# 2021 Final Report Summary Sheet

## Grantee Information

**Project Title:** Insect Management in Cover Crop Systems

**Institution:** University of Illinois Dept. of Crop Sciences

**Primary Investigator**: Nicholas Seiter

**NREC Project #** 2019-3-360691-299-UI

**Is your project on target from an IMPLEMENTATION standpoint?** ☒ Yes ☐ No

**If you answered "no" please explain:**

**Is your project on target from a BUDGET standpoint?** ☒ Yes ☐ No

**If you answered "no" please explain:**

There may be an unspent balance remaining due to pandemic travel restrictions and changes to the budgeting period from the original proposal.

**Based on what you know today, will you meet the objectives of your project on-time and on-budget?** ☒ Yes ☐ No

**If you answered "no" please explain:**

**Have you encountered any issues related to this project?** ☐ Yes ☒ No

**If you answered "yes" please explain:**

**Have you reached any conclusions related to this project that you would like to highlight?** ☒ Yes ☐ No

**If you answered "yes" please explain:**

The risk of insect damage to soybean following a cereal rye cover crop is relatively low, and is secondary to the potential for damage from slugs, voles, and deer. Farmers should scout for these and other management issues during stand establishment, but the relatively low risk of insect damage should not be a deterrent to adopting a winter rye cover crop ahead of soybean.

**Have you completed any outreach activities related this project? Or do you have any activities planned?** ☒ Yes ☐ No

**If you answered "yes" please explain and provide details for any upcoming outreach:**

We have presented results from this study at several Extension conferences and field days (including the 2020 Indiana CCA
Conference, the 2021 Illinois Virtual Crop Management Conferences, and several summer field days). We plan an extension fact sheet on cover crop insect management.

Please write a detailed summary report that includes: Details of each objective and the progress made towards its competition, planned research activities for 2022, major accomplishments, any preliminary findings or data relevant to the project, relevant budgeting, and any publications or outreach accomplished from the research. Please **include a one page summary with relevant data tables or graphs and pictures related to the project that you would like included in the NREC end of the year report.**

This was the third and final year of a 3-year project to examine the impact of cover crop systems on insect pest management in Illinois.

**Objective 1. Assess the impact of cover crop presence on pest and beneficial insect populations at established field experiments and on commercial fields in Illinois**.

We examined 9 commercial fields in 2021 that followed a cereal rye cover crop and saw no economically relevant insect or slug damage. Similarly, our sampling at the NREC-funded Douglas County tile drainage research site revealed no economically relevant insect or slug damage; this was the third time in the three years of the study that insect damage at this site had no impact on production. Because this was the third year of a three-year study, most of our efforts were spent on processing and analysis of collected samples from 2019 and 2020, rather than collection of new field data.

Over the course of three growing seasons, we sampled 74 commercial soybean fields (37 which followed a cereal rye cover crop and 37 of which did not). While insect damage to soybean was higher in cover cropped fields in 2020, this did not represent economically relevant damage. Of these fields, one cereal rye field was sprayed to control armyworms, and one cereal rye field was replanted due to a combination of slug and water damage. (Note that similar damage was observed in surrounding no-cover fields, though not to the same extent). In addition, 4 fields which were undergoing a transition to an organic system (and therefore could not be sprayed) had the edges replanted – 3 of these were rye fields which had stand reduction due to armyworm, while 1 was a control field replanted due to flooding. Overall, insects represented a minimal risk to soybean production in these fields, with true armyworm being the only pest that reduced stands. While this insect does poorly on soybean, high populations concentrated in certain areas of the field can lead to localized stand reduction.

Slugs likely represent the most troublesome invertebrate pest of soybean following a cereal rye cover crop. These mollusks respond not just to the vegetation provided by a cover crop, but the increased residue provides shelter and can favor high slug populations; therefore, residue management strategies likely affect slug damage in addition to cover crop species composition. (For instance, mats or rye cover following

roller-crimping have been reported to harbor high slug populations.) Note that slugs are considered a pest of no-till systems generally, and are by no means only associated with cover crops.

Species composition was similar between cover-cropped and non-cover cropped fields. We identified 37 different beneficial ground beetles throughout the course of the study, and 24 additional species of arthropods. Of these, 23 different species of arthropods occurred consistently enough to perform a statistical analysis comparing their populations in cereal rye fields vs no-rye controls. Most showed no difference between the two treatments; two species of ground beetles had activity densities in cereal rye fields, while two had higher activity densities in control fields.

This project was coordinated by M.Sc. student L. Brodie Dunn, who will defend his thesis in January 2022. We anticipate producing two scientific manucripts based on the result of this work, in addition to an Extension fact sheet on insect management and identification in soybean following a cereal rye cover crop.

**Table 1.** Insect and slug damage to soybean in cover (planted following cereal rye) and no-cover fields. There was no difference between the two treatments in 2019, while in 2020 there was greater damage to soybean when it followed a cover crop. Note that damage is measured in percent of plants showing insect or slug damage.

| Damage, combined | | | | | |
|---|---|---|---|---|---|
| *Year* | *Cover* | *No Cover* | *F-value* | *DF* | *p-value* |
| 2019 | 12.2(±2.3) | 15(±3.2) | 0.90 | 1, 32 | 0.350 |
| 2020 | 46.7(±6.3) | 22.3(±3.9) | 9.63 | 1, 17 | **0.007** |
| *Mean (± SE) percent of stand damaged | | | | | |

**Table 2.** Ground beetle species identified from pitfall traps

| Pitfall captured Carabidae | | | |
|---|---|---|---|
| *Scientific name* | | | |
| *Agonum* spp., Bonelli | ≥ 10 | | *** |
| *Amara* spp., Bonelli | | ≥ 10 | *** |
| *Amphasia* spp., Newman | | ≥ 10 | *** |
| *Anisodactylus* spp., Dejean | | ≥ 10 | *** |
| *Chlaenius tricolor,* Dejean | | ≥ 10 | *** |
| *Cicindelidia punctulata* (Olivier) | | ≥ 10 | *** |
| *Dicaelus elongatus,* Bonelli | | ≥ 10 | *** |
| *Harpalus pensylvanicus* (Degeer) | | ≥ 10 | *** |
| *Poecilus chalcites* (Say) | | ≥ 10 | *** |
| *Pterostichus melanarius* (Illiger) | | ≥ 10 | *** |
| *Pterostichus permundus* (Say) | | ≥ 10 | *** |
| *Poecilus lucublandus* (Say) | | ≥ 10 | ** |
| *Badister notatus,* Haldemann | | <10 | *** |
| *Chlaenius aestives*, Say | | <10 | *** |
| *Chlaenius pusillus*, Say | | <10 | *** |
| *Harpalus katiae,* Battoni | | <10 | *** |
| *Patrobus longicornis* (Say) | | <10 | *** |
| *Scarites* spp., Fabricius | | <10 | *** |
| *Bembidion coxendix,* Say | | <10 | ** |
| *Calosoma frigidum,* Kirby | | <10 | ** |
| *Chlaenius emarginatus,* Say | | <10 | ** |
| *Chlaenius tomentosus,* Say | | <10 | ** |
| *Clivinia bipustulata* (Fabricius) | | <10 | ** |
| *Cyclotrachelus nonnitens* (LeConte) | | <10 | ** |
| *Cyclotrachelus sodalis* (LeConte) | | <10 | ** |
| *Diplocheila obtusa* (LeConte) | | <10 | ** |
| *Gastrillarius honestus* (Say) | | <10 | ** |
| *Harpalus herbivagus,* Say | | <10 | ** |
| *Platynus angustatus,* Dejean | | <10 | ** |
| *Cyclotrachelus politus* (Newman) | | <10 | * |
| *Diplocheila assimilis* (LeConte) | | <10 | * |
| *Galerita bicolor,* Drury | | <10 | * |
| *Harpalus caliginosus* (Fabricius) | | <10 | * |
| *Harpalus erraticus,* Say | | <10 | * |
| *Panagaeus fasciatus,* Say | | <10 | * |
| *Pterostichus* sp., Bonelli | | <10 | * |
| *Trichotichnus autumalis* (Say) | | <10 | * |
| *Check fields only, **Cover fields only, *** present in both | | | |
| Check fields; 25 species, 9 sp. ≥ 10, Check fields: 29 species, 12 sp. ≥ 10 | | | |

**Table 3.** Additional species (not ground beetles) collected in pitfall traps

| | Pitfall capture, non-carabid, ≥ 10 | |
|---|---|---|
| *Common name* | *Scientific Name* | Trt. presence |
| Bean leaf beetle | *Cerotoma trifurcata* (Forster) (Coleoptera: Chrysomelidae) | *** |
| Billbug sp. | Spheophorus (Coleoptera: Spheophorus) | *** |
| Caterpillar sp. | Lepidoptera larvae, various spp. | *** |
| Click beetle | Elateridae (Coleoptera: Elateridae) | *** |
| Crickets | Gryllidae (Orthoptera: Gryllidae) | *** |
| Dark flower scarab | *Euphoria sepulcralis* (Coleoptera: Scarabidae | *** |
| Euschistus spp. | Euschistus spp. (Hemiptera: Pentatomidae) | *** |
| Grasshopper | Acrididae (Orthoptera: Acrididae) | *** |
| Harvestman | Opiliones | *** |
| Isopods | Isopoda | *** |
| Lady beetle larvae | Coccinellidae (Coleoptera: Coccinellidae) | *** |
| Lady beetle spp. | Coccinellidae (Coleoptera: Coccinellidae) | *** |
| Lightening bug | Lampyridae (Coleoptera: Lampyridae) | *** |
| Lycosid Morphospecies A | (Araneae: Lycosidae) | *** |
| Lycosid Morphospecies B | (Araneae: Lycosidae) | *** |
| Myriapoda | Diplopoda and Chilopoda, combined | *** |
| Pink-spotted lady beetle | *Coleomegilla maculata,* De Geer (Coleoptera: Coccinellidae) | *** |
| Red-spotted Rove Beetle | *Platydracus fossator* (Gravenhorst) (Coleoptera: Staphylinidae) | *** |
| Sap beetle | Nitidulidae (Coleoptera: Nitidulidae) | *** |
| Slug | Terrestrial Mollusca w/o shell | *** |
| Snail | Terrestrial Mollusca w/ shell | *** |
| Solider beetle | Cantharidae (Coleoptera: Cantharidae) | *** |
| Spider sp. | Araneae | *** |
| Staphalinidae spp. | Staphalinidae (Coleoptera: Staphalinidae) | *** |

*Check fields only, **Cover fields only, *** present in both (all arthropods that appeared more than ten times appeared in both treatments)

**<u>Objective 2</u>. Determine the effect of cover crop termination timing on pest and beneficial insects in corn at an established field site**

Because 2020 was the last field season for the NREC-funded study titled "Cereal Rye Ahead of Corn: N Catch and Release" that we had sampled in 2019 and 2020, these plots were not available to be sampled. However, 2021 was the first year of a planned 3-year study examining the effect of cereal rye termination timing on corn insect, weed, and disease management that we participated in. This effort is funded by USDA-NIFA, and involves similar studies in 16 different states. Initial observations from this complex dataset are still being analyzed; however, at the Illinois location, cereal rye residue provided suppression of marestail, but resulted in greater incidence of insect damage (including armyworm and stink bugs). This study will contribute toward developing insect management recommendations for corn following a rye cover crop.

During the two years that we observed insect damage in the NREC-funded corn termination trial, we did not observe economically relevant insect damage to corn. In every case, the rye was terminated well before corn planting.

**<u>Objective 3</u>. Determine the effect of cover crop termination timing on pest and beneficial insects in soybean as part of a regional (8 additional locations in 6 additional states) experiment with a common protocol.**

Overall, this protocol showed similar results across the North Central region of the U.S. to what we observed in Illinois through our work on Objective 1: economic damage due to insect feeding in soybean following a cereal rye cover crop is relatively uncommon. In fact, out of 34 total site years (3 of which were from Illinois and funded through this project), no economically relevant insect damage was reported.

During the 2021 field season, the Illinois trial (located at the University of Illinois South Farms, Urbana, IL) had little insect damage. Cereal rye termination timing had no impact on ground beetles, plant stand, insect damage, or soybean yield. This included cereal rye termination timings of 10 days before planting, 1 day after planting, and 7 days after planting. This was similar to the first two years of the study, where termination timing and the presence of cereal rye had little influence on insect damage to soybean.

**Table 4**. Impact of soybean termination timing on ground beetles, plant stand, insect damage incidence, and yield. All values are reported as the mean plus or minus the standard error.

| | Ground beetles per pitfall trap | Plant stand per 35 ft of row | Percent incidence of insect damage | Soybean yield in bushels per acre at 13% moisture |
|---|---|---|---|---|
| No rye (control) | 6.3 ± 1.9 a[a] | 236.3 ± 6.6 a | 75.4 ± 6.6 a | 57.9 ± 4.1 a |
| Rye terminated 10 days before soy planting | 3.5 ± 1.3 a | 233.0 ± 6.4 a | 88.6 ± 2.3 a | 54.8 ± 0.8 a |
| Rye terminated 1 day after soy planting | 2.8 ± 1.7 a | 234.3 ± 10.7 a | 82.9 ± 1.6 a | 59.8 ± 2.1 a |
| Rye terminated 7 days after soy planting | 3.3 ± 1.7 a | 210.3 ± 17.9 a | 80.5 ± 6.2 a | 61.5 ± 1.4 a |
| ANOVA statistics | $F$ = 1.13, df = 3, 9, $P$ = 0.389 | $F$ = 1.36, df = 3, 9, $P$ = 0.315 | $F$ = 1.38, df = 3, 9, $P$ = 0.311 | $F$ = 1.76, df = 3, 8, $P$ = 0.232 |

[a] Means followed by the same letter within a column indicate no difference based on the Fisher test of least significant difference ($\alpha$ = 0.05).

## Summary and Conclusions

Three years of research on commercial farms and on small- and large-scale field experiments show that the risk of insect damage to soybean following a rye cover crop is relatively low. We observed no economically relevant insect damage at any of the field experiments we conducted where cereal rye was planted before soybean. These results are typical for the North Central region of the U.S., where insects did no economically relevant damage to soybean across 34 site-years of a cereal rye termination-timing experiment from 2018-2021. Insect damage to commercial soybean fields was similarly rare; while overall damage to soybean was higher when a cereal rye cover crop was used in one (2020) out of two years, only 4 out of 37 cereal rye fields were either sprayed or suffered economic impacts (note that three of these were undergoing a transition to organic production and could not be sprayed). One cereal rye field was replanted due to slug and water damage during the extremely wet spring of 2019. We observed no economically relevant insect damage in the reduced number of fields we surveyed in 2021. While insect damage following rye is more likely to have an impact in corn, the early rye termination timings used in the commercial corn fields and field experiments we observed resulted in no meaningful insect damage to corn in our observations.

Our primary insect management recommendation to farmers using cover crops ahead of either corn or soybean is vigilance – scout fields during the early vegetative stages to identify stand reduction due to insects (or slugs, voles, deer, etc). If you are in no-till production, inspect fields for slugs and slug damage, particularly during a wet spring. Future work on slugs should determine the impacts of residue management on slug damage and stand loss. Additional work is needed to characterize the extent of stand loss caused by armyworms in soybean; this insect does poorly on soybean as a food source, but there have been several reports of localized threats to stand due to armyworm feeding. While additional stand reducing pests are possible following a cereal rye cover crop, they are manageable.