

South Dakota Report For NCERA-125 – October 2006

1. Project title: Impact of natural enemies on soybean aphid in a field cage experiment

Investigators: Kelley J. Tilmon (South Dakota State University, Brookings SD); Deirdre Prischmann, Louis Hessler, Jon Lundgren (North Central Agricultural Research Laboratory, USDA-ARS, Brookings, SD)

Contact: Kelley Tilmon, (kelley.tilmon@sdstate.edu)

Project description: This field cage experiment was designed to test the relative impact of two natural enemies on soybean aphid population growth under outbreak conditions. The two natural enemies were *Orius insidiosus* (minute pirate bug) and *Harmonia axyridis* (Asian ladybeetle). We found that when aphid populations were already well-advanced on plants, *Orius* did nothing to reduce numbers, but the ladybeetle reduced aphids to below threshold by the end of the experiment. There was no apparent interaction between the two natural enemies. Further, open-plot controls remained below threshold levels throughout the experiment, indicating that the ambient natural enemy populations can play an important role in maintaining aphid populations at acceptable levels.

2. Project Title: Natural enemy response to aphid populations on soybean lines of variable resistance

Investigators: Kelley J. Tilmon (South Dakota State University, Brookings SD)

Contact: Kelley Tilmon, (kelley.tilmon@sdstate.edu)

Project description: Tritrophic interactions have the potential to be an important component of IPM programs. My objective is to evaluate the relative impact of natural enemies on soybean aphids in plant lines that show low, moderate, and high levels of resistance to the soybean aphid. In summer 2006 we tested soybean aphid resistance in a number of different experimental soybean lines currently under development and collected data on natural enemies present. Work in 2007 will focus more directly on the tritrophic interactions of plant resistance, aphids, and natural enemies.

3. Project title: Role of natural enemies in soybean IPM in South Dakota

Investigator: Kelley J. Tilmon (South Dakota State University, Brookings SD)

Contact: Kelley Tilmon, (kelley.tilmon@sdstate.edu)

Project description: The purpose of this ongoing study is to determine the contribution of natural enemies to maintaining soybean aphids below threshold levels, with the specific purpose of ultimately relaying this information to soybean producers as part of soybean IPM recommendations currently under development by my research program

4. Project Title: Soybean aphid and natural enemy population survey

Investigators: Kelley J. Tilmon (South Dakota State University, Brookings SD); Jon Lundgren (North Central Agricultural Research Laboratory, USDA-ARS, Brookings, SD)

Contact: Kelley Tilmon, (kelley.tilmon@sdstate.edu)

Project description: In the summer of 2006 we performed weekly surveys on soybean aphid abundance and natural enemy abundance and identity at a survey site in Brookings County. The purpose was to add to similar yearly data sets generated since the introduction of soybean aphid to the region.

5. Project title: Impact of corn variety on potential predators of larval corn rootworms (Coleoptera: *Diabrotica* spp.).

Investigators: Deirdre A. Prischmann and Kenton E. Dashiell, USDA, Agricultural Research Service, Northern Plains Area, North Central Agricultural Research Laboratory, Brookings SD.

Contact: Deirdre A. Prischmann (dprischmann@ngirl.ars.usda.gov)

Project description: Corn rootworms (Coleoptera: *Diabrotica* spp.) are serious pests of maize around the world. Larvae feed on corn roots, which reduces uptake of water and nutrients and lowers plant yield. Current control practices rely on soil insecticides or genetically modified corn varieties. Although some researchers have investigated natural enemies of adult rootworms, there is a lack of information on predators and parasites that attack soil-dwelling, immature corn rootworm stages. In 2006, we conducted a replicated field study to explore how corn variety impacted density of larval corn rootworms and potential subterranean predators, including ground beetle larvae and predatory mites. Corn varieties tested included two commercially available hybrids, and a corn rootworm resistant Bt variety and its susceptible isoline. Weekly soil cores were taken from June through July, and arthropods extracted using berlese funnels.

6. Project Title: Integrating the management of weeds, crop diseases, and insects in soybeans.

Investigators: Jonathan Lundgren¹, Sharon Clay², Louis Hesler¹, Janet Knodel³, and Marie Langham²

¹ North Central Agricultural Research Laboratory, USDA-ARS

² Department of Plant Sciences, South Dakota State University

³ Department of Entomology, North Dakota State University

Contact: Jonathan Lundgren, (jlundgren@ngirl.ars.usda.gov)

Project description: We evaluated the effects of alternative pest management systems on weeds, crop disease, and insect pests on the economics of soybean production. Three treatments were evaluated: 1) reducing herbicide use and replacing insecticides using a spring-planted small grain cover crop, 2) reducing the frequency of herbicide

applications by one-half, allowing plant diversity resulting from weeds to replace insecticide use, and 3) managing soybean fields conventionally using insecticides and herbicides at rates that mimic common practices on agricultural fields in the region.

In 2005, both reduced-input systems were successful in reducing weed populations and increasing beneficial insects. Natural enemies were significantly more abundant in the weed and cover crop fields, as were populations of soybean aphid and bean leaf beetle. While these natural enemies were not as effective as insecticides in eliminating insect pests, it appears that they did reduce them to what may be a tolerable level. Also, the aphid populations were greatest at the end of the season, when crop damage by these insects is reduced. Ultimately, reducing chemical use to produce soybeans proved to be more profitable (by \$10-20 per acre) than conventional chemical approaches to pest management. The cost of applying herbicides is considerable, and the use of insecticides appeared to necessitate further chemical inputs for managing insects. The cost of applying these chemicals is not recouped through improvements in yield. Currently, the 2006 data seems to reflect some of the patterns observed in 2005, although yields have not been collected at this point.

7. Project Title: The behavior of *Orius insidiosus* in vegetationally diverse systems.

Investigators: Jonathan Lundgren¹, Walter Riedell¹, Kris Wyckhuys², and Nicolas Desneux²

¹ North Central Agricultural Research Laboratory, USDA-ARS

² Department of Entomology, University of Minnesota

Contact: Jonathan Lundgren, (jlundgren@ngirl.ars.usda.gov)

Project description: *Orius insidiosus* is a facultatively phytophagous predator that is abundant in many agricultural systems. Because of its close associations between the predator and plants, we have shown that this beneficial insect responds favorably to plant diversity within cropland. Field and laboratory experiments have explored two mechanisms for how polycultures benefit the populations of this predator. First, *O. insidiosus* displays distinct preferences for certain plants for oviposition, and some non-crop plants are preferred over soybeans. The data shows that these preferences are linked in part to the survivorship of the females offspring on the different plant species. Essentially, females oviposit on plants that are of high-quality for developing nymphs, and that the fitness of these nymphs are leading to larger predator populations in polycultures versus monocultures. We are currently investigating the proximal cues that drive *O. insidiosus* reproductive decisions.

Publications:

Lundgren, J. G., and J. K. Fergen. 2006. The oviposition behavior of the predator *Orius insidiosus* (Say) (Heteroptera: Anthracoridae): acceptability and preference for different plants. *BioControl* 51: 217-227.

Lundgren, J. G., K. Wyckhuys, and N. Desneux. Plant-mediated demographic responses by *Orius insidiosus* to plant diversity. *Ecological Entomology*, in review.

8. Project Title: The gut ecology of Carabidae

Investigators: Jonathan Lundgren¹, Michael Lehman¹, Joanne Chee-Sanford²

¹ North Central Agricultural Research Laboratory, USDA-ARS

² Invasive Weed Management Unit, USDA-ARS

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Project Description: Carabids are abundant ground-dwelling predators in cropland, and although general feeding guilds have been assigned to various taxa, little work on the mechanisms underlying feeding behavior have been conducted. We are interested in microbial contributions to feeding behavior in this group, particularly with regard to the evolution of granivory within Carabidae. Specifically, we have described the bacterial communities of three prominent species within cropland (*Anisodactylus sanctaecrucis*, *Poecilus chalcites*, and *Harpalus pensylvanicus*). Feeding assays have shown that granivorous beetles cured of their bacterial symbionts have reduced seed consumption. Prey consumption is unaffected by curing. This suggests that bacterial residents may be contributing to seed digestion. Future research will identify key seed degrading bacteria, investigate the consistency of infection among granivorous taxa, and determine the ecological and agronomic significance of these early findings.

Publications:

Lundgren, J. G., R. M. Lehman, and J. Chee-Sanford. The bacterial communities within the digestive tracts of ground beetles (Coleoptera: Carabidae), and their potential function in beetle nutrition. *Annals of the Entomological*, submitted.

9. Project Title: Factors underlying the preference for weed seeds by granivorous insects.

Investigators: Jonathan Lundgren, Kurt Rosentrater
North Central Agricultural Research Laboratory, USDA-ARS

Contact: Jonathan Lundgren, (jlundgren@ngirl.ars.usda.gov)

Project Description: The biological control of weed seed banks within cropland is contingent on the preferences of granivorous insects. While the influence of nutrition and chemistry of seeds on granivores is fairly well explored, how structural strength of seeds affects granivory is less understood. We related the seed preferences of three granivorous insects, *Harpalus pensylvanicus*, *Anisodactylus sanctaecrucis*, and *Gryllus pennsylvanicus* (Gryllidae) to seed density, size, and the physical strength of the seed coat. We found that different seed structural characteristics were statistically correlated with the individual preferences of the granivores. The ability of different granivorous species to detect fine differences in the qualities of seeds likely contribute to the niche partitioning of diverse granivore communities, and suggest a way to target specific weed-insect interactions in the biological control of seed banks.

Publications:

Lundgren, J. G., K. Rosentrater. The toughness of seeds and their destruction by granivorous insects. *Journal of Ecology*, submitted.

10. Project Title: Using qPCR to evaluate predation of Colorado potato beetle by *Coleomegilla maculata*.

Investigators: Jonathan Lundgren¹, Don Weber², Dan Rowley², Matt Greenstone²

¹North Central Agricultural Research Laboratory, USDA-ARS

²Insect Biocontrol Laboratory, USDA-ARS

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Project Description: The Colorado potato beetle is a serious pest of potatoes in the U.S. that is currently managed primarily with insecticides. Predation by foliar-dwelling predators, including *C. maculata* (Coccinellidae) likely impact populations, but determining predation rates under field conditions is difficult. We are developing a quantitative PCR assay to determine the frequency of predation, as well as the amount of prey DNA within *C. maculata* larvae. Using CPB-specific primers, we are assessing the influence of prey density and age on the detectability of CPB DNA within *C. maculata* stomachs. Also, we are investigating the influence of different 'chaser' foods on the retention time of the prey DNA. Ultimately, this series of experiments should bring PCR methods up to par with immunological methods for quantifying predation in insects. 2006 Project Report for NCERA-125

11. Project Title: Comparison of soybean insect pests and arthropod natural enemies under various cover crop treatments.

Investigators: Louis Hesler¹, Shannon Osborne¹, and Jonathan Lundgren¹

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Contact: Louis Hesler, (lhlesler@ngirl.ars.usda.gov)

Project description: We evaluated the effects of cover crops on defoliation of soybean seedlings by adult bean leaf beetle and on the abundance of BLB, soybean aphid, and epigeal and foliar natural enemies. In 2006 (the first year of this study), soybean aphid and BLB populations were low, and there was no difference in defoliation among cover crop treatments. Populations of foliar predators were low, but substantial numbers of epigeal predators were sampled. To date, no significant differences in arthropod abundance have been found among cover crop treatments. Analysis of the 2006 data on epigeal predators is still in progress, and at least one additional year of data collection is planned.

12. Project Title: Inventory of natural enemies in soybean fields and their impact on soybean aphid.

Investigators: Louis Hesler¹

¹ North Central Agricultural Research Laboratory, USDA-ARS, Brookings, SD

Contact: Louis Hesler, (lhlesler@ngirl.ars.usda.gov)

Project description: A two-year field study to inventory the natural enemies associated with soybean aphid in South Dakota soybean fields has been completed. We are currently analyzing data and writing up results, but preliminary results indicate that 1) a diverse guild of natural enemies associated with soybean aphid infestations; 2) NE's as an aggregate responded numerically, but inadequately, to soybean aphid infestations

with respect to the current action threshold; 3) large NEs occasionally impacted SBA populations; and 3) exclusion cages used in evaluating NE impact affected SBA population dynamics, indicating that a “cage-effect” must be considered in NE studies.

13. Project Title: Abundance of coccinellids and their potential prey in field-crop and grass habitats in eastern South Dakota.

Investigators: Louis S. Hesler¹, Robert W. Kieckhefer¹, and Michael M. Ellsbury¹
¹ North Central Agricultural Research Laboratory, USDA-ARS, Brookings, SD

Contact: Louis Hesler, (lhessler@ngirl.ars.usda.gov)

Project description: A rich fauna of coccinellids occurs in eastern South Dakota, but abundance of some species has declined in association with establishment of an exotic lady beetle, *Coccinella septempunctata* (L.), in the mid-1980s. In this study, coccinellids were sampled within field-crop and grass habitats in eastern South Dakota to survey for coccinellid species and determine effects of habitat management on abundance. Field crops (maize, wheat-alfalfa intercrop, alfalfa) were subjected to high, intermediate, or low crop-management intensity (CMI), and grass habitats were managed for stands of warm season, cool season, or mixed species. We collected 1,306 adult and 155 larval coccinellids. Four native species (*Coleomegilla maculate* (DeGeer), *Hippodamia convergens* Guerin-Meneville, *H. parenthesis* (Say), and *H. tredecimpunctata* (Say)) and *C. septempunctata* comprised over 96 percent of all coccinellids collected. Four *Coccinella transversoguttata richardsoni* Brown were collected from alfalfa, but *C. novemnotata* Herbst and *Adalia bipunctata* (L.) were not collected. Coccinellid abundance was seldom affected by CMI. Coccinellids were more abundant in wheat-alfalfa in 1995 under high than low CMI. Coccinellid abundance in maize and alfalfa did not differ with CMI. A prey species, *Empoasca fabae* (Harris), was more abundant in alfalfa in 1995 under high and intermediate than under low CMI. Coccinellid abundance was not correlated with that of *E. fabae* in 1995, and showed inconsistent association with *E. fabae* during the study. In grass, total adult coccinellids, adult *H. tredecimpunctata tibialis*, and aphids were more abundant in warm-season grasses than in cool-season or mixed grass stands in one of three years. Results provide further evidence that *C. septempunctata* has become relatively abundant in eastern South Dakota, whereas *C. transversoguttata richardsoni*, *C. novemnotata*, and *A. bipunctata* have become rare or absent. Studies are continuing on the ecology of coccinellids in South Dakota, especially as a second exotic species, *Harmonia axyridis* (Pallas), has established.

Publication:

Hesler, L.S., R.W. Kieckhefer & M.M. Ellsbury. 2005. Abundance of coccinellids (Coleoptera) in field-crop and grass habitats in eastern South Dakota. *Great Lakes Entomol.* 38:83-96.