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The impact of biodiversity services in row crop production in annual verses perennial landscapes

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Disciplines
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The impact of biodiversity services in row crop production in annual versus perennial landscapes

Abstract:
Researchers studied the behavior of soybean aphids in fields and prairies, and the implications for biological control of these pests.

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$35,389 for year one
$36,590 for year two

ECOLOGY

Q Does the occurrence of native, perennial habitat (i.e., prairie) increase the abundance of beneficial insects and lower the abundance of the soybean aphid, a significant pest of soybeans?

A Although beneficial insects, such as lady beetles, are common in soybean fields and are a source of mortality for the soybean aphid, prairie did not significantly contribute to increasing the biological control of this pest. The prairies that were studied contained plants that beneficial insects are attracted to, but the abundance of these plants was low. This may explain why prairies did not significantly contribute to the abundance and diversity of beneficial insects in adjacent soybean fields. Results suggested that landscape factors affect soybean aphid abundance at a scale much larger than what was addressed in this study.

Background

The project objective was to characterize the relationship between soybean aphids, their associated natural enemies and landscape features surrounding soybean fields. Perennial habitats such as prairie contribute to many ecosystem services that are valued for annual crop production. In this project's study-system, there is prior evidence that perennial habitat contributes to the biological control of soybean aphids, possibly because prairies contain flowering plants that are attractive to insect predators of aphids. The investigators conducted the project studies on soybean fields near the reconstructed prairies of the Neal Smith National Wildlife Refuge (NSNWR) near Prairie City, Iowa.

Approach and methods

To accomplish their objective, investigators conducted two concurrent projects. In the first project, they explored the effects of prairie and plant nutrients on soybean aphid and the natural enemies that feed on them. Researchers hypothesized that the abundance of natural enemies in soybean fields would be positively correlated with an increased amount of prairie land cover surrounding the field and that predator populations would be influenced by plant macronutrient (N, P and K) levels. In turn, it was expected that a greater abundance of natural enemies would reduce the abundance of soybean aphid. In the second project, they tested four different sites across the state to determine how the proximity to prairie affects the presence of soybean aphid and their natural enemies in soybean. They theorized that soybean fields closer to prairies would have a greater abundance of natural enemies and reduced numbers of aphids.

Results and discussion

The first project yielded information that the soybean aphid and its natural enemies

Aeriel view of research plots.

are not highly influenced by landscape features within and around the NSNWR. Project results suggested that variability in the abundance of soybean aphid was most affected by one or more unmeasured abiotic and/or biotic factors associated with the particular crop year. Going forward, they considered that a component of this 'year' factor is the immigration of aphids. As the field study suggests, this immigration is likely due to stands of buckthorn found many miles away from the study site.

The second project did not provide evidence that proximity to prairie consistently affected aphid populations. Rather, sentinel plant results suggested there was no difference between soybean acreage and prairie in soybean aphid predation. Investigators found native plant species in the prairies that are attractive to beneficial insects. However, the relative abundance of plants attractive to insects was very low. Therefore, the diversity and abundance of plants may not have been optimal for enhanced biological control of soybean aphids.

Conclusions

Although the research team did not observe an impact of existing prairies on the abundance of soybean aphids and their natural enemies on soybean fields, they did gather insight into aspects of prairies that could help increase prairie potential to deliver ecosystem services. Many of the natural enemies that attack soybean aphids were found within these prairies, as were plants that these insects use as sources of nectar and pollen. These data suggest that efforts to increase the abundance and diversity of beneficial insects within prairies and adjacent cropland should focus on increasing the diversity of flowering forbs.

In the first project, researchers anticipated that as the area around soybean fields was comprised of more perennial habitat (i.e., prairie), the community of natural enemies would be more abundant and diverse. Given the evidence that this community provides biological control of the soybean aphid, they expected that there would be fewer aphids within fields that are nearest prairie. They did not observe evidence to support either hypothesis.

During the course of the field work, they observed aphid outbreaks that increased with each subsequent year. While previous research had revealed that a decline in soil fertility can increase the risk of soybean aphid outbreaks, researchers did not observe evidence to support the hypothesis that plants with varying concentrations of N, P or K had a greater risk of aphid outbreaks. Rather, they observed a dramatic migration of aphids during the growing seasons that mirrored what was observed in the soybean fields. The source of immigrant aphids at the study site is not clear, but is not likely to be local. Each year the team walked the perimeter of soybean fields comprising the study, in addition to woodlots in the NSNWR and local parks, and did not find the overwintering host of the suspect aphids.

Through the second project, they did not observe evidence that proximity to prairie consistently affected aphid populations. Rather, sentinel plant results suggest there was no difference in aphid predation between soybean and prairie. Measurements of the plant community within the prairies that were part of the study and comparison of the four sites suggest that remnant and reconstructed prairies were quite different. To what extent this variation contributed to measurements of natural enemy abundance and diversity, as well as aphid suppression is not clear. Results from our survey of

Weed seed remover.

prairies within Jasper County, Iowa, suggest that the abundance of native plants that were attractive to beneficial insects was low, and as such did not contribute to the prairies serving as a source habitat for beneficial insects.

Impact of results

Project data suggest that some as yet unaccounted for aspects of the agroecosystem are responsible for the year-to-year variability in aphid abundance. Data from the suction trap network (www.ncipmc.org/traps/) suggest that aphid immigration could help explain this variation.

As the ultimate source of these migrants, buckthorn is a key component of soybean aphid invasion found within the landscape. Specifically, the project modeling suggests that by reducing the rate of immigration, producers can prevent outbreaks from occurring. How aphid immigration into soybeans varies with the abundance of buckthorn is not clear. However, the relationship between landscape features, aphid abundance, and the diversity and abundance of their natural enemies within soybean fields is apparent from this and previous studies. These results suggest that management of the aphid will require a landscape approach that considers more than adjacent field composition

Education and outreach

The two projects have been fully summarized in the dissertation of Nicholas Schmidt in completion of the Ph.D. program in the Department of Entomology at Iowa State University. Data generated from this project were featured in several poster and oral presentations at regional and national meetings, such as the Entomological Society of America meetings in 2007, 2008, 2009 and 2010. Presentations also were offered at the Kansas Entomological Society and the U.S. Regional Association for Landscape Ecology.

Data generated from this project were used in two peer-reviewed manuscripts. The first project has recently been accepted for publication in the journal Environmental Entomology. The second project report also will be submitted to Environmental Entomology.

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Leveraged funds

The principal investigator used the data set from this project to support a proposal to the USDA-AFRI program that funds research on invasive species; Common Buckthorn (Rhamnus cathartica) as a Keystone Invader in Agricultural Landscapes ($500,000). This proposal was funded in 2010 to aid O'Neal and his colleagues at Michigan State University and Ohio State University. A goal of this new project is to understand the role of buckthorn in supporting soybean aphid populations and identify management strategies for both aphids and buckthorn. A website has been created (http://buckthornwatch.org) to encourage a network of citizen volunteers to collect buckthorn and soybean aphid data across the region.