Soybean Entomology Research and Extension in the North Central Region

Project Director: Kelley Tilmon, Ohio State University

Co-PIs:

Tom Hunt, Justin McMechan, Robert Wright, Ana Vélez (University of Nebraska), Kevin Rice (University of Missouri), Nick Seiter, Brian Diers (University of Illinois), Glen Hartman, Doris Lago-Kutz (USDA-ARS Illinois) Erin Hodgson, Matt O'Neal (Iowa State), Brian McCornack (Kansas State), Chris DiFonzo (Michigan State), Christian Krupke (Purdue University), Shawn Conley (University of Wisconsin), Louis Hesler, Shannon Osborne (USDA ARS South Dakota), Adam Varenhorst (South Dakota State), Bruce Potter, Robert Koch, George Heimpel (University of Minnesota), Reed Johnson, Chia Lin, Andy Michel (Ohio State University), Janet Knodel (North Dakota State University), Mauricio Urrutia, David Onstad (Corteva Agriscience)

Project Objectives

Program I. Extension/Outreach and Farmer Feedback
- 1.1 Extension coordination and deliverables
- 1.2 Determining farmer needs and priorities

Program II. Insect Management and Profitability
- 2.1 Management guidelines for defoliating insects
- 2.2 Cover crops: insects in cereal rye to soybean transition systems
- 2.3 Pollinators to improve soybean yield
- 2.4 Insecticide-resistant soybean aphids
- 2.5 Soybean stem borer

Program III. Aphid Resistant Varieties and Aphid Virulence Management
- 3.1 Advancing aphid resistant soybeans through a public-private partnership
- 3.2 Soybean breeding for aphid resistance

Program IV. Insect Monitoring
- 4.1 Biological control of soybean aphid
- 4.2 Monitoring soybean aphids and other soybean insect pests in suction traps

Progress Report
(**Combined Report**: Year 2, October 2020 – March 2021 on extension; Year 3 October 2020 – March 2021)

Program I. Extension/Outreach and Farmer Feedback

1.1 Extension coordination and deliverables

Participants: Kelley Tilmon* (Ohio State University), with contributions all team members
*Project leader

During the reporting period we began work on an updated Second Edition of the popular Stink Bugs of the North Central Region field guide. Because of budget cutbacks and rebudgeting demands we will not be able to immediately supply these deliverables in hard copy, but we will create electronic versions for free online distribution. We will be design them so that they can readily be turned into print versions when resources permit. We have also nearly completed layout on an extension factsheet on pollinators found in soybean in the region. Some funds were already set aside for this publication before budget cuts and it is a less expensive item to produce so some hard copies will be available. In addition, the NC Region project teamed up with the Gall Midge project to combine resources to produce a Soybean Gall Midge Alert Card, a postcard-sized quick ID and alert communication designed for easy distribution, especially in areas where gall midge has not yet arrived. We collaborated with several state soybean boards to arrange for a distribution of distribution of 74,000 copies in 14 states, in addition to online delivery.

1.2 Determining farmer needs and priorities

Participants: Tom Hunt* (University of Nebraska), Kevin Rice* (University of Missouri) *Project leaders

This objective is focused on farmer participation and feedback to assess needs and thoughts. We contracted with a professional focus group consultant, Dr. Mary Anne Casey, to help us conduct a series of farmer focus groups. Focus group sessions were conducted with 4-5 participants representing four quadrants of the North Central Region (NE, NW, SW. SE) and a global session comprised of 5 crop consultants/advisors. Dr. Casey conducted the NCSRP focus group sessions on Feb 23, March 9, 10, 23, 25, 2021. Drs. Tom Hunt and Kevin Rice facilitated. Interview responses are being analyzed with the final report expected in early May 2021. This report will be distributed to various soybean checkoff organizations. The results of this report will help inform our future research and extension efforts and also our next proposal to the NCSRP.

Program II. Insect Management and Profitability

2.1 Management guidelines for defoliating insects

Participants: Nick Seiter* (University of Illinois), Erin Hodgson (Iowa State), Brian McCornack (Kansas State), Chris DiFonzo (Michigan State), Christian Krupke (Purdue), Kelley Tilmon (Ohio State). *Project leader

In 2020, we sampled 33 fields in 6 states using a reduced protocol (10 sample points per field) to measure the extent of defoliation. Current efforts are focused on data analysis and preliminary manuscript preparation. Efforts in 2021 will focus on developing Extension materials based on this work.

2.2 Cover crops: pest and beneficial insects in cereal rye to soybean transition systems

Participants: Justin McMechan* (University of Nebraska), Shawn Conley (University of Wisconsin), Louis Hesler and Shannon Osborne (USDA ARS South Dakota), Thomas Hunt (University of Nebraska), Bruce Potter (University of Minnesota), Kevin Rice (University of Missouri), Nick Seiter (University of Illinois); Kelley Tilmon (Ohio State University), and Robert Wright (University of Nebraska). *Project leader

Yield data analysis from 2020 found that with the exception of two sites there was no significant reductions in yield with delayed termination of a rye cover crop. In general, arthropod data from 2020 showed an increase in total arthropod activity with delayed terminations compared to early or no cover crop. The source of increase arthropod activity in pitfall traps with delayed terminations varied between sites but was primarily associated with ground beetles, spiders, or sap beetles. No significant pest pressure was associated with a rye cover crop or termination date at any of the locations in 2020. For 2021, a total of 10 sites across 6 states were planted to a rye cover last fall with planting dates ranging from late-September to mid-November. Cover crop terminations are scheduled to begin in mid- to late-April due to excessive cover crop growth at some sites

2.3 Pollinators to improve soybean yield

Participants: Reed Johnson*, Chia Lin, and Kelley Tilmon (Ohio State University) *Project leader

Honey bee pollination experiments. Two colonies were installed near the center of six soybean fields in 2020 to evaluate the effect of bee pollination on soybean yield. Significant honey buildup was observed in these colonies during soybean bloom as the honey bees collected nectar from soybean flowers. A total of 144 plants were hand-harvested from each field to evaluate seed production at different distances from pollinators. Seed counting is complete for three fields. A positive effect of pollinators was observed in one of the largest fields (120 acres), where plants near the honey bee colonies and along field edges with ambient pollinators produced more full pods and heavier seeds than plants that were far away from either of the sources. Interestingly, in the largest field (133 acres), similar effects of pollinator manipulation were observed in 2018 but not in 2020 when the experiment was repeated. In 2020, the grower planted five “wildflower habitats” in this field and broke up the homogeneity of the soybean cover. We hypothesize that the new wildflower habitats attracted additional pollinators and improved pollination in areas where soybean flowers were less likely to be visited by pollinators in the past. In 2021, we plan to install honey bee colonies along field edges, which is more practical for growers and beekeepers than installing bees in field centers. We will compare yield in soybean plants grown in different distances from honey bee colonies.

Floral attractiveness traits and cage experiments. Two bee-attractive and two less attractive varieties, identified from 2019 field surveys, were planted in the horticultural cages with or without honey bees. Cage experiments confirmed that floral attractiveness was primarily driven by floral nectar production. The varieties that produced more nectar were visited more frequently by honey bees than the varieties that produced less nectar in the same cage. Pollination by honey bees increased the percentage of full seed pods by approximately 7%. The effect size did not differ significantly between varieties. We plan to test foraging preferences of honey bees and soybean yield response to bee pollination in 4 – 8 additional varieties with cage experiments in 2021.

2.4 Insecticide-resistant soybean aphids

Participants: Robert Koch* (University of Minnesota), Ana Vélez (University of Nebraska), Janet Knodel (North Dakota State University); with contributions from other NCSRP participants including Andy Michel (Ohio State University), Erin Hodgson (Iowa State University), Adam Varenhorst (South Dakota State University), Louis Hesler (USDA ARS South Dakota), and Tom Hunt (University of Nebraska) *Project leader

Pyrethroid insecticides: Data continue to be analyzed comparing efficacy of field applications of pyrethroids to levels of mortality observed in glass-vial assays. These results will help determine out ability to predict efficacy of field sprays based on results of glass-vial assays. Experiments are underway in growth chambers and a greenhouse to assess potential fitness costs of pyrethroid resistance in soybean aphid. These experiments include several insecticide-resistant and insecticide-susceptible populations. Clonal lines of soybean aphid are being established for on-plant assessment of resistance to thiamethoxam.

2.5 Soybean stem borer (*New objective in Year 2*)

Participants: Kevin Rice* (University of Missouri), Robert Wright (University of Nebraska), Raul Villanueva (University of Kentucky) *Project leader

Six field sites were planned to conduct sunflower trap crop evaluation. Two field sites were lost due to COVID travel restrictions during 2020. Two field sites experienced low dectes infestation pressure even though they had previous high dectes numbers. Two field sites experience high dectes populations. Sunflower trap crops at these sites also experienced high infestations from stem boring weevils. We believe the weevils emerge earlier than dectes and outcompete dectes for larvae resources. We will conduct the trap cropping study at 6 field sites in 2021 and quantify weevil infestations.

Program III. Aphid Resistant Varieties and Aphid Virulence Management

3.1 Advancing aphid resistant soybeans through a public-private partnership

Participants: Matt O'Neal* (Iowa State University), Andy Michel* (Ohio State University), Mauricio Urrutia* (Corteva), David Onstad* (Corteva), Kelley Tilmon (Ohio State University), Thomas Hunt (University of Nebraska), Deirdre Prischmann (North Dakota State University), Adam Varenhorst (South Dakota State University), Louis Hesler (USDA ARS South Dakota). *Project leaders

Field testing aphid resistant soybean varieties for commercialization: Field work was conducted at five sites in the summer of 2020. Data for each location has been collected and is being summarized. Aphids were provided to objective leaders for Obj 3.1.2 (Aphid IRM) and Obj 2.4 (insecticide resistance). We have completed bioassays for aphids collected in 2020. The frequency of any virulence was low (> 2%) in any individual population. Through our screening, we have found 3 aphid colonies that appear to survive on the Rag1/2/3 triple stack. Continued bioassays with these colonies are ongoing with seed from Brian Diers

Insect resistance management for aphid-resistant soybeans: We published a study that supported the positive benefit of refuges in managing virulent aphid frequencies. This study also showed that insecticidal seed treatments had no positive impact on managing virulence. (Esquivel et al. 2021, *PMS*, doi.org/10.1002/ps.6328). An IRM model for virulence is improving with additional data. We have added data and research from South Dakota State University (A. Varenhorst).

3.2 Soybean breeding for aphid resistance

Participants: Brian Diers* (University of Illinois), Glen Hartman* and Doris Lago-Kutz (USDA-ARS) *Project leaders

Agronomic results along with the phenotypic data on aphid resistance were compared and a manuscript on the release notice for some of this germplasm was started.

Program IV. Insect Monitoring

4.1 Biological control of soybean aphid

Participants: George Heimpel*, with contributions from other project team members *Project leader

Aphelinus numbers were low, with most states reporting no mummies. In August *A. certus* were at moderate densities of 0.5 to 4.4 per plant in Minnesota, Wisconsin, and Iowa. These numbers represent limited sampling of 1 to 4 fields in June, July, and August, and *A. certus* was not found until late July. More extensive sampling in Minnesota (at least 2 fields per county from 68 counties) found *A. certus* in 34 counties across the center of the state. We have found no evidence of *Aphelinus glycinis* from 2017 to 2020. Our studies of *A. certus* overwintering have shown it is freeze-intolerant, with mortality of 50% at -17°C for 9 days, and our studies are consistent with mummies overwintering insulated in leaf litter under snow. Similar to past years, in a few sites we found a high number of tan braconid mummies, from which emerged the parasitoid *Lysiphlebus testaceipes*. In late June, when aphids were just beginning to be noticed, an aphid-infested plant on the Saint Paul, Minnesota, campus produced more than 40 tan mummies. In early July, Illinois found 19 tan mummies. Later in the season we found tan mummies in Iowa on July 28 (12 mummies) and August 24 (8 mummies), and at low levels (1 to 3 mummies) in Wisconsin July 28 and August 24 and in Minnesota August 17. For *L. testaceipes*, similar to 2020 it has been patchy, i.e. a few solitary mummies but also 12 or more mummies from 1 to 3 fields of the 72 sampled each year.

4.2 Monitoring soybean aphids and other soybean insect pests in suction traps

Participants: Glen Hartman* and Doris Lagos-Kutz (USDA-ARS/ University of Illinois) and Nick Seiter (University of Illinois), with contributions from other project team members *Project leader

All the samples received from May through October 2020 were processed (samples stored in ethanol at -20 Celsius). Aphid data was entered into excel files and the information updated at https://www.eddmaps.org, and shared with our collaborators and extension personnel through https://suctiontrapnetwork.org/data/. Preparation for the coming suction trap season 2021 started with packaging supplies to 33 locations. Supply packages will be shipped to our collaborators during the next reporting period for operation of the suction traps from May 21rst through October 22nd, 2021 (23 weeks).