Story County showed that one week after the application of beneficial attractant lures, the density of soybean aphid populations in the treated plots was reduced by more than 60 percent, compared to reductions of less than 20 percent in the control fields. After two weeks, soybean aphids declined by 80 percent in the treated plots. Even in control plots, an average reduction of 50 percent was noted. The decreases inside the control plots could be due to many lured predatory insects migrating to these



Lacewing adult



Lacewing larvae



Lure in the field

adjacent control plots because fewer food sources (soybean aphids) were available in the treated plots following the increased predation. Significant increases in predatory insect numbers were observed in plots outfitted with beneficial insect attractant dispensers after just one week.

Researchers identified one of the soybean leaf volatiles (benzaldehyde) emitted from the plant leaves at two growth stages that is highly appealing to winged soybean aphids. This soybean volatile compound also elicited significant active responses from the antennae of winged soybean aphids.

The density of the initial soybean aphid population and the timing for application of attractant lures are critical factors for the effectiveness of suppression. It would be helpful to have a monitoring tool that would predict soybean aphid

outbreaks at an early stage. This could spur growers to take action before the aphid outbreak reaches the economic threshold.

Conclusions

- An entire community of beneficial insects found in soybean fields was observed to be attacking soybean aphids.
- Most of the beneficial insects that were found locally appeared to play important roles in suppressing soybean aphid population density.
- Methyl salicylate, a soybean aphid-induced volatile, is used as a chemical cue by several beneficial insects for locating prey-soybean aphids.
- The beneficial insect attractant lures that were developed have demonstrated their appeal to the soybean aphid's natural enemies, and may be effective for more than four weeks.
- The application of those attractant lures in soybean aphid-infested fields can increase the number of predatory insects in the field and further reduce the soybean aphid population.
- Increased soybean yields have been observed from the soybean fields treated with beneficial insect attraction lures when compared with control fields.
- Late soybean aphids from the spring and summer can be captured in traps baited with either benzaldehyde or soybean aphid pheromone blend.

Impact of results

The investigators demonstrated that the beneficial insect attractant lures that were developed can be highly attractive to many common natural enemies of soybean aphids that are found locally. The application of these attractant lures in soybean aphid-infested fields can significantly increase the number of their natural enemies, therefore reducing the damage caused by the soybean aphids. The use of soybean-associated plant volatiles and soybean aphid sex pheromone blends in aphid traps can provide useful information for monitoring the population density in the field; however, more studies are needed because the results are not consistent.

The technologies developed for use against this aphid species also may provide help in developing sustainable control strategies against aphid pests that afflict other economically important crops such as alfalfa, corn, fruit trees, and wheat. The development of this system that works against soybean aphids will give soybean producers a new tool in combating this pest, and may be especially helpful to growers of organic soybeans who currently have no economically sound, non-insecticidal population suppression weapons against this pest.

However, the use of in-field attractant lures may be cost prohibitive due to the high labor costs of attractant lure deployment. A foliar application of this kairomone system may be more cost effective for growers. By tank-mixing this product with the final application of a post-emergent herbicide, growers may have a more cost effective soybean aphid preventative. This innovation also can benefit the conventional growers who use it. Unlike regular insecticides, it will not disrupt the biological control of other soybean pests such as spider mites.

Education and outreach

Three scholarly papers were written on the project findings. Two have been published and one has been submitted for publication. *Agri-News* published two stories on the aphid research done by the project.

Presentations on the results of the project were given at the PFI annual meetings and ISU Extension farm field days. Scholarly presentations were offered at the annual meeting of the Entomological Society-USA, annual meeting of the International Society of Chemical Ecology, the World Plant Protection Congress, and at the U.S. Department of Agriculture laboratories in Beltsville, MD.

Leveraged funds

A proposal was submitted to Grow Iowa Value Fund to support the tank-mixing technology development, and the decision won't be known until summer 2006.

For more information contact Junwei Zhu, Entomology, Iowa State University, 407 Science II, Ames, Iowa 50011; (515) 294-1610, e-mail jwzhu@iastate.edu