S1080 Alabama State Report 2022

Scott H. Graham

Associated Post-Docs:

Associated Students:

Alabama Overview:

- Key insect pest activity, observations or general findings
- Overview of major projects or any multi-state collaborations

Report summary – In 2022, the Alabama Extension Soybean Entomology Team conducted several research trials and insect monitoring efforts were made to provide recommendations and information to soybean producers and field advisors across Alabama.

(1)

Document changing soybean pest and beneficial arthropod assemblages. Soybean is injured by a diverse guild of insect pests feeding on leaves, stems, roots, nodules, and pods. The major insect pests in these guilds have markedly changed in the last two decades due to the introduction and range expansion of invasive insects and the adaptation of native pests.

Short Summary:

Alabama produced 355,000 acres of soybeans in 2022, up ≈20% from 2021, with an average of 45 bushels per acre. Insects were not a major yield limiting factor for Alabama soybean. Defoliating caterpillars and stink bugs were the primary insect pests observed in fields. However, the kudzu bug also made a comeback in 2022. An estimated 20% of soybean acres were treated for kudzu bug in 2022, up from just 6% in 2021. The redbanded stink bug was a factor on a limited number of acres, while the southern green stink bug was the dominate species infesting fields. Velvetbean caterpillar and soybean looper caused significant defoliation in fields in the south where rains limited the ability to make timely insecticide applications. In some areas of central and north Alabama, threecornered alfalfa hopper were a concern for late planted soybeans as dry weather in June provided no alternate hosts for TCAH. Other pests, like Japanese beetle, bean leaf beetle and corn earworm were observed in low numbers in some fields but not at economic levels.

Peer reviewed pubs:

Non-peer reviewed

Musser, F.R., A.L. Catchot, Jr, J.A. Davis, C. DiFonzo, **S.H. Graham**, J.K. Greene, B. Jenson, D.L. Kerns, R.L. Koch, D. Owens, D.D. Reisig, P. Roberts, T.A. Royer, N.J. Seiter, S.D. Stewart, S.V. Taylor, B.C. Thrash, K.J. Tilmon, R.T. Villanueva, and M.O. Way. 2022. 2021 Soybean Insect Losses in the United States. Midsouth Entomologist. 15.

Professional presentations:

n/a

Extension presentations:

See section 4

Impact statements:

The yearly documentation of insect pest infestations and losses allows for historical references to observe trends over time and understand how complexes change over time.

(2)

Characterize soybean insect biology and ecology The range expansion of invasive pests, coupled with the adaptation of native pests, necessitate further research into how insects cope with new selection pressures

Short Summary:

A soybean looper and bollworm pheromone trapping program was on Alabama Agricultural Experiment Stations and grower fields in north (Limestone Co.), central (Autauga, Elmore Co.) and south (Monroe, Baldwin, Escambia, Henry Co.) Alabama. Trap counts were low overall. The peak soybean looper flight was near the historical average (mid-August).

Peer reviewed pubs:

n/a

Professional presentations:

n/a

Extension presentations:

See section 4

Impact statements:

Monitoring moth activity provides historical references for pest movement, which can be altered by weather or other events. Understanding when and how these pests move across Alabama provides insights on future management strategies. This monitoring program also allows for in-season alerts for famers and field advisors for when to intensify scouting efforts for these pests.

(3)

Develop coordinated best management practices (BMPs). As soybean insect pest assemblages change, there is a need to update pest management strategies.

Short Summary:

A study was done in North Alabama (Belle Mina) to evaluate the impacts of cover crops on early season pest pressure and the impacts of insecticide seed treatment on yield. A cover crop blend of cereal rye and crimson clover was used in this study with 3 burndown timings. Crover crops were burned down early (4 weeks preplant), late (2 weeks preplant) and at-plant. Within each burndown timing soybean seed were either treated with an insecticide seed treatment

(imidacloprid, Gaucho) or fungicide only. There were main effects of burndown timing and IST on stand where both at-plant burndown and fungicide only treated seed resulted in sigificiantly lower plant populations than early or late burndown or seed treated with an IST. For yield, only IST was significant, where the use of an IST resulted in a 3.5 bushel increase.

Another study was done to evaluate the stink bug control of "caterpillar" materials (e.g., Elevest, Besiege, etc). This study was done in central Alabama in Prattville. Trials were done in maturity group 6.9 and 3.5 varietes. No differences in stink bug counts were observed for either variety at 5 or 14 days after application. However, significant control of kudzu bugs was observed in the MG 3.5 soybeans. All tested products/tank-mixtures significantly reduced kudzu bug populations but Diamond. These results suggest that full rates of the pyrethroid components of "caterpillar" premix insecticides should be used if threshold populations of stink bugs are in the field when caterpillar applications are needed.

Other insecticide efficacy trials were done for soybean looper and velvetbean caterpillar.

Peer reviewed pubs:

n/a

Professional presentations:

n/a

Extension presentations:

See section 4

Impact statements:

Results from these studies drive insecticide recommendations for Alabama soybean producers.

(4)

Educate farmers, industry, colleagues, general public, and agricultural professionals using traditional tools and innovative methods. Our Working Group works extensively with stakeholders at all levels. For our clientele, we represent one of the only unbiased sources of information for decision-making of IPM strategies.

Short Summary:

In 2022, the AL Extension Soybean Entomology gave several updates and recommendations to soybean producers and field advisors across Alabama. Updates were made via county production meetings, field days, blog posts, etc.

Peer reviewed pubs:

n/a

Professional presentations:

n/a

Extension presentations:

Kesheimer, K.A. and **S.H. Graham**. 2022. Insect Management in Corn and Soybean. Panhandle Corn and Soybean Update Meeting. Chipley, FL.

Graham, S.H. 2022. Insect Management Considerations for 2022. Elmore/Macon Co. Cotton and Grain Production Meeting. Shorter, AL.

Graham, S.H. 2022. Management of Insects in Cover Cropping Systems. 2022. Wiregrass Cover Crop Field Day. Headland, AL.

Graham, S.H. 2022. Insect Management Considerations for 2022. Autauga Co. Cotton and Grain Production Meeting. Autaugaville, AL.

Graham, **S.H.** 2022. Insect Management Considerations for 2022. Tuscaloosa County Cotton and Grain Production Meeting. Tuscaloosa, AL.

Graham, **S.H.** 2022. Insect Management Considerations for 2022. Black Belt Cotton and Grain Production Meeting. Marion Junction, AL.

- 2 Soybean Scout Schools (49 attendees)
- 10 contributions to newsletters
- 6 blog posts
- 6 Pest Patrol Hotline Updates

Impact statements:

Extension updates, scouting schools and personal contacts help to improve IPM adoption for Alabama soybeans and increase the profitability of the industry statewide.

S1080: Improving Soybean Arthropod Pest Management in the U.S.

2023 Delaware Annual Report

David Owens and Michael Crossley

Personnel: Michael Crossley, Thabu Mugala (Ph.D. student), David Owens, Morgan Malone

Season Overview

Slugs and seedcorn maggot were major pests in the spring of 2022, and caused several fields to be replanted. Weather at the end of April to mid-May was unusually foggy and cloudy, wet, and cool. Bait applications were greater in 2022 than in 2021 with reports of aerial application.

Unusually high green stink bug activity was noted in the blacklight trap network (primarily used to monitor corn earworm (https://www.udel.edu/academics/colleges/canr/cooperative-extension/sustainable-production/pest-management/insect-trapping/), and many reports came in of threshold level stink bug populations in full season bean fields prior to R3. Fungicide + insecticide tank mixtures were applied to many fields.

Late-season pest pressure was dominated by corn earworm in August in double crop soybean fields throughout Sussex County DE (lower third of the state). Activity was extremely high, with field counts up to 5x over threshold and some reports of fields being retreated due to inadequate pyrethroid efficacy. Dectes damage was noted by one farmer.

Slugs were collected from 15 sites across the Delmarva Peninsula as part of Thabu Mugala's research project examining natural enemies.

A prophylactic insecticide+herbicide application trial was placed on 3 cooperating farms; no significant differences were noted in yield responses. The addition of insecticide did reduce stink bug activity at one farm where the herbicide application was delayed until R2, the insecticide did not prevent stink bugs from exceeding economic thresholds at a second site, and at the third site, corn earworm was above threshold late in the season in all treated and insecticide-free plots. Some minor decreases in defoliator activity were noted, but nothing that would support a vegetative stage prophylactic insecticide application.

Publications

Musser, F.R., A.L. Catchot, Jr, J.A. Davis, C. DiFonzo, S.H. Graham, J.K. Greene, B. Jenson, D.L. Kerns, R.L. Koch, D. Owens, D.D. Reisig, P. Roberts, T.A. Royer, N.J. Seiter, S.D. Stewart, S.V. Taylor, B.C. Thrash, K.J. Tilmon, R.T. Villanueva, and M.O. Way. 2022. 2021 Soybean Insect Losses in the United States. Midsouth Entomologist. 15.

Owens, D. and J. Deidesheimer. 2022. Efficacy of selected insecticides against grasshoppers in soybean, 2020. A. M. T. 47: tsac064.

Owens, D., J. Deidesheimer, C. N. Stubbs, and S. Cotten. 2022. Efficacy of selected insecticides and miticides against twospotted spider mites in soybean, 2020. A. M. T. 47:tsac020

Owens, D., J. Deidesheimer, and N. Bounds. 2022. Efficacy of selected insecticides against soybean looper in soybean, 2020. A. M. T. 47: tsac006.

Extension

Circulars

Weekly Crop Update sent weekly on Fridays to more than 1,000 unique email addresses; 22 editions in-season. https://sites.udel.edu/weeklycropupdate/.

Fact Sheets

Praise-God Igwe, Maria Cramer, David Owens, Galen Dively, and Kelly Hamby. 2022. "Managing Slugs in Field Crops Using IPM Principles" University of Maryland Extension publication FS-2022-0629 https://extension.umd.edu/resource/managing-slugs-field-crops-using-ipm-principles-fs-2022-0629.

Presentations

Owens, D. 2022. "Insect Pest Reflections." Mid-Atlantic Crop Management School November 15-17, Ocean City, MD.

Owens, D., D. Wilkerson, and J. Deidesheimer. 2022. "Hindsight 2021 for Soybean Pests." Delaware AgWeek (Virtual).

Owens, D. and S. V. Taylor. 2022. "Combating slugs as pests of soybeans and corn" Northeast IPM Center IPM Toolbox Webinar series.

Impacts

11 site visits covering slugs, seedcorn maggot, corn earworm, aphids, stink bugs, Dectes stem borer, and isopods. 3 farms with strip trials placed evaluating prophylactic insecticide herbicide tank mixtures. 9 fields scouted continuously in the spring for slugs. 3 pesticide efficacy trials placed on cooperator farms targeting slugs and corn earworm.

Funding for project activities was made possible in part by Sussex County Council, Delaware Soybean Board, USDA-NIFA CPPM-EIP program, and Maryland Grain Producers Utilization Board.

University of Florida

Annual Report of 2022 Activities for January 2023 Annual Meeting

Major goals of the project

1) Document and characterize the spatial and temporal occurrence and population dynamics of arthropod pests in several field crops in the agricultural landscape of the Florida Panhandle. The long-term contribution will be to improve pest management decision-making and efficiency in the agriculture of the region.

What was accomplished in the period?

1. In 2020, the first case of resistance of *Spodoptera exigua* to chlorantraniliprole in the U.S. was reported by the Entomology Program at West Florida Research and Education Center, University of Florida. Further studies were performed and the fitness and stability of resistance of this species were documented (Rabelo et al., 2022). Studies were also performed with the pyrethroid bifenthrin. The results indicated that resistance to chlorantraniliprole was not stable through the generations kept in the laboratory without selection pressure, likely due to fitness cost. On the other hand, to bifenthrin was stable with no shift in fitness. The knowledge of the stability of resistance is a crucial aspect when recommending rotation of insecticides with different mode of action.

2. Collaborative work with Southern Insect Management Research Unit, USDA Agricultural Research Service, Stoneville, MS, United States and Syngenta performed a year-round pheromone trapping, from 2018 to 2021. The accomplishments of the study were to document the occurrence and seasonal flight of *H. armigera* in the host plants corn, soybean, and sunflower in the southern region, determine the possible occurrence of hybrids between *H. armigera* and *H. zea* caught in the pheromone trapping, and evaluate the performance of insecticides commonly adopted to manage this genus in high-input systems of seed production. This study also provided data on the magnitude of occurrence and seasonal phenology of flight on the island, and the performance of insecticides currently adopted for the management of *Helicoverpa* spp. The results of this work also contributed with validated information for mitigation plans, in a scenario of *H. armigera* invasion in the continental U.S.

3. The snail *Bulimulus bonariensis* in row crops have increased the population in recent years in the Florida Panhandle, including in soybean. Even though this species does not cause injury from feeding on the crops, especially during the seedling stage. Several laboratory and field studies have been performed, including the overwintering survival, dispersal capacity, and IPM tactics, such as validation of sampling and trapping techniques, pesticide performance, and impact of cultural practices in the survival of the species.

Products:

Flores-Rivera, X. L., **Paula-Moraes, S.V.**, Johnson, J.W., Perera, O.P. 2022. *Helicoverpa* genus on the edge of the continental U.S.: Flight phenology, analysis of hybrid presence, and insecticide performance in high-input field crops in Puerto Rico. *Front. Insect Sci.* https://doi.org/10.3389/finsc.2022.1010310

Rabelo, M.M., Santos, I.B., **Paula-Moraes, S.V**. 2022. *Spodoptera exigua* (Hübner) (Lepidoptera: Noctuidae) fitness and resistance stability to diamide and pyrethroid insecticides in the United States. *Insects*, 13: 365. https://doi.org/10.3390/insects13040365

Rabelo, M.M., Dimase, M., **Paula-Moraes, S.V. 2022**. Ecology and management of the invasive land snail *Bulimulus bonariensis* (Stylommatophora: Bulimulidae) in row crops. *Front. Insect Sci.* https://doi.org/10.3389/finsc.2022.1056545

S1080 Illinois State Report 2022

Nick Seiter, University of Illinois Dept. of Crop Sciences | nseiter@illinois.edu

Joe Spencer, Illinois Natural History Survey | spencer1@illinois.edu

Associated Post-Docs: none during report period

Associated Students: Graduate student Sagnika Das joined Joe Spencer's lab (co-advised by Nick Seiter) as a Ph.D. graduate student in the Department of Crop Sciences at the University of Illinois in August 2021. Sagnika began her first season of fieldwork in 2022. Sagnika is working on the Corteva Future CRW Management Program project, examing innovative ways to manage western and northern corn rootworm injury in corn. Because some Midwest WCR adults lay eggs in soybean fields, Sagnika's project looks at rotated corn and much of her monitoring activity occurs in rotated soybean fields. Sagnika received her B.S. and M.S. degrees in India. On her Master's degree (at The Institute of Agricultural Sciences, Banaras Hindu University, Varanasi) she worked to evaluate the efficacy of trap designs for fruit flies. She brings valuable experience in insect rearing, microscopy, spectrometry and integrated pest management. During 2022, Sagnika was involved with extensive on-farm WCR monitoring as part of the Corteva project. She also investigated the effect of sticky trap orientation on beetle catch (a report of that work in University of Illinois soybean fields is included here.

Illinois Overview:

- Overall pest pressure in soybean in 2022 was low in IL.
- Favorable planting conditions resulted in relatively few instances of seedling pests
- Sporadic infestations of spider mites occurred in areas under high drought stress, but these were generally short-lived and not widespread.
- Stink bug infestations were slightly elevated compared with the previous year
- Soybean aphid remains virtually nonexistent throughout most of the state
- Abundance of rotation-resistant western corn rootworm beetles in IL soybean remains low.

Report summary – Please emphasize collaborations with other states/members of the group when possible and relevant. Add a short summary to this section as related to the below objectives.

(1)

Document changing soybean pest and beneficial arthropod assemblages. Soybean is injured by a diverse guild of insect pests feeding on leaves, stems, roots, nodules, and pods. The major insect pests in these guilds have markedly changed in the last two decades due to the introduction and range expansion of invasive insects and the adaptation of native pests.

Short Summaries:

A. Surveys for dectes stem borer and soybean gall midge were conducted in Illinois through funding from the Illinois Soybean Association and North Central Soybean Research Program.

The soybean gall midge survey was a multi-state effort coordinated by Justin McMechan at UNL. Soybean gall midge was not found in Illinois; dectes stem borer is most abundant in areas of southern Illinois where no-till production is most prevalent. The aphid Suction Trap Network funded by NCSRP is a multi-state collaboration headquartered in Illinois that provides information on the abundance of pest aphids throughout the North Central region and elsewhere in the eastern U.S.

B. The abundance of rotation-resistant WCR adults in Champaign County, IL soybean fields remains low as it has been since 2015. Generally low abuandance is consistent with data collected from statewide surveys. The WCR threat to rotated corn is low, though higher populations may be present in the Northern portion of the state.

Peer reviewed pubs:

Musser, F. R., A. L. Catchot, Jr., J. A. Davis, C. DiFonzo, S. H. Graham, J. K. Greene, B. Jensen, D. L. Kerns, R. L. Koch, D. Owens, D. D. Reisig, P. M. Roberts, T. A. Royer, N. J. Seiter, S. D. Stewart, S. V. Taylor, B. C. Thrash, K. J. Tilmon, and R. T. Villanueva. 2022. 2021 Soybean insect losses in the United States. Midsouth Entomologist 15: 39-63.

Professional presentations:

Extension presentations:

Impact statements:

(2)

Characterize soybean insect biology and ecology The range expansion of invasive pests, coupled with the adaptation of native pests, necessitate further research into how insects cope with new selection pressures

Short Summary:

1. Western corn rootworm (WCR) adult monitoring in soybean fields is necessary to make informed, IPM-based decisions about management tactics that will be appropriate in subsequent rotated corn. In practice, few growers monitor their fields. As part of a larger project to assess innovative management techniques, the potential to use unmanned aerival vehicles (UAVs or drones) to visit and photograph WCR on Pherocon AM sticky traps is under evaluation. To accommodate close UAV access to sticky traps, the traps were mounted at angle. The effect of non-vertical trap mounting on WCR captures was evaluated by comparing WCR abundance on standard vertically-oriented (0°) sticky traps to traps mounted at 45°, 67° and 90° (horizontal). WCR abundance on Pherocon AM sticky traps declined as trap angle deviation from vertical increased. However, the relationship between WCR abundance on angled traps was well-correlated with vertical sticky trap abundance (adjusted r^2 was 0.74 for traps at 45° angles) which may allow angled trap data to be interpreted like vertical trap data.

Peer reviewed pubs:

Editor Reviewed:

1. Spencer, J.L., and S.A. Hughson. 2023. Resistance to crop rotation. Chapter 6 (pages 191-244) in Insect Resistance Management: Biology, Economics and Prediction, 3rd Ed., D.W. Onstad, and L.M. Knolhoff (eds.) Academic Press. Oxford, UK. 556 p.

Professional presentations:

Extension presentations:

Impact statements:

(3)

Develop coordinated best management practices (BMPs). As soybean insect pest assemblages change, there is a need to update pest management strategies.

Short Summary:

We participated in a multi-state project evaluating pheromone traps as a sampling tool for stink bugs in soybean.

Peer reviewed pubs:

Black, J. L., G. M. Lorenz, A. J. Cato, N. R. Bateman, and N. J. Seiter. 2022. Efficacy of Helicoverpa armigera nucleopolyhedrovirus on soybean for control of *Helicoverpa zea* (Boddie) (Lepidoptera: Noctuidae) in Arkansas agriculture. Insects 13(1), 91. https://doi.org/10.3390/insects13010091

Ribeiro, A. V., Aita, R. C., D. T. Pezzini, C. D. Difonzo, T. E. Hunt, J. J. Knodel, C. H. Krupke, L. Marchi-Werle, A. P. Michel, N. J. Seiter, R. J. Wright, W. D. Hutchison, and R. L. Koch. 2022. Optimization of sample unit size for sampling stink bugs (Hemiptera: Pentatomidae) in soybean. Crop Protection 157: 105986. https://doi.org/10.1016/j.cropro.2022.105986

Professional presentations:

Extension presentations:

Impact statements:

(4)

Educate farmers, industry, colleagues, general public, and agricultural professionals using traditional tools and innovative methods. Our Working Group works extensively with stakeholders at all levels. For our clientele, we represent one of the only unbiased sources of information for decision-making of IPM strategies.

Short Summary:

We continue to deliver digital and in-person Extension content to our farmer and crop-advisor stakeholders to meet their evolving informational needs. In 2022, we presented 3 webinars and 12 in-person Extension talks related to soybean insect management to an audience of 1,225. An annual report of applied research, including routine evaluations of soybean insecticides for pest control, was published by Illinois Extension to provide our clientele with up-to-date information on control performance and insect pest distributions in Illinois.

Peer reviewed pubs:

Professional presentations:

Extension presentations:

Seiter, N. (Presenter). Insect update. January 13, 2022. Posey County Ag Day. Audience: Farmers, Crop Advisors. Impact: discussed management recommendations for fall armyworm, dectes stem borer, and in cereal rye cover crops. Contact: Hans Schmitz. Attendance: 85. State focus area: Food and Environment.

Seiter, N. (Presenter). Insect management in corn and soybean. January 19, 2022. Illinois Extension Crop Management Conference. Audience: Farmers, Crop Advisors. Impact: discussed management recommendations for fall armyworm, dectes stem borer, and in cereal rye cover crops. Contact: Talon Becker. Attendance: 15. State focus area: Food and Environment.

Seiter, N. (Presenter). Insect defoliation and insecticide use in Illinois. February 1, 2022. Illinois Soybean Association Soybean Summit. Audience: Farmers, Crop Advisors. Impact: discussed frequency of defoliating insect pests and residual activity of insecticides. Contact: Jill Parrent. Attendance: 25. State focus area: Food and Environment.

Seiter, N. (Presenter). Insect management in corn and soybean. February 8, 2022. Illinois Extension Crop Management Conference. Audience: Farmers, Crop Advisors. Impact: discussed management recommendations for corn rootworm, soybean insecticides, and fall armyworm. Contact: Dennis Bowman. Attendance: 90. State focus area: Food and Environment.

Seiter, N. (Presenter). Insect management in corn and soybean. February 15, 2022. Illinois Extension Crop Management Conference. Audience: Farmers, Crop Advisors. Impact: discussed management recommendations for corn rootworm . Contact: Phillip Alberti. Attendance: 40. State focus area: Food and Environment.

Seiter, N. (Panelist). The research and experience behind the updated cover crop guide - panel discussion. February 16, 2022. Illinois NREC Investment Insight Live. Audience: Farmers, Crop Advisors. Impact: discussed best management practices for cover crop systems. Contact: Julie Armstrong. Attendance: 130. State focus area: Food and Environment.

Seiter, N. (Presenter). Insects and cover crops. March 14, 2022. March Bi-state Advanced Soil Health Training. Audience: Farmers, Crop Advisors. Impact: discussed best management practices for insect management in cover crop systems. Contact: Chelsea Harbach. Attendance: 30. State focus area: Food and Environment.

Seiter, N. (Presenter). Managing insect pests in crops. June 10, 2022. Dekalb County Summer Ag Institute. Audience: K-12 Teachers. Impact: provided an overview of agricultural pest management for K-12 science teachers. Contact: Rhodora Collins. Attendance: 12. State focus area: Food and Environment.

Seiter, N. (Presenter). Insect management update - above-ground Bt traits and soybean insecticides. July 20, 2022. Orr Agronomy Field Day. Audience: Farmers, Crop Advisors. Impact: discussed status of above ground traits and how to make insecticide decisions in soybean. Contact: Luke Merritt. Attendance: 30. State focus area: Food and Environment.

Seiter, N. (Presenter). Above-ground Bt traits and scouting for soybean insects. July 28, 2022. Ewing Field Day. Audience: Farmers, Crop Advisors. Impact: discussed resistance management in above-ground Bt traits and scouting techniques for soybean insects. Contact: Talon Becker. Attendance: 80. State focus area: Food and Environment.

Seiter, N. (Presenter). New Soybean Defoliation Thresholds. December 14, 2022. Indiana Certified Crop Advisor Conference. Audience: Crop Advisors. Impact: discussed new economic thresholds for soybean defoliators. Contact: John Obermeyer. Attendance: 111. State focus area: Food and Environment.

Seiter, N. (Presenter). Rootworms and defoliating insects in soybeans. December 15, 2022. Illinois Certified Crop Advisor Conference. Audience: Crop Advisors. Impact: discussed new rootworm trait packages and economic thresholds for soybean defoliators. Contact: Lisa Martin. Attendance: 200. State focus area: Food and Environment.

Impact statements:

Research Reports

Objective 1: Document changing soybean pest and beneficial arthropod assemblages. Soybean is injured by a diverse guild of insect pests feeding on leaves, stems, roots, nodules, and pods. The major insect pests in these guilds have markedly changed in the last two decades due to the introduction and range expansion of invasive insects and the adaptation of native pests.

Western corn rootworm abundance in rotated soybean fields in Champaign County, IL.

Joseph L. Spencer[2] and Sagnika Das[1]

[1]Department of Crop Sciences; sagnika2@illinois.edu
[2]Illinois Natural History Survey; spencer1@illinois.edu
University of Illinois, Urbana-Champaign

Overall crop rotation-resistant western corn rootworm beetle (WCR) abundance per sweep in 2022 soybean fields (0.013 ± 0.002 WCR/sweep ± SEM) was numerically highest in August (0.016 ± 0.003 WCR/sweep ± SEM); however this was not significantly greater than their abundance in July (0.009 ± 0.003 WCR/sweep ± SEM, $F(1,34)=2.151$, $P=0.1517$) but was lower than that the overall mean from 2021 (0.041 ± 0.005 WCR/sweep ± SEM). A total of just 47 WCR beetles were collected in 5,400 sweeps. This remains far below Champaign Co. collection rates from 2005-2006 (0.73 beetles per sweep) and the >1.5 WCR per sweep in 2004, but is consistent with modest populations that have been the rule since 2015. Despite conditions that were generally favorable for WCR larval survival in nearby cornfields, this pest is still at very low abundance compared to historical trends. Notably, sweep data pooled across distant counties (Warren, Woodford, and DeKalb) had a very similar mean abundance: 0.011 ± 0.004 WCR/sweep (± SEM). Those data are consistent with generally low numbers of WCR adults in soybean fields. We monitor WCR in soybean because WCR egg laying in there can lead to unexpected damage in rotated corn. The threat from rotation-resistant WCR remains low in East-central Illinois (data from the distant counties suggest that this is likely true across much of Illinois). These data are consistent with county level samples for WCR in soybean from E. Illinois that were collected for a statewide sampling program that systematically samples WCR and other pests in soybean fields. WCR populations do not present an economic threat in local rotated cornfield. Higher, borderline damaging populations may be present in N. Illinois based on statewide surveys. Other potentially damaging pests like bean leaf beetle (BLB) and Japanese beetle (JB) were also in relatively low abundance (0.042 ± 0.008 BLB/sweep and 0.053 ± 0.009 JB/sweep, respectively) in Champaign County, as they were in 2021 (0.247 ± 0.102 BLB/sweep and 0.031 ± 0.005 JB/sweep, respectively). The fact that many of these pests had low abundance suggests that some more general factors may be acting broadly on local field crops.

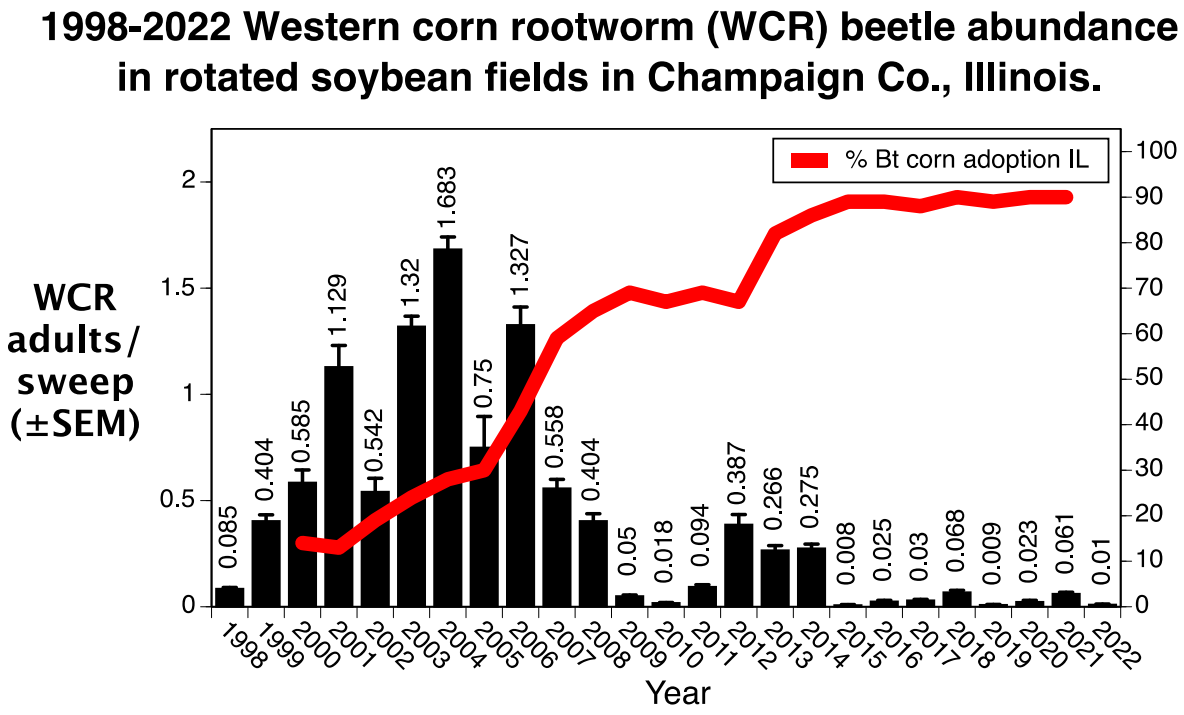

Figure_. Western corn rootworm (*Diabrotica virgifera virgifera* LeConte, WCR) abundance (WCR adults/sweep ± SEM) in soybean fields from Champaign County, IL. The red line depicts mean percentage adoption of insecticidal Bt corn hybrids in Illinos. Bars present data for the month with peak WCR abundance (typically August). Primary sample location was moved from UI Shaw Farm to UI South Farm and ABE Farm in 2021.

Objective 2. Characterize soybean insect biology and ecology The range expansion of invasive pests, coupled with the adaptation of native pests, necessitate further research into how insects cope with new selection pressures

[This project supports work on the existing project "On-farm assessment of innovative approaches to corn rootworm management and monitoring", funded by Corteva Future CRW Management Program, J.L. Spencer, N.J. Seiter, and C.H. Krupke]

Sticky Trap Orientation Affects Western Corn Rootworm Capture

Sagnika Das[1] and J.L. Spencer[2]

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[2]Illinois Natural History Survey; spencer1@illinois.edu
University of Illinois, Urbana-Champaign

Objective: Determine the effect of sticky trap angle on western corn rootworm (WCR) capture in soybean fields.

Locations: All study plots were located on University of Illinois farmland: 1. Agricultural and Biological Engineering (ABE) Farm, Urbana, IL (40.070777, -88.209591), 2. Cruze Farm, Champaign, IL (40.081331, -88.242600), and 3. Main Farm, Champaign, IL (40.087117, -88.230537)

Introduction: Currently, Bt corn hybrids are the primary tactic adopted to manage western corn rootworm (*Diabrotica virgifera virgifera* LeConte) (WCR) populations across the U.S. Corn Belt. In the eastern Corn Belt, where most corn is grown in rotation with soybeans, effective WCR beetle monitoring techniques are needed because numbers of egg-laying beetles in soybean fields are related to the risk of larval injury in first-year corn. Monitoring beetle abundance using a set of Pherocon® AM sticky traps yields data important for making pest management decisions which can reduce the unnecessary application of insecticides or use of Bt hybrids. As part of a project to evaluate innovative tools to improve the adoption of integrated pest management-based monitoring, we are testing the use of an unmanned aerial vehicle (a UAV or drone) to remotely visit and photograph WCR beetles captured on Pherocon® AM sticky traps. Challenges associated with walking far out into soybean fields to check a number of sticky traps are often cited as a reason why monitoring WCR abundance is unpopular. If a UAV could be used to visit all the sticky traps in a field and return with high resolution photographs of each trap, it may be possible to identify and count captured WCR on the traps without walking repeatedly through the fields. Eliminating the need to repeatedly walk into the fields could make sticky trap monitoring more palatable to growers and/or their crop consultants.

In a preliminary study, we were able to identify and count beetles from UAV-acquired images of sticky traps in the field; however, standard vertically oriented sticky traps are difficult to approach with a UAV because their faces are often at canopy level. Approaching the canopy too closely increases the risk of entangling and crashing the UAV. Traps oriented at an angle could be approached from above with less crash-risk and photographed more easily, but a tilted trap orientation may affect capture efficacy. In this study, we tested the effect of trap orientation

angle (i.e., vertical - 0˚, 45˚, 67˚, & horizontal - 90˚) on the numbers of beetles captured per trap. We will report on the relationship between trap angle and beetle capture and also consider whether beetle counts from top sides of angled traps (i.e. the only side a UVA could photograph from above) are representative of the total beetle captures from both sides of nearby vertically-oriented traps. If UAV-based observations take less time and provide data that are as predictable as those data obtained from personal visits to "standard" vertical traps, their use may increase adoption of IPM-based WCR monitoring.

Materials & Methods: Field experiments were established at three University of Illinois, Urbana-Champaign soybean field locations (0.76 m row spacing). Angled trap treatments were distributed in groups (blocks) of four angled traps using a randomized complete block design with a total of 34 replicates distributed across the three locations. Pherocon® AM Unbaited Yellow Sticky Traps (Great Lakes IPM, Vestaburg, MI 48891) were mounted at four different angles (0˚, 45˚, 67˚, & 90˚) on 2.54 cm dia. 1.5 m tall PVC poles spaced *ca*. 11.5 m apart and installed in the soybean row. (Figure 1). A vertically oriented, 0˚ angle, sticky trap is the conventional orientation for traps used to monitor WCR beetles in soybean fields. At the other extreme, a 90˚ trap angle was oriented horizontally. Traps were attached to PVC poles using mounts constructed from PVC couplers, garden stakes, wire locks, binder clips, & twist ties. Before traps were placed in the field, the intended top side of each was marked with a "T" in the lower right corner; the unmarked side was the bottom (Figure 2). To distinguish between the sides of vertical traps, one side was designated as the top and marked with a "T" like the other angle treatments. At the time of trap visitation, WCR beetle counts from the top and bottom sides of each trap were recorded separately on datasheets while in the field. Trap arrays were sampled for up to 6 weeks (July-August 2022). The length of the sampling interval sometimes varied among the sites due to weather limitations, thus for analyses, WCR counts were converted to WCR/trap/day during the trapping period at each site. Beetle capture data were non-normal and were analyzed using non-parametric methods. WCR/trap/day data for each angle treatment were analyzed within a sample location using the non-parametric Kruskal-Wallis test; if significant, the non-parametric Steel-Dwass method ($q=2.569$, $\alpha = 0.05$) was used to perform multiple comparisons among trap angles. The predictive value of the relationship between WCR/trap top/day (for all four trap angle treatments) vs total (i.e., top + bottom side) WCR/trap/day for the conventional vertically oriented (0˚) traps was investigated using linear regression. All data analyses were performed using JMP Pro software 16.2.0 (2021 SAS Institute).

Results: Total (combined top and bottom counts) WCR captures were significantly greater on the conventional 0˚ (vertical) sticky trap than on the other angled trap treatments. At the two locations (M2N and ABE Farms) where WCR were abundant, captures on sticky traps significantly decreased as the trap angle deviated from vertical (Figure 3). WCR abundance at the Cruze Farm was low; there were no treatment-based differences in WCR captures at that location.

WCR trapped on the bottom sides of angled traps cannot be photographed with a UAV. For UAV monitoring to be informative, WCR counts from the top sides of angled traps (WCR/trap top/day) should be representative of the total WCR/trap/day on conventional, vertically oriented

(0˚) sticky traps. We explored that relationship by regressing WCR/trap top/day for all angled trap treatments (including WCR/trap top/day for the "T" sides of the vertical traps) onto total WCR/trap/day for the associated vertical trap in each treatment block. The relationship between WCR/trap top/day collected on the "T" side of angled traps was predictive of the total WCR/trap/day on an entire vertical trap. For vertical traps, the collection rate of WCR on the designated top sides (i.e., WCR/trap top/day collected on the "T" side) was highly predictive of the total WCR/trap/day on the entire vertical trap ($Y=0.0027+2.00*X$; $R^2=0.97$). When WCR/trap top/day for the 45˚, 67˚, & 90˚ angled traps was regressed against the total WCR/trap/day on vertical traps, the best fit was obtained with 45˚ traps ($Y=0.1014+4.13*X$; $R^2=0.74$), with progressively poorer fits for traps mounted at 67˚ ($Y=0.1448+5.30*X$; $R^2=0.63$) and 90˚ ($0.2089+7.41*X$; $R^2= 0.60$) (Figure 4). While significant linear relationships were present for each regression, the predictive value of the regression for the 45˚ trap tops vs. total WCR on vertical traps suggest that using sticky traps mounted on 45˚ degree mounts will yield results that are most predictive of results expected from standard vertically oriented (0˚) traps

The ability to use angled sticky traps for monitoring will enable a UAV to approach & photograph a trap with less risk of crashing into the soybean foliage. Use of this innovative approach may facilitate greater adoption of sticky trap monitoring leading to more judicious use of management tactics (including new Bt corn hybrids) and prolong future product utility while reducing grower input costs and unnecessary use of pesticides. In addition to evaluating the effect of trap angle on WCR captures, we will also explore computer image analysis and visualization methods to enable automated and accurate counting of WCR in photographs taken with our UAV's 12 MP camera.

We do not expect that many growers would choose to individually adopt UAV-assisted pest monitoring on their farms. However, as crop consultants and advisors increasingly rely on UAVs for other types of on-farm monitoring and management tasks, UAV-assisted pest monitoring may be a service they could provide to clients. UAVs are increasingly used on and off the farm; we believe exploring new opportunities for their application in fields crops research will yield innovative solutions to many current challenges.This study will be repeated in 2023.

Summary: We conclude that mounting sticky traps at angles that deviate from the conventional (0˚) vertical orientation significantly decreased WCR beetle captures. However, WCR collection data from the top sides of angled sticky traps is strongly predictive of total WCR/trap/day on conventional, vertically-oriented sticky traps.

Funding: A "Futuristic Methods to Sustain Management of Corn Rootworm Populations" grant from Corteva Agriscience™ (Indianapolis, IN) funds Sagnika Das' graduate research; additional project support was provided by a USDA HATCH Award to J.L. Spencer [ILLU-875-969].

Acknowledgments: We thank Tim Lecher (Agricultural and Biological Engineering Farm, Urbana, IL) for assistance with planting, plot maintenance, and harvest. We also thank undergraduate student assistants, Jacob Burns and Madisen LeShoure, for assisting with plot maintenance and data collection.

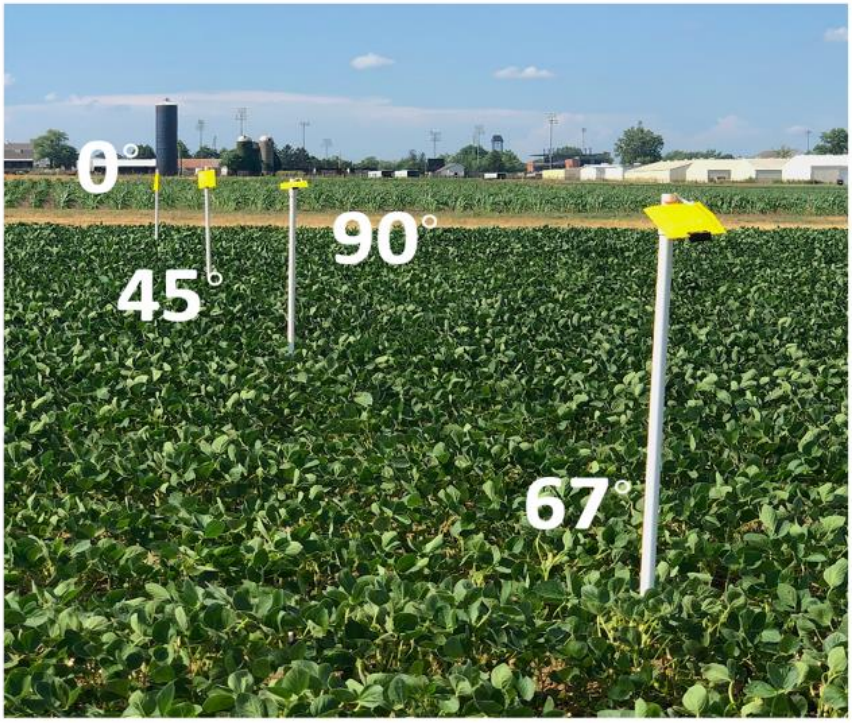

Figure 1. Angled traps array in the Main Farm soybean field. Pherocon® AM Unbaited yellow sticky traps are mounted on 2.54 cm dia. 1.5 m PVC poles at four different angles.

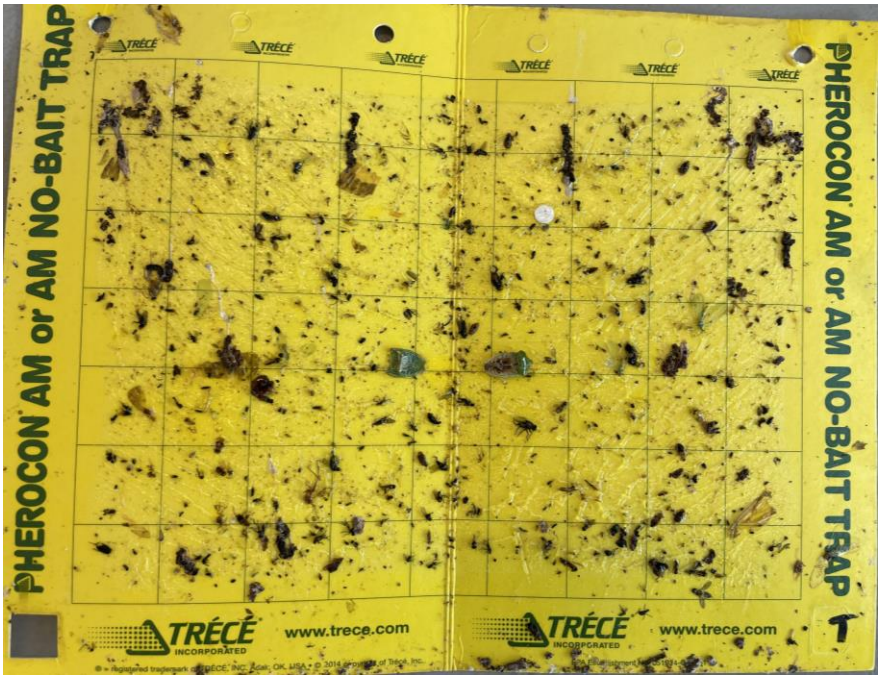

Figure 2. Top vs. Bottom side of a 0◦ (vertically-oriented) sticky trap. The top sides of 0◦ traps were indicated with a "T" (lower right); the unmarked side was designated as the bottom.

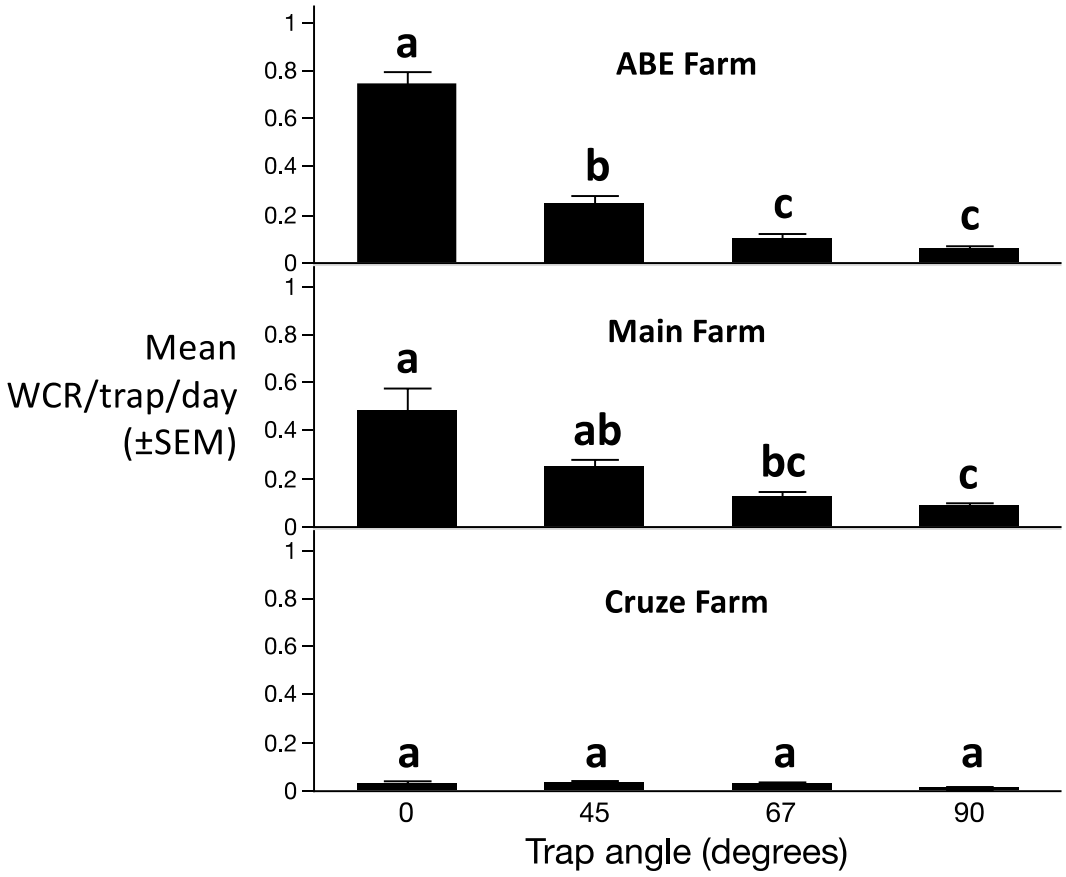

Figure 3. Mean WCR/trap/day (±SEM) vs. Trap angle for sticky traps placed in soybean at three University of Illinois farm locations from July-August, 2022. Data were non-normal and were analyzed using the non-parametric Kruskal-Wallis test, followed by the non-parametric Kruskal-Wallis test, followed by the non-parametric Steel-Dwass method ($q=2.569$, $\alpha = 0.05$) to perform multiple comparisons within location. Bars bearing the same letter within location are not significantly different at $\alpha = 0.05$.

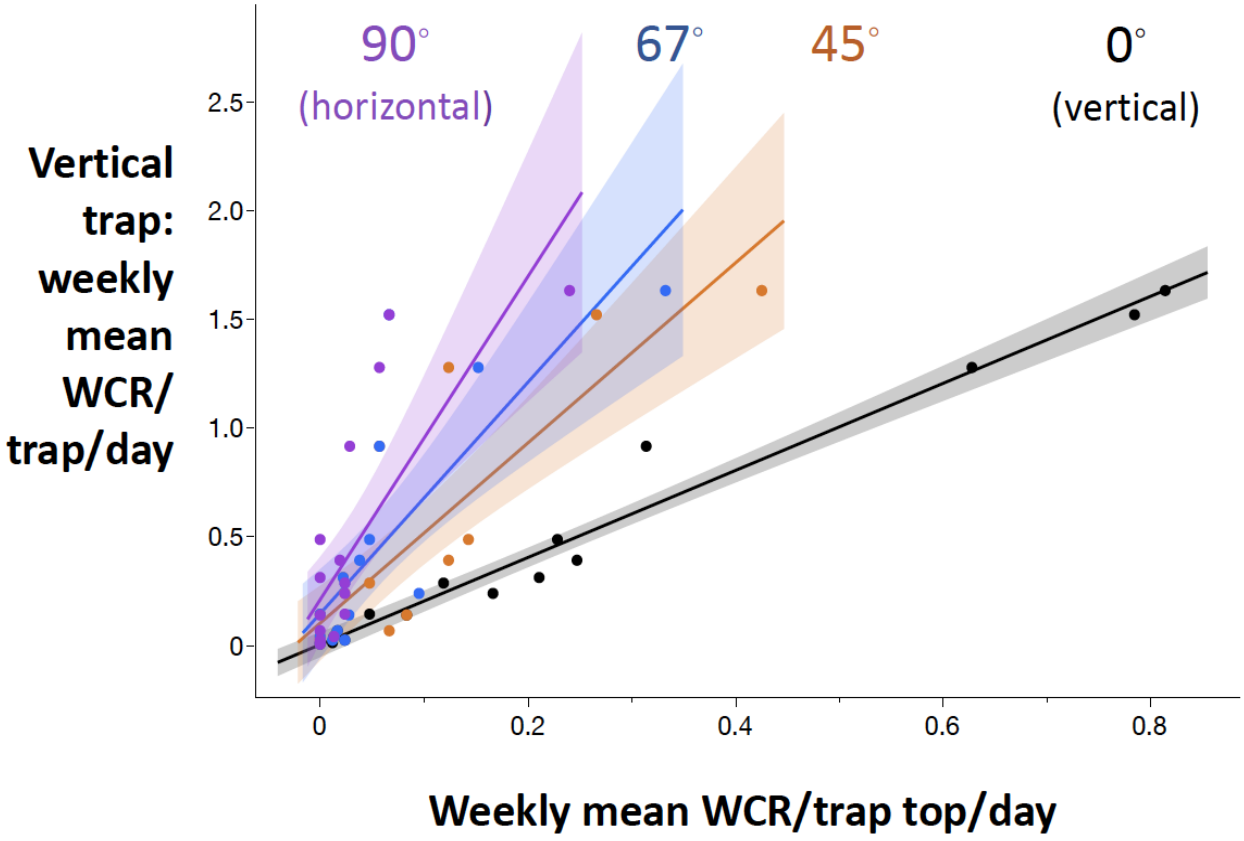

Figure 4. Regression of weekly mean WCR/trap top/day for all trap angles vs. mean total WCR/trap/day on vertical traps. WCR captured on trap tops (or on the designated "top" of a vertical trap) were compared to total WCR captures on vertical traps to assess whether WCR captured on trap tops could be predictive of total WCR captured on conventional vertical sticky traps. Shaded areas are 95% confidence intervals. See text for details.

2022 Dectes stem borer survey – larvae and stem tunneling

Nicholas Seiter[1] and Ashley Decker[2], University of Illinois Department of Crop Sciences
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[2]Research Specialist in Entomology

Objective: Determine the distribution and severity of dectes stem borer larvae in Illinois.

Materials and Methods: Soybean fields (n = 18) in southern IL were sampled in September-October 2022 (growth stages R6-R8). The main stems of 25 soybean plants per field were split open, and the presence or absence of dectes stem borer larvae and/or their tunnels was recorded. In addition, eight no-till fields in Warren and Henderson Counties in western Illinois were sampled post-harvest by examining soybean residue for dectes tunnels and larvae at the basal portion of the plant remaining after harvest (i.e. the portion of the plant where dectes stem borer larvae overwinter. These values were then used to determine the percent of plants infested for each field.

Summary: The level of infestation ranged from 0-92% of plants infested with either tunnels or larvae in previously (2021) surveyed areas in south-central Illinois (see map on following page; last year's survey results can be found at https://go.illinois.edu/2021PestPathogenARB). No dectes stem borer larvae were found in Warren or Henderson Counties. This is the second year of a planned multi-year survey to observe the distribution and spread of this insect. If you are interested in participating in future surveys, please email nseiter@illinois.edu with the subject line "Illinois dectes survey."

Funding: The Illinois Soybean Association provided funding for this effort.

Acknowledgements: We thank Andrea Kohring (Precision Conservation Management), Phil Krieg (Syngenta), Randy McElroy (Bayer CropScience), Talon Becker (University of Illinois Extension), and Chelsea Harbach (University of Illinois Extension) for their help identifying and/or surveying fields. In addition, we thank Dennis Bowman (University of Illinois Extension) for preparing Fig. 2).

Figure 5. Dectes stem borer larva and tunnel in a soybean stem

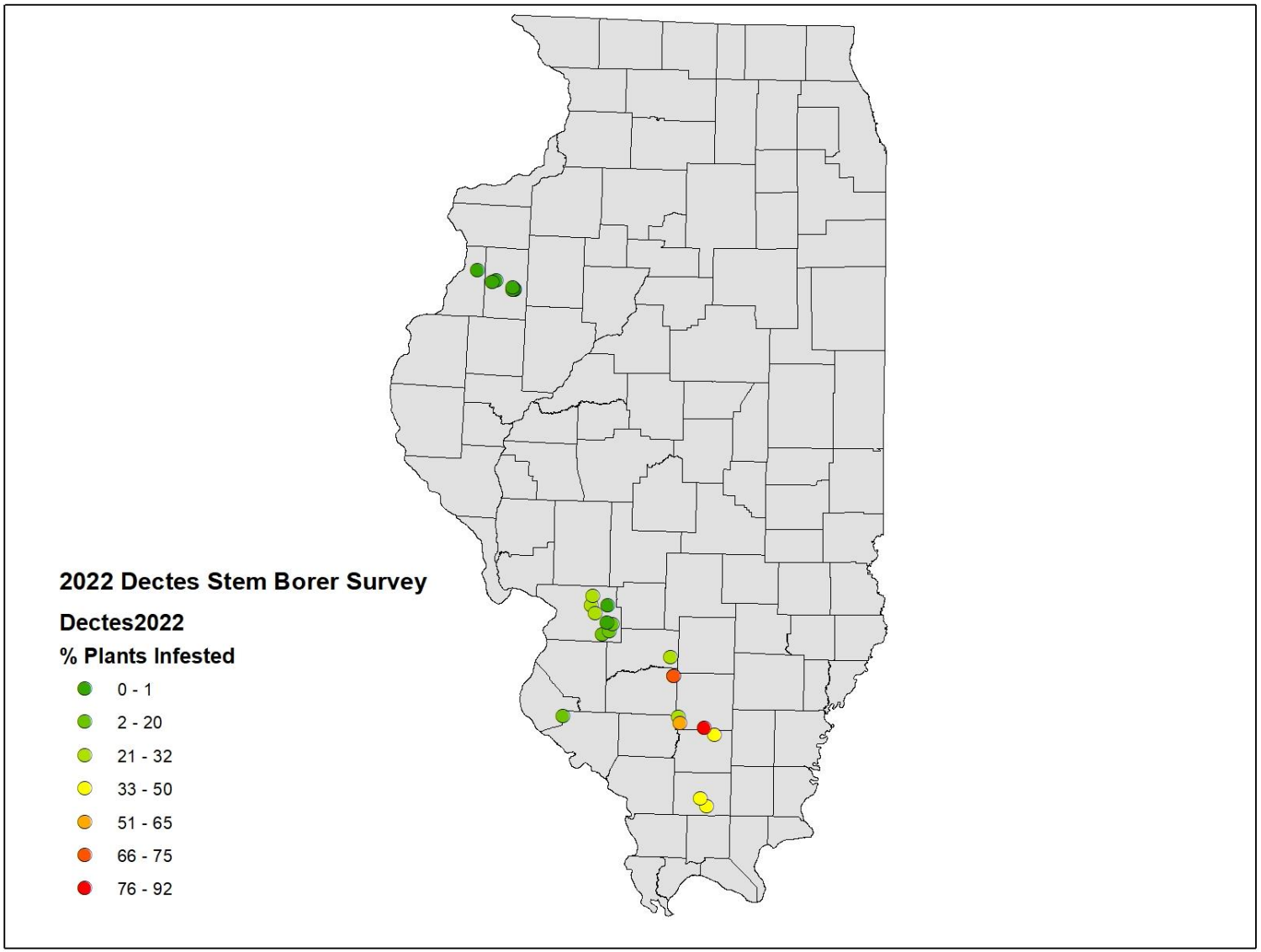


Figure 6. Map showing percent infestation of fields sampled for dectes stem borer larvae and tunneling in Illinois

Soybean Gall Midge Survey – Illinois 2022

N. J. Seiter and K. A. Estes

Objective: inspect soybean fields throughout Illinois to facilitate early detection of the soybean gall midge, *Resseliella maxima*, a new pest of soybean that has not been found in Illinois

Outcome: We inspected 338 soybean fields in 53 counties and found no evidence of soybean gall midge in Illinois.

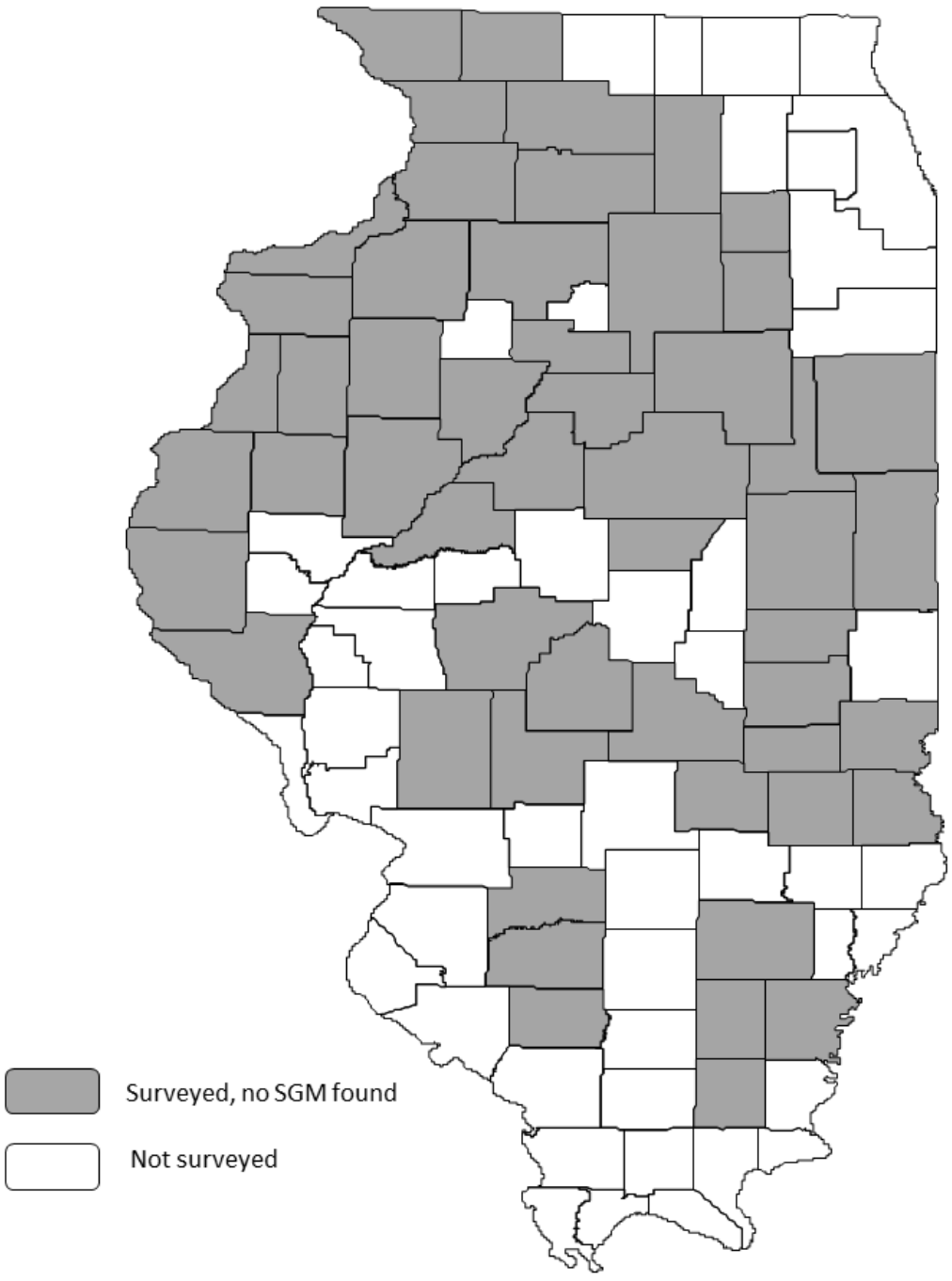
Survey methods: Our survey efforts were conducted in two phases. The majority (302) of fields we examined for soybean gall midge were sampled as part of the Illinois Statewide Insect Survey; plants were assessed along the edge of every soybean field every 60-100 feet for signs of soybean gall midge infestation (dead/wilting plants and discolored stems). We conducted an additional survey of 36 fields in 9 counties (Hancock, Henderson, Mercer, Rock Island, Henry, Whiteside, Carroll, Stephenson, and Jo Daviess) along the northwestern border of Illinois with Missouri, Iowa, and Wisconsin. Fields were selected approximately every 5-10 miles in a transect along the state border that had rotation patterns that placed them at elevated risk of soybean gall midge infestation (adjacent soybean fields and dense uncultivated vegetation in near proximity). Fields in this survey were examined for signs of gall midge infestation for a timed period of 5 minutes per field along the field edge adjacent to soybean grown the previous year (the most likely location to observe initial soybean gall midge activity). The epidermis of the stem was removed from areas showing potential signs of infestation to look for larvae. No soybean gall midge larvae were found during either survey. Soybean gall midge surveys will be repeated during Summer 2023.

Acknowledgements: We thank Dr. Justin McMechan (University of Nebraska) for coordinating survey efforts and developing the monitoring protocol we used.

Funding: Funding for this survey was provided by the Illinois Soybean Association and the North Central Soybean Research Program.

For continuously updated information on where soybean gall midge has been found in the U.S. and how to manage it, visit www.soybeangallmidge.org

2022 Soybean Gall Midge Field Survey



University of Illinois, Department of Crop Sciences
Illinois Cooperative Agricultural Pest Survey Program

S1080 State Report – Kentucky 2022

Raul T. Villanueva
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General Comments:

There were two issues that restricted the good development of studies conducted at the University of Kentucky's Research and Education Center at Princeton

1. The absence of proper area to work (infrastructure to conduct bioassays, and process material) due to the total destruction of the Research and Education Center at Princeton in 2021. The entomology group were not able to rent a space until July 2021 although we worked temporarily in the garage of the Lyon Co. Extension office, and growth chambers arrived by middle of July. Despite these inconveniences most of studies were conducted and completed under these difficult conditions.
2. The severe drought that occurred in western KY in 2022 had a negative impact on the population of stink bugs, slugs, aphids, and bean leaf beetles. Snails prefer moist soils and humid environmental conditions. Stink bugs also were affected negatively by this environmental condition, and in many soybean fields populations were extremely low in 2022 compared with 2021. However, other pests, such as lepidopteran, grasshoppers and three-cornered alfalfa hopper were not affected.

Main topics evaluated in 2022.

SHIFTS ON SPECIES COMPOSITION OF STINK BUGS IN WESTERN KY AND 2022 DROUGHT

The brown marmorated stink bug (BMSB) is an invasive species that up until 2020 was present in most of the eastern part of KY but absent in the western part of the state. Thus, in spite of significant scouting populations of BMSB were not detected in western KY soybean fields until 2020, The absence of BMSB in the western part of the state prior to 2020 might be due to very low populations in field crops, and slow geographic expansion of this pest. During the maturation stages of soybean, 2,223 stink bugs were collected from commercial soybeans fields in central and western KY counties. Compared to data collected in 2020 and 2021, the total number of stink bugs collected in 2022 dramatically decreased in more than 50%. Results from these data shown that the most abundant species was the green stink bug in soybeans, and the proportion of BMSB has increased since 2020. Mean number of stink bugs per 100 sweeps varied significantly in both western and central counties during 2021 and 2022. In 2022, there were no stink bugs recorded in 28% of the sampled fields and in 9% of the sampled locations we found one single stink bug/100 sweeps. This could be attributed to the severe drought documented in the Midwest during the 2022 growing season, especially in western Kentucky. Interestingly, despite the drought conditions during 2022, the proportion of BMSB were still higher compared to 2020; BMSB percentage numbers for 2020, 2021, and 2022 were 14.3%, 40.5%, and 29.2%, respectively. This may suggest that the populations of BMSB would be increasing in upcoming years.

SNAIL OUTBREAK DURING DROUGHT, MANAGEMENT AND PREDATION OF MOLLUSKS.

It is reported that slugs thrive in low disturbance fields compared to conventional tillage areas. Because mollusks attack plants during the early stages of development, their impact can be devastating; they can reduce plant densities or destroy entire fields overnight and increase costs when replanting is conducted. These types of events are increasing in frequency in the soybean fields of Kentucky. Here, we describe a snail outbreak in Lyon Co. KY in 2022 and the results of an application of metaldehyde to control snails. The causal agent was a native snail species. It caused severe injuries to soybeans under

very particular situations, heavy organic matter from the previous crop that provided good environmental conditions, and their survival under severe drought conditions presented in KY in 2022. In this occasion, all the soybean foliage and stem were completely consumed in many areas of the fields by snails, and their numbers ranged from 1 to 106 snails/5 ft-row lengths whereas the areas where there were plants (mean ± SEM = 14.6 ± 1.3 plants/5-ft) the ranges were from 1 to 14 snails. In addition, in these same locations the mean depth of the organic matter were 4.2 and 2.5 in-deep, the air temperatures were 108.0 ±1.0^{o} F and 97.7 ± 0.6^{o} F, and temperatures under the organic matter were 79.4 ± 0.8^{o} F and 77.3^{o} ± 0.5^{o} F, respectively. An application of the metaldehyde bait (Deadline-MPs) at 10 Lbs/A before conducting a replanting was made. This application was successful it caused >85% mortality of snails 1 day after the application, and replanted soybeans successfully maturate without further populations of snails. The price of soybeans are relatively good nowadays compared to previous years, and the grower was able to pay the $20/A fee to proceed with a preventative tactic to replant soybeans. Further studies need to be conducted to understand the presence of slugs and snail, the abundance of cover crops and organic matter in soybean fields, as well the evaluations of molluscicides with different formulations, different active ingredients, and costs for this management tactic. Studies were also conducted on the predation of different stages of slugs (eggs, immatures, and adults) by predacious carabid beetles. We determine that two species of carabids were able to consume eggs, nymphs and adult slugs, these species were identified as *Anisodactylus rusticus* and *Pterostichus atratus.* Sustainable practices to conserve and enhance the presence of these predatory beetles need to be studied in the future.

KUDZU BUG EXPANSION:

Kudzu bug populations in KY have been concentrated in counties bordering TN, in areas where kudzu plants were growing. We have found kudzu bugs in the Land Between the Lakes in April in 2022. Based in this capture and previous captures in eastern KY, it is feasible that kudzu bugs might be overwintering in Kentucky as adults in sheltered locations including human dwellings, or organic matter where kudzu plants were growing. In 2021 and 2022 we found a couple of kudzu bugs, immature and mature forms during sweep samples on soybeans. We did not see this before these two year. Also, when sampling for kudzu bug parasitoids were conducted in 2021 and 2022, parasitoids were not found in these two-year study.

COCKLEBUR WEEVIL DISRUPTS DECTES DEVELOPMENT IN SUNFLOWERS USED AS TRAP CROP

The soybean stem borer *Dectes texanus* is a native beetle that feeds on soybeans. Dectes larvae debilitate the plant causing lodging. Previous works proposed the use of sunflower as a trap crop to reduce the attacks of Dectes. However, this interaction can be disrupted by the red cocklebur weevil (RCW) *Rhodobaenus quinquepunctatus*. The feasibility of using sunflower as a trap crop in soybeans was evaluated considering the interaction with the RCW within the same host plant. During two consecutive years (2021-2022), the attacks and incidence of dectes on soybean and sunflower were evaluated in Lyon and Caldwell Counties, KY. Ten sunflower plants were randomly removed from a sunflower plot every 2 weeks from August to September, while soybeans were randomly chosen from rows at 0, 5, 10, 20, 50, 100 and 200 m away from the sunflowers. Larvae of Dectes and RCW were recorded from each host plant. Overall, the highest numbers of Dectes were found in soybean plants 0.5 and 10 m away from the sunflowers in 2021 and 2022, respectively. In 2021, the number of Dectes significantly decreased as the distance to sunflower increased, but in 2022, the lowest incidence of Dectes in soybean stalks was found 200 m away from the sunflowers. The highest proportion of soybean plants infested with Dectes were found at 10 and 20 m. The RCW was only found feeding on sunflower stalks (n=75). Larva of RCW colonized sunflowers earlier than Dectes, Dectes colonizes soybeans by late June to mid-August whereas, adult RCW were observed since mid-April. The RCW was found in larger proportions (80%) than Dectes on sunflower plants in 2021 and 2022. Tunnels of RCW were found

mainly in the lower half of the sunflowers. Pupation occurred at the root and then adults chewed their way out of the plants. The interaction between Dectes and RCW was previously unknown and is apparently restricting the success of Dectes larva in sunflowers. Therefore, the use of sunflower as a trap crop may be disrupted by this competitive relationship in KY. Although sunflower is an attractive host for Dectes, the cocklebur weevil infested these plants earlier than Dectes, thus restraining Dectes to complete its life cycle and might be causing mortalities that were not recorded in this study. Low Dectes and RCW populations in 2022 were related to a severe drought that occurred in western KY. More research needs to be done to understand the interaction between the RCW and Dectes in sunflowers, and its use as trap crop in soybean systems.

Peer reviewed publications

- Illán, J. G., Zhu, G., Walgenbach, J. F., Acebes-Doria, A., Agnello, A. M., Alston, D. G., Heather Andrews, Elisabeth H Beers, J Christopher Bergh, Ricardo T Bessin, Brett R Blaauw, G David Buntin, Erik C Burkness, John P Cullum, Kent M Daane, Lauren E Fann, Joanna Fisher, Pierre Girod, Larry J Gut, George C Hamilton, James R Hepler, Richard Hilton, Kim A Hoelmer, William D Hutchison, Peter J Jentsch, Shimat V Joseph, George G Kennedy, Grzegorz Krawczyk, Thomas P Kuhar, Jana C Lee, Tracy C Leskey, Adrian T Marshal, Joshua M Milnes, Anne L Nielsen, Dilani K Patel, Hillary D Peterson, Dominic D Reisig, Jhalendra P Rijal, Ashfaq A Sial, Lori R Spears, Judith M Stahl, Kathy M Tatman, Sally V Taylor, Glynn Tillman, Michael D Toews, Raul T Villanueva, Celeste Welty, Nik G Wiman, Julianna K Wilson, and Frank G Zalom. 2022. **Evaluating invasion risk and population dynamics of the brown marmorated stink bug across the contiguous USA.** Pest Management Science. DOI 10.1002/ps.7113
- Musser, Fred; A. Catchot, S. Conley, J. Davis, C. Difonzo, S. C. Graham, J. Greene, B. Jensen, D. Kerns, G. Lorenz, D. Owens, D. Reisig, P. Roberts, T. Royer, N. Seiter, R. Smith, S. Stewart, S. Taylor, B. Thrash, K. Tilmon, **R. T. Villanueva,** and M. Way. 2022. 2021 **Soybean insect losses in the United States. Midsouth Entomologist. Midsouth Entomologist 15:39-63**. Available at: https://midsouthentomologist.org.msstate.edu/pdfs/Vol15_1/15-5-Musser_etal.pdfs.

New Extension peer-reviewed publications

- ENTFACT 159: Red Cocklebur Weevil. R. T. Villanueva, and Armando Falcon-Brindis. https://entomology.ca.uky.edu/ef159
- ENTFACT 158: Threecornered Alfalfa Hopper in Soybeans. R. Villanueva

Kentucky Pest News - 2022

- The broad-headed sharpshooter, an insect of vibrant colors October 18, 2022. R. T. Villanueva.
- A new pest for soybeans reported in Minnesota and Quebec, the leafminer Macrosaccus morrisella. September 20. R. T. Villanueva.
- Presence of soybean podworm seen on maturing soybeans. September 20. R. T. Villanueva.
- Calculator for stored grain capacity, bin sub-floor volume and wall and grain surface areas. September 6. S. McNeil, and R. T. Villanueva.
- Deer, slugs, voles, blister beetles, and what else is damaging soybeans? September 6. R. T. Villanueva.
- Snails captured while conducting net sweeps for insects in soybeans. August 16. R. T. Villanueva.
- Searching for parasitoids of kudzu bug egg in Kentucky: Year 2. August 16. Clara Bradley and Raul T. Villanueva.
- Japanese beetles feeding on soybean blooms. August 2. R. T. Villanueva.
- If drought persists, grasshoppers in soybeans might be a pest to cause worry. July 12. R. T. Villanueva.
- Insect and mite pests during hot, dry weather. July 12. R. T. Villanueva.
- Snail outbreak during the drought and hot conditions affect soybeans. June 28. R. T. Villanueva.
- Stink bugs in wheat may have an early awakening and affect corn and soybean seedlings. May 10. R. T. Villanueva.
- Small, creepy, and beautiful predacious tigers of the soil. May 10. A. Falcon-Brindis and R. T. Villanueva.
    - Conducive weather for seedcorn maggot & slug outbreaks in field crops. April 12. R. T. Villanueva.

S1080 Louisiana State Report 2022

Jeffrey A. Davis

Associated Post-Docs: none

Associated Students: Scott T. Lee (PhD), Colin Bonser (PhD), Tyler Musgrove (MS)

Louisiana Overview:

The biggest news of last year was the weather. We were in a drought much of June followed by too much rain. It rained every day from July 22 to September 10, 2022 causing many of our early beans to split and sprout in the pods. Control failures were also prevalent if insecticides made it out. Only 40% of our crop was harvested.

In general, pest populations were normal except for redbanded stink bug (the dominant soybean pest) with populations the highest they have been since its arrival in 2000. Other hemipteran pests include threecornered alfalfa hopper, Southern green stink bug, green stink bug, and brown stink bug. Of lepidopterans, soybean looper is the most widespread followed by velvetbean caterpillar and green cloverworm.

Report summary

(1) Document changing soybean pest and beneficial arthropod assemblages. Soybean is injured by a diverse guild of insect pests feeding on leaves, stems, roots, nodules, and pods. The major insect pests in these guilds have markedly changed in the last two decades due to the introduction and range expansion of invasive insects and the adaptation of native pests.

Short Summary:

Over the past two decades, management practices within Louisiana soybean production have shifted. Surveys monitoring foliage-foraging arthropod populations in soybean took place across six locations within Louisiana over seven years (2012-2018). Temporal associations of both functional pest groups, defoliating and sucking, and predator groups in relation to soybean phenology were observed. Additionally, soybean maturity groups (III, IV, and V) were also evaluated to delineate potential differences. Results indicated higher abundances of sucking pests compared to defoliating pests across both data sets (2012-2014 and 2015-2018). Functional pest groups were more abundant in later soybean reproductive periods, mainly attributed to *Chrysodeixis includens* and *Piezodorus guilinii*. Predator populations were mainly comprised of Araneae and Geocoridae throughout the survey period (2012-2014 and 2015-2018). From 2015–2018, soybean growth had a significant effect on total predator abundance with more predators present at the pod-fill (R5/R6) and soybean maturity stage (R7/R8). Correlations between total pest abundance and total predators exhibited a moderate positive linear relationship. Soybean maturity group only influenced sucking pest abundance, with later maturing groups (IV and V) having higher numbers.

Peer reviewed pubs:

Musser, F. R., A. L. Catchot, Jr., J. A. Davis, C. DiFonzo, S. H. Graham, J. K. Greene, B. Jensen, D. L. Kerns, R. L. Koch, D. Owens, D. D. Reisig, P. M.Roberts, T. A. Royer, N. J. Seiter, S. D. Stewart, S. V. Taylor, B. C. Thrash, K. J. Tilmon, and R. T. Villanueva. 2022. 2021 Soybean insect losses in the United States. MidSouth Entomol. 15: 39 – 63.

Lee, S. T., C. Li, and J. A. Davis. 2022. Predator-pest dynamics of arthropods residing in Louisiana soybean agroecosystems. Insects 13: 154.

Professional presentations:

Lee, S. T., and J. A. Davis. 2022. Pesticide-induced reduction of natural enemies leads to outbreak in soybean looper, *Chrysodeixis includens* (Walker), in Louisiana soybean. 2022 Annual Meeting of the Entomological Society of America, Vancouver, BC. November 14, 2022.

Extension presentations:

None

Impact statements:

The switch to early soybean production by Louisiana growers has shifted the pest complex, resulting in higher abundances of sucking herbivorous pests. Although the endemic natural enemy community was correlated to observed pest populations, economic threshold levels were still reached by sucking herbivorous pests. Early season establishment of predators may limit early "explosion" of pest populations.

(2) Characterize soybean insect biology and ecology The range expansion of invasive pests, coupled with the adaptation of native pests, necessitate further research into how insects cope with new selection pressures

Short Summary:

Hemp (*Cannabis sativa* L.) is a reemerging crop in the United States with increasing outdoor acreage in many states. This crop offers a potential host for polyphagous, defoliating lepidopteran pests currently present in Louisiana. The ability of soybean looper (*Chrysodeixis includens* (Walker)) (Lepidoptera: Noctuidae), fall armyworm (*Spodoptera frugiperda* (J.E. Smith)), and beet armyworm (*Spodoptera exigua* (Hübner)) to develop and reproduce on hemp was investigated in this study. Larvae of all three species reared on 'Maverick' had significantly faster preadult developmental times compared to the other hosts. *Chrysodeixis includens* larvae fed excised leaves of 'Maverick' and 'Pipeline' experienced higher intrinsic and finite rates of increase, higher net reproductive rates, and faster mean generation and doubling times. *Spodoptera frugiperda* larvae reared on 'Maverick', 'Pipeline', and 'UA5414RR' had higher intrinsic and finite rates of increase, higher net reproductive rates, and faster mean generation and doubling times. *Spodoptera exigua* larvae had the highest survivorship on 'Maverick' and similar, positive lifetable statistics when reared on 'Maverick' and 'Pipeline'. The results of this study indicate hemp is an alternative host plant that has the potential to influence the population dynamics of *C. includens*, *S. frugiperda*, and *S. exigua* in Louisiana agroecosystems they co-occur in.

Research indicates that nanoparticles can be an effective agricultural pest management tool, though the unintended effects on the insect must be evaluated before their use in agroecosystems. *Chrysodeixis includens* (Walker) (Lepidoptera: Noctuidae) was used as a model to evaluate chronic parental and generational exposure to empty, positively charged zein nanoparticles ((+)ZNP) and methoxyfenozide-loaded zein nanoparticles (+)ZNP(MFZ) at low-lethal concentrations. To determine concentration limits, an acute toxic response test on meridic diet

evaluated (+)ZNP(MFZ) and technical grade methoxyfenozide using two diet assay techniques. No differences in acute toxicity were observed between the two treatments within their respective bioassays. With these results, population dynamics following chronic exposure to low-lethal concentrations were evaluated. Parental lifetables evaluated cohorts of *C. includens* reared on diet treated with LC_5 equivalents of (+)ZNP, (+)ZNP(MFZ), or technical grade methoxyfenozide. Compared to technical grade methoxyfenozide, (+)ZNP(MFZ) lowered both the net reproductive rate and intrinsic rate of increase, and was more deleterious to *C. includens* throughout its lifespan. This was contrasted to (+)ZNP, which showed no differences in population dynamics when compared to the control. To evaluate chronic exposure to (+)ZNP, generational lifetables reared cohorts of *C. includens* on LC_5 equivalent values of (+)ZNP and then took the resulting offspring to be reared on either (+)ZNP or untreated diet. No differences in lifetable statistics were observed between the two treatments, suggesting that (+)ZNP at low ppm do not induce toxic generational effects. This study provides evidence into the effects of nanodelivered methoxyfenozide and the generational impact of (+)ZNP.

Peer reviewed pubs:

Arey, N. C., N. P. Lord, and J. A. Davis. 2022. Evaluation of hemp (*Cannabis sativa*)(Rosales: Cannabaceae) as an alternative host plant for polyphagous noctuid pests. J. Econ. Entomol. 115: 1947 – 1955.

O'Hara, F. M., Z. Liu, J. A. Davis, and D. R. Swale. 2022. Catalyzing systemic movement of inward rectifier potassium channel inhibitors for antifeedant activity against the cotton aphid, *Aphis gossypii* (Glover). Pest. Manag. Sci. 79: 194 – 205.

O'Hara, F. M., J. A. Davis, and D. R. Swale. 2022. Profile of commercialized aphicides on the survivorship and feeding behavior of the cotton aphid, *Aphis gossypii*. Pestic. Biochem. Phys. 186: 105174.

Bonser, C. A. R., C. E. Astete, C. M. Sabliov, and J. A. Davis. 2022. Life history of *Chrysodeixis includens* (Lepidoptera: Noctuidae) on positively charged zein nanoparticles. Environ. Entomol. 51: 763 – 771.

Kacsó, T., E. A. Hanna, F. Salinas, C. E. Astete, E. Bodoki, R. Oprean, P. P. Price, V. P. Doyle, C. A. Bonser, J. A. Davis, and C. M. Sabliov. 2022. Zein and lignin-based nanoparticles as soybean seed treatment: translocation and impact on seed and plant health. Appl. Nanosci. 12: 1557 – 1569.

Professional presentations:

Arey, N. C. and J. A. Davis. 2022. Impact of hemp on the population dynamics of three noctuids. Invited Presentation: Hemp Diseases, Pests, and Management Symposium. 2022 Annual Meeting of the Southeastern Branch of the Entomological Society of America, San Juan, PR. March 30, 2022.

Bonser, C. A. R., C. Tamez, J. C. White, C. E. Astete, C. M. Sabliov, and J. A. Davis. Field testing zein as a nanodelivery system for methoxyfenozude. 12th annual LSU Entomology Department Graduate Student Symposium, Baton Rouge, LA. October 21, 2022. (infographic)

O'Hara, F. M., J. A. Davis, Z. Liu, and D. R. Swale. 2022. Development of antifeedant insecticides targeting hemipteran potassium ion channels. 2022 Annual Meeting of the Entomological Society of America, Vancouver, BC. November 13, 2022.

O'Hara, F. M., Z. Liu, J. A. Davis, D. R. Swale. 2022. Optimization of inward rectifier potassium channel inhibitors to prevent hemipteran feeding. 2022 American Chemical Society, Division of Agrochemicals Fall National Meeting. Chicago, IL. (poster)

Sabliov, C. M., C. E. Astete, J. White, and J. A. Davis. 2022. Agrochemical nanodelivery systems for a sustainable agriculture. 21st International Union of Food Science & Technology (IUFoST) World Congress, Singapore. November 3, 2022.

Extension presentations:

None

Impact statements:

Hemp will impact the growth rates of many lepidopteran pests of soybean within the agroecoscape. In addition, nanoparticles can deliver insecticides with minimal harm to the environment.

S1080 Mississippi State Report 2022

Fred Musser, Angus Catchot, Don Cook, Whitney Crow, Jeff Gore

Associated Post-Docs: none

Associated Students: Jacob Smith, Gene Merkl, Judge Fortenberry, Sena Isbilir, Tom Paul, Sawyer Hopkins

Mississippi Overview:

- The primary insect pests in Mississippi during 2022 were stink bugs, corn earworm and soybean looper as has been reported every year since insect losses were first estimated in 2004. As such, most of our research and extension efforts were focused on these three pests during 2022. This includes compiling estimated insect losses in soybean for the nation (Obj. 1), studying the genetic and physiological bases of insecticide resistance in soybean looper (Obj. 2), studying the overwintering behavior of redbanded stink bug (Obj. 2), studying the efficacy and residual of various types of management strategies (Obj. 3), and developing improved insect sampling methods (Obj. 3). In addition to presenting and publishing these data in professional forums, several presentations and publications targeted growers and consultants (Obj. 4).

Report summary – In total, we published 0 refereed and 20 other articles, presented 14 papers at professional meetings and gave 16 extension presentations. These publications and presentations spanned all 4 objectives of the S1080 project. Several were multi-state efforts, but the majority were done entirely within Mississippi.

(1)

Document changing soybean pest and beneficial arthropod assemblages. Soybean is injured by a diverse guild of insect pests feeding on leaves, stems, roots, nodules, and pods. The major insect pests in these guilds have markedly changed in the last two decades due to the introduction and range expansion of invasive insects and the adaptation of native pests.

Short Summary:

Soybean insect losses are compiled annually. The report covering 2021 includes data from 18 states representing 54% of U.S. soybean acreage. Over time, the changes in infestation and injury reported can provide an indication of the spread or contraction of insect populations with changes in weather and production practices.

Peer reviewed publications: none

Other publications:

Musser, F. R., A. L. Catchot, Jr., J. A. Davis, C. DiFonzo, S. H. Graham J. K. Greene, B. Jensen, D. Kerns, R. L. Koch, D. Owens, D. D. Reisig, P. Roberts, T. Royer, N. J. Seiter, S. D. Stewart, S. Taylor, B. Thrash, K. Tilmon, and R. T. Villanueva. 2022. 2021 soybean insect losses in the United States. Midsouth Entomol. 15:39-63. http://midsouthentomologist.org.msstate.edu/.

Professional presentations:

Musser, F. 2020-21 pest distributions and damage in soybean. S1080 annual meeting, Feb. 16, 2022.

Extension presentations: none

Impact statements: none

(2)

Characterize soybean insect biology and ecology The range expansion of invasive pests, coupled with the adaptation of native pests, necessitate further research into how insects cope with new selection pressures

Short Summary:

Two graduate students, Tom Paul and Sena Isbilir, conducted studies on stink bug overwintering and recolonization, and the mechanisms of insecticide resistance in soybean looper, respectively.

Peer reviewed publications: none

Other publications: none

Professional presentations:

Aboughanem-Sabanadzovic, N., F. Musser, and S. Sabanadzovic. Viome of bean leaf and banded cucumber beetle in Mississippi. MS Entomol. Assn annual meeting, Mississippi State, MS. Nov. 1, 2022.

Musser, F. and B. Catchot. Insecticide resistance monitoring for bollworm and soybean looper. Beltwide Cotton Conferences, San Antonio, TX, Jan. 6, 2022.

Paul, T.G., F.R. Musser, P. Chakrabarti, A.L. Catchot, and S.F. Ward. 2022. Development of an overwintering suitability model for redbanded stink bug, a pest of soybean. Spring 2022 Graduate Research Symposium, Mississippi State, MS, Feb 26, 2022.

Paul, T., A. Catchot, S. Ward, P. Basu, and F. Musser. Quantifying site selection and survival of redbanded stink bug, a pest of soybean. Beltwide Cotton Conferences, San Antonio, TX, Jan. 5, 2022.

Isbilir, S., B. Catchot, F. Musser, and S.-J. Ahn. Mutation screening and expression profiling of ryanodine receptor in soybean looper, *Chrysodeixis includens*. BCH-EPP Student Research Symposium. Nov. 18, 2022.

Isbilir, S., B. Catchot, F. Musser, and S-J. Ahn. Expression profiles of the ryanodine receptor, a target of diamide insecticide, in soybean looper, *Chrysodeixis includens*. SEB- Entomol. Soc. Amer. Meeting, San Juan, PR, March 26-30, 2022

Sanders-Catchot, L., F. Musser, B. Catchot and A. Catchot. Insecticide resistance monitoring for soybean loopers. SEB- Entomol. Soc. Amer. Meeting, San Juan, PR, March 29, 2022

Extension presentations: none

Impact statements: none

(3)

Develop coordinated best management practices (BMPs). As soybean insect pest assemblages change, there is a need to update pest management strategies.

Short Summary:

Three graduate students, Jacob Smith, Judge Fortenberry and Sawyer Hopkins, were involved in conducting research on residual activity of insecticides, optimizing the use of nuclear polyhedrosis viruses (NPV), and using insect growth regulators for insect control in soybean, respectively. Another graduate student, Gene Merkl, completed research on using a drone to sample insects in soybean. An effort to publish the results of insecticide efficacy trials conducted over the last several years resulted in a large number of Arthropod Management Test publications.

Peer reviewed publications: none

Other publications:

Merkl, E. M. 2022. Utilizing unmanned aerial systems to sample insects in soybean. M.S. thesis. Dept. of Biochemistry, Molecular Biology, Entomology and Plant Pathology, Mississippi State University.

Smith, J. H. 2022. Determining residual and systemic activity of commonly used insecticides in soybean and cotton. M.S. thesis. Dept. of Biochemistry, Molecular Biology, Entomology and Plant Pathology, Mississippi State University.

Cook, D.R., W.D. Crow, and J. Gore. 2022. Performance of selected insecticide against soybean looper in soybean 3, 2021. Arthropod Manag. 47(1). https://doi.org/10.1093/amt/tsac102

Cook, D.R., W.D. Crow, and J. Gore. 2022. Performance of selected insecticide against saltmarsh caterpillar and soybean looper in soybean, 2021. Arthropod Manag. 47(1). https://doi.org/10.1093/amt/tsac105

Cook, D.R., W.D. Crow, and J. Gore. 2022. Performance of selected insecticide against soybean looper in soybean 2, 2021. Arthropod Manag. 47(1). https://doi.org/10.1093/amt/tsac101

Cook, D.R., W.D. Crow, and J. Gore. 2022. Performance of selected insecticide against soybean looper in soybean 1, 2021. Arthropod Manag. 47(1). https://doi.org/10.1093/amt/tsac104

Cook, D.R., W.D. Crow, and J. Gore. 2022. Performance of selected insecticide against saltmarsh caterpillar in soybean 1, 2021. Arthropod Manag. 47(1). https://doi.org/10.1093/amt/tsac106

Cook, D.R., W.D. Crow, and J. Gore. 2022. Efficacy of selected insecticides against stink bugs in soybean, 2021. Arthropod Manag. 47(1). https://doi.org/10.1093/amt/tsac088

Crow, W.D., A.L. Catchot, D. Bao. 2022. Efficacy of selected insecticides for control of stink bugs in soybean, 2018. Arthropod Manag. 47(1). https://doi.org/10.1093/amt/tsac059

Crow, W.D., A.L. Catchot, D. Bao. 2022. Efficacy of selected insecticides for control of redbanded stink bug in soybean, 2019. Arthropod Manag. 47(1). https://doi.org/10.1093/amt/tsac060

Cook, D.R., W.D. Crow, and J. Gore. 2022. Performance of selected insecticides against soybean looper infesting soybean 3, 2019. Arthropod Manag. 47(1). https://doi.org/10.1093/amt/tsac044

Cook, D.R., W.D. Crow, and J. Gore. 2022. Performance of selected insecticides against stink bugs infesting soybean 1, 2019. Arthropod Manag. 47(1). https://doi.org/10.1093/amt/tsac045

Cook, D.R., W.D. Crow, and J. Gore. 2022. Performance of selected insecticides against corn earworm infesting soybean, 2019. Arthropod Manag. 47(1). https://doi.org/10.1093/amt/tsac041

Cook, D.R., W.D. Crow, and J. Gore. 2022. Performance of selected insecticides against soybean looper infesting soybean 2, 2019. Arthropod Manag. 47(1). https://doi.org/10.1093/amt/tsac043

Cook, D.R., W.D. Crow, and J. Gore. 2022. Performance of selected insecticides against stink bugs infesting soybean, 2018. Arthropod Manag. 47(1). https://doi.org/10.1093/amt/tsac048

Cook, D.R., W.D. Crow, and J. Gore. 2022. Performance of selected insecticides against soybean looper infesting soybean 1, 2019. Arthropod Manag. 47(1). https://doi.org/10.1093/amt/tsac042

Cook, D.R., W.D. Crow, J, Gore, and M. Threet. 2022. Performance of selected insecticides against stink bugs infesting soybean 2, 2019. Arthropod Manag. 47(1). https://doi.org/10.1093/amt/tsac046

Professional presentations:

Fortenberry, J., A.L. Catchot, D.R. Cook, W.D. Crow, J. Gore, and B. Catchot. November 2022. Activity level of NPV following application and characteristics of infected *Helicoverpa zea*. Entomology Society of America, Entomological Society of Canada, and the Entomological Society of British Columbia Joint Meeting. Vancouver, British Columbia, Canada.

Hopkins, S., W.D. Crow, D.R. Cook, A.L. Catchot, and J. Gore. November 2022. Efficacy of insect growth regulators on Lepidoptera pest of soybean. Entomology Society of America, Entomological Society of Canada, and the Entomological Society of British Columbia Joint Meeting. Vancouver, British Columbia, Canada.

Hopkins, S., W.D. Crow, D.R. Cook, A.L. Catchot, and J. Gore. October 2022. Efficacy of insect growth regulators on Lepidoptera pest of soybean. Mississippi Association of Entomology, Nematologists, and Plant Pathologist. Mississippi State, MS.

Fortenberry, J., A.L. Catchot, W.D. Crow, D.R. Cook, and J. Gore. October 2022. Horizontal transmission of NPV-Heligen. Mississippi Association of Entomology, Nematologists, and Plant Pathologist. Mississippi State, MS.

Fortenberry, J., A.L. Catchot, B. Catchot, J. Gore, W.D. Crow, and D.R. Cook. March 2022. American Phytopathologist Society and Southeastern Branch Joint Meeting, Residual of NPV and feeding habits of *Helicoverpa zea* after ingestion, Entomology Society of America, San Juan, Puerto Rico.

Fortenberry, J., D.R. Cook, A.L. Catchot, W.D. Crow and, J. Gore. January 2022. Residual of NPV and feeding habits after ingestion. National Cotton Council of America, Beltwide Cotton Conference, San Antonio, TX.

Extension presentations: none

Impact statements: none

(4)

Educate farmers, industry, colleagues, general public, and agricultural professionals using traditional tools and innovative methods. Our Working Group works extensively with stakeholders at all levels. For our clientele, we represent one of the only unbiased sources of information for decision-making of IPM strategies.

Short Summary:

The Mississippi Crop Situation blog is a resource of pest management information widely used by farmers and consultants in Mississippi and the surrounding region for all agronomic crops, including soybean. Therefore we have published several articles on pest management in the blog. In addition, overall soybean insect management was a topic at many winter producer meetings during 2021.

Peer reviewed publications: none

Other publications: none

Extension publications:

Crow, W. D., D. Cook and T. Irby.Redbanded stink bug management and inclement weather. Miss. Crop Situation blog. Aug. 24, 2022 https://www.mississippi-crops.com/2022/08/24/redbanded-stink-bug-management-and-inclement-weather/

Crow, W. RBSB ditch bank survey 4.22.22. Miss. Crop Situation blog. Apr. 20, 2022. https://www.mississippi-crops.com/2022/04/20/rbsb-ditch-bank-survey-4-22-22/

Professional presentations: none

Extension presentations:

Crow, W. Surveying for red banded stinkbugs. Miss. Crop Situation podcast. May 3, 2022. http://extension.msstate.edu/content/surveying-for-red-banded-stinkbugs

Crow, W. and D. Cook. Soybean insect management. Regional Extension meetings for producers. 15 locations in MS during Winter and Spring 2022.

Impact statements: none

North Carolina
Dominic Reisig
Project: S1080: Biology, impact, and management of soybean insect pests in soybean production systems **Reporting period:** 10/1/2021 to 9/30/2022
Associated Students: Taynara Possebom

Accomplishments under the major goals of the project:

(1) Document changing soybean pest and beneficial arthropod assemblages. Soybean is injured by a diverse guild of insect pests feeding on leaves, stems, roots, nodules, and pods. The major insect pests in these guilds have markedly changed in the last two decades due to the introduction and range expansion of invasive insects and the adaptation of native pests.

- The article authored by Musser et al. (2022) in this reporting period documented soybean insect pest incidence and damage across 47% of the US soybean acreage. I contributed estimates from North Carolina. Yearly reporting from North Carolina has revealed that corn earworm is consistently the top pest. Stink bugs and soybean loopers are usually the second and third most important pests.

(2) Characterize soybean insect biology and ecology. The range expansion of invasive pests, coupled with the adaptation of native pests, necessitate further research into how insects cope with new selection pressures

- *Helicoverpa zea* is one of the most serious insect pests of US soybean. Economic thresholds for *H. zea* were developed from soybean varieties with determinate growth habits. However, southern US farmers have recently planted more soybeans varieties with indeterminate growth habits. In the peer-reviewed article reported during this period, we found no yield differences among varieties or between growth habits, regardless of *H. zea* pressure. In the high population tests, yield was highest in the low population plots, but there was no compensation by the plant in yield components except in number of pods with one seed. In contrast, yield components varied widely across varieties, but these differences were independent of *H. zea* pressure. These results suggest the economic threshold can be used for determinate and indeterminate growth habits, but more research is needed to confirm this with a larger selection of varieties, planting dates, and maturity groups.

(3) Develop coordinated best management practices (BMPs). As soybean insect pest assemblages change, there is a need to update pest management strategies.

- Nothing to report

(4) Educate farmers, industry, colleagues, general public, and agricultural professionals using traditional tools and innovative methods. Our Working Group works extensively with stakeholders at all levels. For our clientele, we represent one of the only unbiased sources of information for decision-making of IPM strategies.

- Soybean insect management recommendations were presented at three field days in North Carolina, reaching 314 total individuals.
- Soybean insect management recommendations were presented at nine county-based North Carolina grower meetings, reaching 438 total individuals.
- One online training was held related to soybean insects, reaching 17 county agents with soybean responsibilities.
- Three soybean insect scouting schools were held, reaching 46 individuals.
- YouTube and the web was used to reach growers. In addition, articles (n= 4) were posted on soybeans.ces.ncsu.edu

Peer-reviewed articles

- Schug, H., D. Reisig, A. Huseth, B. Thrash, and R. Vann. 2022. *Helicoverpa zea* (Lepidoptera: Noctuidae) thresholds and yield compensation between soybeans with determinate and indeterminate growth habits. J. Econ. Entomol. 115: 1564-1570. doi: 10.1093/jee/toac119

Non-peer reviewed articles

1. Musser, F., A. L. Catchot, Jr., J. A. Davis, C. DiFonzo, S. H. Graham, J. K. Greene, B. Jensen, D. L. Kerns, R. L. Koch, D. Owens, D. D. Reisig, P. Roberts, T. Royer, N. J. Seiter, A. Sisson, S. D. Stewart, S. Taylor, B. Thrash, K. Tilmon, and R. T. Villanueva. 2022. Soybean invertebrate loss estimates in the United States- 2021. CPN-1029-21
2. Musser, F. R., A. L. Catchot, Jr., J. A. Davis, C. DiFonzo, S. H. Graham, J. K. Greene, B. Jensen, D. L. Kerns, R. L. Koch, D. Owens, D. D. Reisig, P. M. Roberts, T. A. Royer, N. J. Seiter, S. D. Stewart, S. V. Taylor, B. C. Thrash, K. J. Tilmon, and R. T. Villanueva. 2022. 2021 soybean insect losses in the United States. Midsouth Entomol. 15: 39-63.
3. Reisig, D. D. and A. S. Huseth. 2022. Insect control in soybeans. 2022 North Carolina Agricultural Chemicals Manual. North Carolina Cooperative Extension Service, College of Agriculture and Life Sciences, N.C. State University, Raleigh, N.C. pp. 91-94.

YouTube videos

- Scouting insect pests in cover crops prior to soybean planting. 2022. https://www.youtube.com/watch?v=rSDEi9qvKBk

Webpages

NCCE soybeans portal (soybeans.ces.ncsu.edu)

1. Corn Earworm Flight is Beginning- Scout Soybeans
2. Should you Control Corn Earworm Differently in Soybean with Indeterminate and Determinate Growth Habits? (co-authored with MS student Possebom)
3. The Impact of Insecticides on Soybean at Flowering on Beneficial Insects
4. Scout Soybeans for Kudzu Bug

Impacts:

The current economic threshold for *Helicoverpa zea* can be used for determinate and indeterminate growth habits.

My program also enhanced soybean crop health and grower profits by delivering new research-based insights for insecticide application against stink bugs, a critical soy crop pest that caused over $20 million in losses and costs to control this insect during 2022. Thanks to this Extension research being shared at numerous grower meetings statewide and via the NCCE portal system, growers were able to avoid unnecessary sprays, reducing treatment costs and avoiding killing beneficial insects. Assuming that 15% of NC soybean acres were treated according to Extension recommendations, growers secured an estimated savings of over $2.4 million.

Outputs:

- Soybean insect management recommendations were presented at three field days in North Carolina, reaching 314 total individuals.
- Soybean insect management recommendations were presented at nine county-based North Carolina grower meetings, reaching 438 total individuals.
- One online training was held related to soybean insects, reaching 17 county agents with soybean responsibilities.
- Three soybean insect scouting schools were held, reaching 46 individuals.
- As reported above, YouTube and the web was used to reach growers. In addition, articles (n= 4) were posted on soybeans.ces.ncsu.edu

Biology, impact, and management of soybean insect pest in soybean production systems
S-1080

2022 North Dakota State Report

State Representative:
Dr. Janet Knodel, Professor & Extension Entomologist
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North Dakota State University, Fargo, North Dakota

Post-Doctoral Researcher: **Dr. Veronica Calles Torrez**
Research Specialist: **Patrick Beauzay**

State Overview:

- The key insect pests that we scout for are soybean aphids, spider mites, grasshoppers and bean leaf beetles. North Dakota was recovering from a severe drought in 2022, and grasshoppers were the most common insect pest problem. Spider mites were observed in 30% of soybean fields scouted. Soybean aphids increased late in the season, but generally continued to be low since 2018. Bean leaf beetles is increasing, and some soybean fields were treated for the 2nd generation in southeastern North Dakota.
- We collaborate in the multistate project *Regional Response to Insecticide-Resistant Soybean Aphids,* the *Pheromone-Baited Traps for Stink Bug Monitoring and Thresholds* and the *Soybean Gall Midge – New Detection Survey* for the NCSRP. In addition, we are active surveying for the soybean gall midge in North Dakota as part of the North Dakota Soybean Council (NDSC) since funding is limited in the NCSRP. Our ND IPM Crop Survey Program survey continues to survey for economic insect pests of soybean through trained IPM scouts throughout the state.

North Dakota is participating in these two objectives:

- Document changing soybean pest and beneficial arthropod assemblages. Soybean is injured by a diverse guild of insect pests feeding on leaves, stems, roots, nodules, and pods. The major insect pests in these guilds have markedly changed in the last two decades due to the introduction and range expansion of invasive insects and the adaptation of native pests.

- Educate farmers, industry, colleagues, general public, and agricultural professionals using traditional tools and innovative methods. Our Working Group works extensively with stakeholders at all levels. For our clientele, we represent one of the only unbiased sources of information for decision-making of IPM strategies.

<u>OBJECTIVE 1</u>: Document changing soybean pest and beneficial arthropod assemblages.

- **NCSRP Multistate Project - Regional Response to Insecticide-Resistant Soybean Aphids**
  - Continue to participate in this objective to compare results of glass-vial bioassay of soybean aphid susceptibility to newer insecticides and Modes of Action, and field efficacy trials for control of pyrethroid-resistant soybean aphids. (Project Leader Robert Koch & James Menger-Anderson)

- **NCSRP Multistate Project – Pheromone-Baited Traps for Stink Bug Monitoring and Thresholds**
  - Continue to participate in this objective to adapt a monitoring technology from fruit orchards – sticky cards baited with stink bug pheromones – as a sampling tool for stink bug thresholds in soybeans. Traditional scouting with a sweep net is very difficult in dense vegetation. Baited sticky cards can be mounted at field edges for quick monitoring. (Project Leader Kevin Rice & Kelley Tilmon)

- **NCSRP Multistate Project – Soybean gall midge – New Detection Survey**
  - Continue to participate in this objective to document the new distribution of soybean gall midge adjacent to previously infested areas including in new states. This will increase farmer awareness of soybean gall midge in new areas and allow us to mobilize resources and direct our education efforts in areas with soybean gall midge. (Project Leader Justin McMechan)

- **Research supported by the *North Dakota Soybean Council***

Objective 1: Screening populations of soybean aphids for insecticide resistance.

Soybean aphids were not an economic pest problem in 2022 due to the lingering drought. Since soybean aphids are mobile, pyrethroid resistant soybean aphid populations could migrate yearly into North Dakota from other resistant areas, such as south-central Minnesota where pyrethroid-resistance was first observed in 2015. Since pyrethroid resistant soybean aphids can vary by year and locations, continued screening of additional populations of soybean aphids in ND is key to determine their presence or absence of resistance and efficacy of insecticides. These findings will be essential for soybean growers, so they can wisely decide which insecticide to use when soybean aphid populations need to be controlled (above the E.T. level) in eastern North Dakota.

Objective 2: To survey for the invasive soybean gall midge in North Dakota

Soybean gall midge, *Resseliella maxima*, continues to be an economic new pest of soybeans and has increased its presence in Iowa, Minnesota, Nebraska, South Dakota and Missouri from a total of 67 counties in 2018, 114 counties in 2020, 140 counties in 2021 and 155 counties in 2022 (Source: J. McMechan, University of Nebraska).

Field observations from soybean gall midge-infested states indicate that this insect is commonly found near field edges and on soybean plants adjacent to dense vegetation such as shelterbelts or uncut grass. Therefore, at each field site, a line-transect was walked near the field edge, and 10 consecutive plants were examined for the presence of soybean gall midge or symptomatic plants at 10 sampling sites per field. A total of 100 plants per field was examined. Sampling sites were separated by 60 ft. If darkened areas were present at the base of stems, the outer epidermis of the stem was peeled back to see if white - orange larvae were present. At each field site, the GPS location and crop stage were recorded.

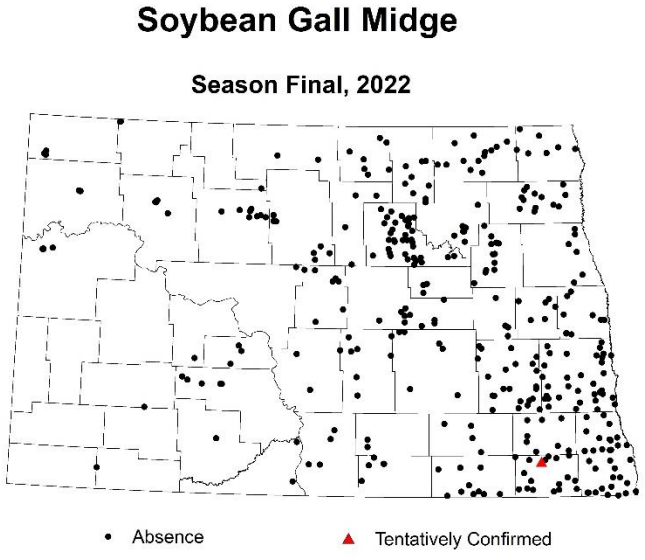


Figure 1. Survey of soybean gall midge in soybean fields 2022.

A total of 436 soybean fields in 45 counties was surveyed to detect soybean gall midge larvae from early June to mid-September in ND in 2022 (Fig. 1). The most intense survey was conducted in counties of the central and eastern part of the state. Soybean crop stages were between VE (cotyledon emergence) and R7 (beginning maturity).

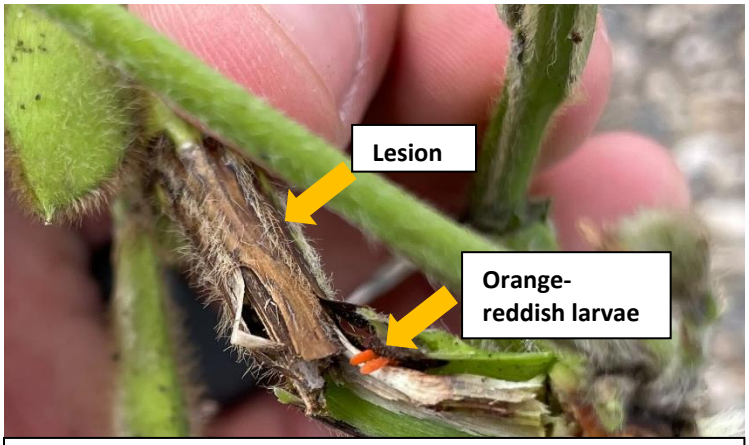


Figure 2. Soybean stem infested with 'suspect' soybean gall midge larvae from Sargent County, ND (B. Schulzetenberg, Centrol Crop Consulting)

Results from the 2022 soybean gall midge survey were negative for 435 soybean fields in the state (Fig. 1). However, suspect soybean gall midge larvae were observed in one soybean field near Gwinner (Sargent County). Brandon Schulzetenberg, Centrol Crop Consulting, reported the suspect soybean gall midge (Fig. 2) showing two bright orange larvae on a soybean stem lesion on 16 August 2022. After looking at the pictures of larvae in the stem lesion and the lack of white mold infection on soybean stem, we visited the field to collect larvae for DNA typing the next day. After scouting for a total of 8 hours, we finally found only one stem with a lesion on the field edge that had about 10 tiny white to orange-reddish larvae. The infestation was obviously very low due to the difficulties in finding one midge-infested stem. The lesion was located mid-plant, which suggests that this was the second generation of soybean gall midge. Larvae were collected and carefully placed in a 95% alcohol vial, and then sent to Dr. Justin McMechan's laboratory at the University of Nebraska for DNA testing on whether it is a positive match for soybean gall midge or white-mold gall midge. **DNA results matched soybean gall midge DNA by 92%.** However, geneticists like to have a 96% match to positively confirm the species identification. DNA tests for the white-mold gall midge were also conducted and were 100% negative. White-mold gall midge is a common gall midge in North Dakota soybean fields infected with *Sclerotinia* white mold. In 2023, we plan to continue surveying soybean fields to detect soybean gall midge presence and to re-visit the Sargent County field to collect more larvae for DNA testing.

Peer-reviewed research publications:

- Menger, J., A.V. Ribeiro, B. Potter, I. Valmorbida, E. Hodgson, **J. Knodel**, and R.L. Koch. 2022. Lack of evidence for fitness costs in soybean aphid (Hemiptera: Aphididae) with resistance to pyrethroid insecticides in the Upper Midwest Region of the United States. J. Econ. Entomol.: 1-12. https://doi.org/10.1093/jee/toac096
- Ribeiro, A.V., Aita, R.C., D.T. Pezzini, C.D. DiFonzo, T.E. Hunt, **J.J. Knodel**, C.H. Krupke, L. Marchi-Werle, A.P. Michel, N.J. Seiter, R.J. Wright, W.D. Hutchison and R.L. Koch. 2022. Optimization of sample unit size for sampling stink bugs (Hemiptera: Pentatomidae) in soybean. Crop Protection 157. https://doi.org/10.1016/j.cropro.2022.105986
- Calles Torrez, V., P. Beauzay and **J. Knodel.** 2023 (in press). Survey of Bees (Hymenoptera: Apoidea) in Flowering Soybean and Sunflower Fields in North Dakota. *Journal of the Kansas Entomological Society.*

OBJECTIVE 4: Educate farmers, industry, colleagues, general public, and agricultural professionals using traditional tools and innovative methods.

EXTENSION OUTREACH (meetings, publications) increase knowledge on the importance of Integrated Pest Management strategies for control of soybean aphids and other soybean insect pests. Some examples are field scouting, economic thresholds, insecticide recommendations, development of insecticide resistance, role of biological control agents and host plant resistance.

- **Trade magazine:**
  - Soybean Pests in North Dakota Can Be Elusive: Be Prepared (Part 1 of 2). Carol Brown (editor), Soybean Research and Information Network (SRIN). Dec. 12, 2022. https://soybeanresearchinfo.com/research-highlight/soybean-pests-in-north-dakota-can-be-elusive-be-prepared-part-1-of-2/
  - Soybean Pests in North Dakota Can Be Elusive: Be Prepared (Part 2 of 2) - Soybean Gall Midge May Be in North Dakota. Carol Brown (editor), Soybean Research and Information Network (SRIN). Feb. 13, 2023. https://soybeanresearchinfo.com/research-highlight/soybean-pests-in-north-dakota-can-be-elusive-be-prepared-part-2-of-2/

- **Peer-reviewed Extension Publications with soybean insect information:**
  - **Knodel, J.J.**, P. Beauzay, M.A. Boetel, T.J. Prochaska and A. Chirumamilla. 2022. 2023 North Dakota Field Crop Insect Management Guide E1143 (revised). NDSU Ext., Fargo, ND. https://www.ndsu.edu/agriculture/ag-hub/publications/north-dakota-field-crop-insect-management-guide
  - **Knodel, J.J.**, P. Beauzay and V. Calles Torrez. 2023. Insect management in soybean. *In* Soybean Production Field Guide for North Dakota. A-1172 (revised). H. Kandel and G. Endres (*editors*), NDSU Ext., Fargo, ND.

- **Extension Banners for Outreach**
  - A large banner titled 'Integrated Pest Management (IPM) of Soybean Arthropod Pests' was developed, and is available for outreach to soybean growers (Fig. 3). The large banner discusses IPM of soybean aphids, two-spotted spider mites, and grasshoppers in soybean fields. Three of these banners were printed; one was given to the NDSC office, one for NDSU Extension Entomology outreach in Fargo and the other for NDSU Extension outreach at the NCREC in Minot.

Figure 3. New Soybean Arthropod Pest banner at the ND Corn-Soybean Expo in Fargo on February 21, 2022.

- **Extension Newsletter – NDSU Extension *Crop & Pest Report*: (soybean insect articles only)**
  1. Knodel, J.J. 2022. Revised soybean aphid pub. NDSU Extension *Crop and Pest Report* #2 (May 12, 2022).
  2. Knodel, J.J. 2022. Soybean aphid – overwintering mortality. NDSU Extension *Crop and Pest Report* #2 (May 12, 2022).
  3. Knodel, J.J. 2022. Scout for bean leaf beetle in soybeans and dry beans. NDSU Extension *Crop and Pest Report* #6 (June 9, 2022).

4. Knodel, J.J. 2022. First detection of soybean aphids in ND. NDSU Extension *Crop and Pest Report* #8 (June 23, 2022).
5. Knodel, J.J. 2022. Aphid update. NDSU Extension *Crop and Pest Report* #11 (July 14, 2022).
6. Knodel, J.J. 2022. Aphid update. NDSU Extension *Crop and Pest Report* #12 (July 21, 2022).
7. Beauzay, P.B., and Knodel, J.J. 2022. Red headed flea beetle in soybean, corn and wheat. NDSU Extension *Crop and Pest Report* #13 (July 28, 2022).
8. Knodel, J.J. 2022. Aphid update. NDSU Extension *Crop and Pest Report* #13 (July 28, 2022).
9. Knodel, J.J. 2022. Aphid update. NDSU Extension *Crop and Pest Report* #14 (August 4, 2022).
10. Knodel, J.J. 2022. Soybean aphids increasing. NDSU Extension *Crop and Pest Report* #15 (August 11, 2022).
11. Knodel, J.J. 2022. Scout for bean leaf beetles in soybeans and dry beans. NDSU Extension *Crop and Pest Report* #15 (August 11, 2022).
12. Knodel, J.J. 2022. Soybean aphid update. NDSU Extension *Crop and Pest Report* #16 (August 25, 2022).
13. Calles-Torrez, V., Beauzay, P.B., and Knodel, J.J. 2022. Soybean gall midge – 'tentatively' confirmed in ND. NDSU Extension *Crop and Pest Report* #18 (September 22, 2022).
14. Knodel, J.J., and Beauzay, P.B. 2022. 2022 IPM crop survey – soybean and sunflower. NDSU Extension *Crop and Pest Report* #18 (September 22, 2022).

- **Extension Presentations: (**All are invited talks about soybean insects by Dr. Knodel.)

Training and professional development on soybean insect pests were provided at the following key meetings:

- Certified Crop Advisor Training, Jan. 6 ,2022. Total audience = 11 people.
- Getting It Right Soybean Production Workshop, Jan. 25, 2022. Total audience = 153 people.
- Best of the Best in Wheat and Soybean Research, Feb. 2, 2022. Total audience = 105 people.
- 2022 North Dakota Agriculture Consultants Annual Meeting, Feb. 7, 2022. Total audience = 145 people.
- 2022 Northern Corn Soy Expo, Feb. 21, 2023. Total audience = 100 people.
- Introduction to Crop Scouting School, Feb. 22, 2022. Total audience = 57 people.
- 10th International IPM Symposium, March 2, 2022. Total audience = 350 people.
- Class IPM lecture, Plant Sciences 225, April 27, 2023. Total audience = 97 people.
- IPM Scout Training, June 1 & 2, 2022. Total audience = 18 people.
- NDSU Agronomy Seed Farm Annual Field Tour, July 18, 2022. Total audience = 95 people.
- Field Day North Dakota State College of Science and Bismarck State College, July 22, 2022. Total audience = 100 people.
- NDSU Ag Recertification Pesticide Training, Nov. 30, 2022. Total audience = 110 people.
- Getting It Right Soybean Production, Dec. 20, 2022. Total audience = 153 people.

- **NDSU Extension's Integrated Pest Management Survey**

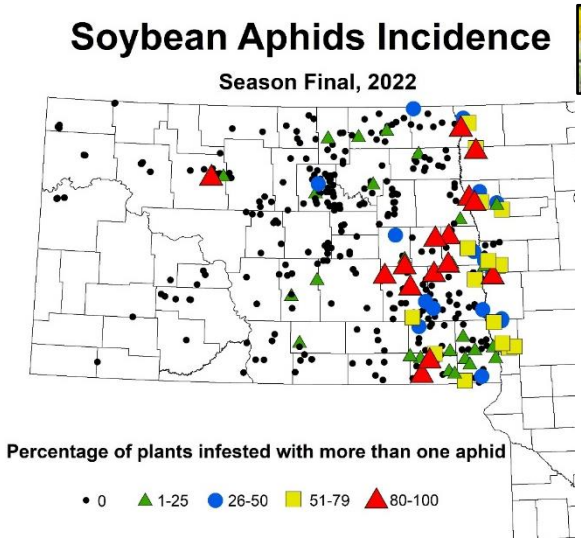
The ND IPM Crop Survey is supported by the National Institute of Food and Agriculture, Crop Protection and Pest Management - Extension Implementation Program, award number 2021-70006-35330.

Six NDSU IPM scouts surveyed a total of 404 soybean fields in North Dakota during 2022. The survey was initiated in early June and continued through August 18. Crops were surveyed from the 2-leaf stage through R6 growth stage in soybeans.

IPM survey data/maps provide near real-time pest information to North Dakota producers and others in agriculture to assist with scouting and pest management decision making. Soybean pest maps from the 2022 IPM Survey in North Dakota were uploaded weekly onto the NDSU IPM website - Soybeans.

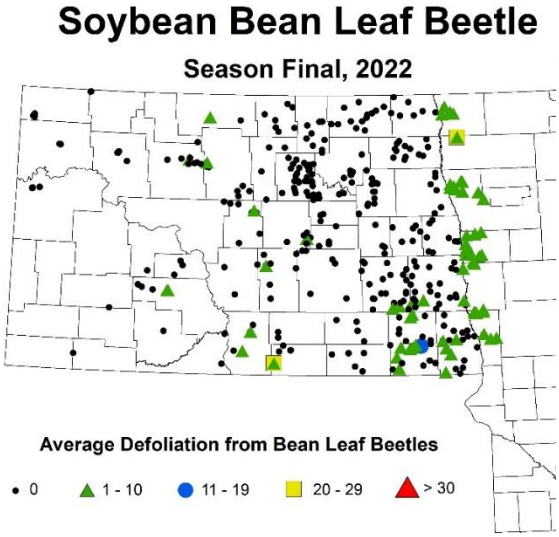
Some of the insect pest highlights for soybean insect pests are summarized below.

Soybean aphids - No soybean aphids were observed in 87% of the soybean fields surveyed for the fourth year in a row! There were no soybean aphids observed in 91% of the soybean fields in 2021, 96% in 2020 and 93% in 2019. Late in the season, soybean aphids started to increase in sporadic locations. The percent of plants infested with soybean aphids in fields was low with an average of 37% of plants infested and ranged from 1 to 100% of plants infested. The average number of aphids per plant was 20 aphids per plant and ranged from 1 to 330 aphids per plant. Most of the positive fields were located in the eastern part of North Dakota. Soybean aphids reached the economic threshold (E.T.) level in only two fields in Barnes and Ward Counties (average of 250 aphids per plant, 80% of plants infested with one or more aphids and increasing population levels).



Spider mites were observed in 30% of the soybean fields scouted and most common on field edges late in the season.

Bean leaf beetles are becoming a more common pest of soybean in North Dakota. Beetles were detected in sweep net samples and defoliation estimates in soybean. Defoliation ranged from 1 to 20% defoliation. The second generation was more common in August. It was present in southeastern North Dakota, but also was found in north central and east central North Dakota. Bean leaf beetle was present at economic levels in a small percentage of soybean fields in 2022.



S1080 Nebraska State Report 2022

Justin McMechan, Thomas E. Hunt, Robert Wright, and Ana Velez

Associated Post-Docs:

Gabi Carmona (Advised by Justin McMechan
Matheus Ribeiro (Advised by Justin McMechan and Ana Velez)

Associated Students:

PhD Sandwich Student: Matheus Sacilotto (2022, Brazil), Advised by T.E. Hunt and R.J. Wright
Vilma Montenegro, M.S. Student. (Advisor: Justin McMechan)
Ravneet Kaur, M.S. Student (Advisors: Ana Velez and Justin McMechan)
Natasha Umezu, M.S. Student (Advisor: Justin McMechan)
Mikaelison da Silva Lima, M.S. Student (Advisor: Justin McMechan)
Pragya Gupta, M.S. Student (Advisor: Justin McMechan)
Madeline Johnson (REEU Student) Advisor: Justin McMechan
Natalie Johnson (REEU Student) Advisor: Ana Velez and Justin McMechan
Anna Kelley, Summer Intern Ohio MPHM Program (Advisor: Justin McMechan)

Nebraska Overview:

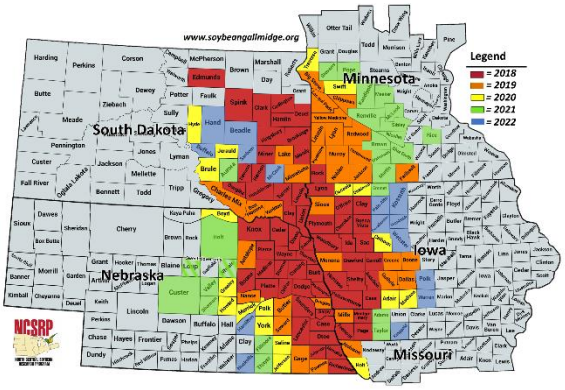
Field surveys for soybean gall midge larvae in 2022 shows that the insect is not hard to find in eastern Nebraska soybean fields. Although it was frequently found in soybean fields, plant injury was not as severe as in previous years. Adult emergence of soybean gall midge from overwintering sites was first reported in early-June in Nebraska. Adult emergence numbers were quite a bit lower than in previous seasons. The drop in adult activity in emergence cages could be the result of a drier than normal season. The dry weather also resulted in an increase in spider mites which were an occasional pest of soybean. After harvest, several soybean farmers reported increased lodging associated with Dectes stem borer. This is likely a result of early girdling associated with dry weather in late-summer and early-fall. Although no numbers were recorded a greater number of Dectes stem borer were observed in overwintering soybean gall midge emergence cages during the summer.In general, defoliating insects did not cause significant issues in the state. Japanese beetle presence in soybean is being noticed further west in the state.

(1) Document changing soybean pest and beneficial arthropod assemblages.

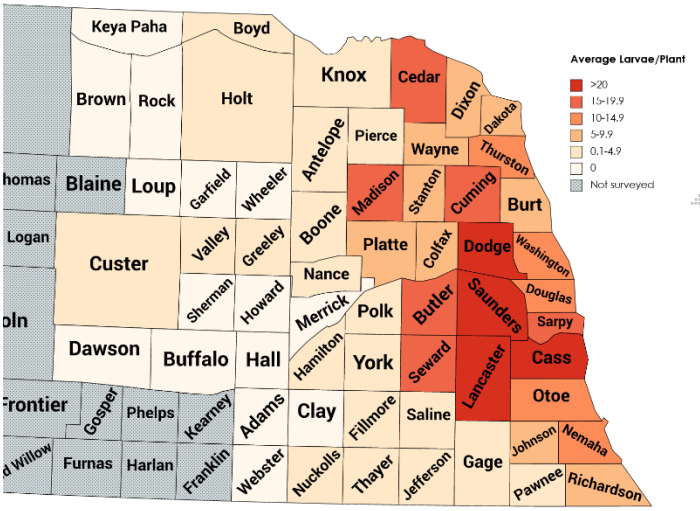
Soybean is injured by a diverse guild of insect pests feeding on leaves, stems, roots, nodules, and pods. The major insect pests in these guilds have markedly changed in the last two decades due to the introduction and range expansion of invasive insects and the adaptation of native pests.

Short Summary:

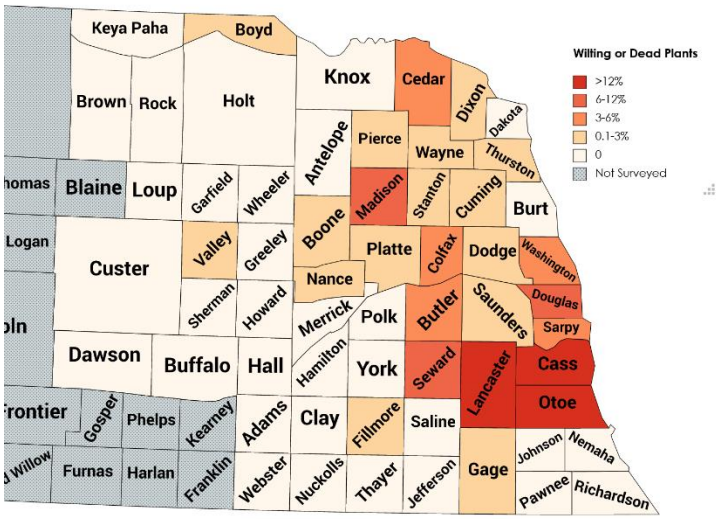
A multi-state (NE, IA, SD, MN, MO, KS, IL, WI, and ND) field survey was conducted to determine the distribution of soybean gall midge. States with no history of soybean gall midge were provided a list of high-risk fields (164 GPS locations) based on USDA CropScape and Google Earth from the University of Nebraska – Lincoln. Results yielded no new state records for soybean gall midge apart from a tentative identification of soybean gall midge in North Dakota. In states with a historical record of soybean gall midge a total of 15 new counties were identified as infested for a total of 155 counties.



In Nebraska, field surveys on the distribution and severity of soybean gall midge in Nebraska continued for the 3rd year as a result of Nebraska Soybean Board funding. The results of the 2022 survey found two additional counties (Nuckolls and Hamilton). In the central part of the state, larvae when detected remains at less than five larvae per plant. Eastern counties vary in larval abundance with 10 counties showing average larval numbers greater than 15 larvae per plant. Approximately 77% of fields surveyed in counties with a historical report of soybean gall midge were found to be infested.



In general, wilting and dead plants for soybean gall midge corresponded to counties with greater larval presence. Some wilting was observed in two counties in the central part of the state albeit at very low levels.



Peer reviewed pubs:

None.

Professional presentations:

Kaur, R. A. Velez, T. Hunt and **A.J. McMechan**. 2022. Characterizing the geographic distribution of newly emerged pest, the soybean gall midge across its geographic and host plant range. North Central Branch Entomological Society of America Meeting. Minneapolis, MN. March.

Extension presentations:

McMechan, A.J., T.E. Hunt, R. Wright. 2022. Soybean gall midge research: research update on an emerging pest of soybean. Crop Production Clinic. Mead, Beatrice, Norfolk. 310 participants

McMechan, A.J. A. Varenhorst, E.W. Hodgson, B. Potter, T.E. Hunt, R. Wright. 2022. Midwest Soybean Gall Midge Series: Insights on soybean gall midge distribution, scouting, ecology, and chemical control. Webinar Online. 410 participants

McMechan, A.J. 2022. Soybean gall midge: understanding risk and the road to management. Agronomy Society of America Series. Online. 174 participants.

Impact statements:

(2) Characterize soybean insect biology and ecology.

The range expansion of invasive pests, coupled with the adaptation of native pests, necessitate further research into how insects cope with new selection pressures

Short Summary:

A multi-state adult emergence network for soybean gall midge funded by the North Central Soybean Research Program shows the continued challenge of tracking adults using modified Illinois rootworm emergence cages. Adults were monitored at 20 sites in NE, IA, SD, MN. First adult emergence from overwintering sites was reported in east-central Nebraska on June 2nd. Current year's soybean first adult detection was approximately one month later on July 1st. The average duration of adult emergence from overwintering sites was less than the 2021 (36 days) with an average of 24 days. A total of 914 adults were collected during the season, significantly less than the 5,276 collected in 2021.

Peer reviewed pubs:

Lawton, D., A. Huseth, G. Kennedy, A. Morey, W. Hutchison, D. Resig, S. Dorman, D. Dillard, R. Venette, R. Groves, J. Adamczyk, I. Barbosa Dos Santos, T. Baute, E. Burkness, A. Dean, G. Dively, S. Dorman, H. Doughty, S. Fleischer, J. Green, J. Greene, K. Hamilton, E. Hodgson, T. Hunt, S. Malone, F. Musser, D. Owens, J. Palumbo, S. Paula-Moraes, J. Peterson, F. Reay-Jones, D. Reisig, S. Rondon, A. Seaman, L. Spears, S. Stewart, S. Taylor, T. Towles, C. Welty, J. Whalen, R. Wright and M. Zuefle. 2022. Pest population dynamics are driven by a continental overwintering gradient. PNAS. 119(37) e2203230119. https://doi.org/10.1073/pnas.2203230119

Helton, M., N. Tinsley, **A.J. McMechan** and E. W. Hodgson. 2022. Developing an injury severity to yield loss relationship for soybean gall midge (Diptera: Cecidomyiidae). Journal of Economic Entomology. https://doi.org/10.1093/jee/toac038

Professional presentations:

McMechan, A.J., E. Hodgson, A. Varenhorst, B. Potter, T. Hunt, and R. Wright. 2022. Soybean Gall Midge: Understanding ecology and management through field research. North Central Branch Entomological Society of America Meeting. Minneapolis, MN. March.

Da Silva Lima, M. and **A. J. McMechan**. 2022. Seasonal dynamics of soybean gall midge cocoons in soil from infested soybean fields. ESA, ESC, and ESBC Joint Annual Meeeting. Vancouver, BC, Canada. November

Lima, M., T. Possebom, D. Montezano, J. Knodel, K. Anderson, T. Hunt, V. Montenegro, **A. J. McMechan**. 2022. Cocoon distribution of soybean gall midge in the soil profile. North Central Branch Entomological Society of America Meeting. Minneapolis, MN. March.

Agpawa, E. and **A.J. McMechan**. 2022. Impact of artificial rainfall and physical barriers on the timing and abundance of soybean gall midge. North Central Branch Entomological Society of America Meeting. Minneapolis, MN. March.

Montenegro, V. and **A. J. McMechan.** 2022. Soybean gall midge: understanding larval abundance on soybean plants during the growing season. North Central Branch Entomological Society of America Meeting. Minneapolis, MN. March.

Umezu, N., R. Stacke, and **A. J. McMechan.** 2022. Evaluating the role of hail damage in soybean gall midge infestation. North Central Branch Entomological Society of America Meeting. Minneapolis, MN. March.

Extension presentations:

Impact statements:

(3)

Develop coordinated best management practices (BMPs).

As soybean insect pest assemblages change, there is a need to update pest management strategies.

Short Summary:

Cultural, chemical, and host plant resistance tactics were evaluated for the management of soybean gall midge. An NCSRP funded field border mowing study to disrupt overwintering adults was conducted in NE and MN. Results were inconsistent between the two sites with some indicating of an early season reduction in infestation. Additional treatments were added to this study for 2023 to further understand this tactic. Hilling soybean, a tactic that is not currently used in soybean was further evaluated with different timings of hilling relative to plant development stage. Results found that hilling at V2 and V5 stage soybean was effective in reducing larval number, plant injury and protecting yield. R2 hilling reduced larval number but did significantly reduce plant injury or protect yield compared to plots without hilling. Industry trials were conducted on a wide range of products (seed treatment, liquid in-furrow, granular at-plant, and foliar). Seed treatment studies were lost in a hailstorm in early June. Of the remaining studies, none with the exception of Thimet 20G, showed a consistent response to soybean gall midge.

Host plant resistance against soybean gall midge was evaluated at four locations across NE, IA, and SD. Of the 72 accession lines evaluated, all were found to be infested in at least one site. Although larvae were present in all treatments, their number per plant and the severity of plant injury varied between accession lines indicating that some lines may be have some level of resistance.

Peer reviewed pubs:

Ribeiro, A.V., Aita, R.C., D.T. Pezzini, C.D. DiFonzo, T.E. Hunt, J.J. Knodel, C.H. Krupke, L. Marchi-Werle, A.P. Michel, N.J. Seiter, R.J. Wright, W.D. Hutchison and R.L. Koch. 2022. Optimization of sample unit size for sampling stink bugs (Hemiptera: Pentatomidae) in soybean. Crop Protect. 157 (105986) https://doi.org/10.1016/j.cropro.2022.105986

Lawton, D., A. S. Huseth, G. G. Kennedy, A. C. Morey, W. D. Hutchison, D. D. Reisig, S. J. Dorman, D. Dillard, R. C. Venette, R. L. Groves, J. J. Adamczyk, I. Barbosa Dos Santos, T. Baute, S. Brown, E. Burkness, A. Dean, G. P. Dively, H. B. Doughty, S. J. Fleischer, J. Green, J. K. Greene, K. Hamilton, E. Hodgson, T. Hunt, D. Kerns, B. R. Leonard, S. Malone, F. Musser, D. Owens, J. C. Palumbo, S. Paula-Moraes, J. A. Peterson, R. Ramirez, S. I. Rondon, T. L. Schilder, A. Seaman, L. Spears, S. D. Stewart, S. Taylor, T. Towles, C. Welty, J. Whalen, R. Wright, and M. Zuefle. 2022. Pest population dynamics are related to a continental overwintering gradient. Proceedings of the National Academy of Sciences. 119: e2203230119.

Professional presentations:

Gupta, P., G. Carmona, M. Geraldo Pires De Mello Ribeiro, and **A. J. McMechan**. 2022. Impact of timing of hilling on the management of soybean gall midge. ESA, ESC, and ESBC Joint Annual Meeting. Vancouver, BC, Canada. November

Umezu, N., G. Carmona, **A. J. McMechan.** 2022. Planting date and an at-plant insecticide as managment strategy for soybean gall midge. ESA, ESC, and ESBC Joint Annual Meeeting. Vancouver, BC, Canada. November

Kolbe, B. E. Hodgson, and **A.J. McMechan.** 2022. Pre-season tillage effects on *Resseliella maxima* emergence. North Central Branch Entomological Society of America Meeting. Minneapolis, MN. March.

Extension presentations:

Impact statements:

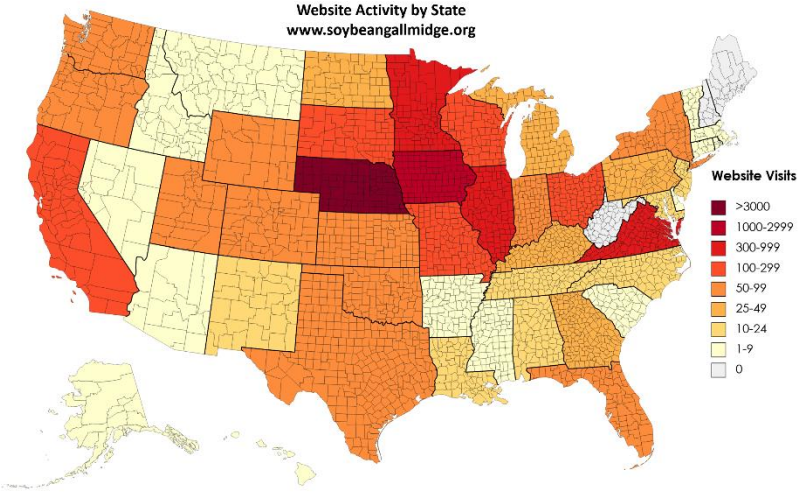
(4)

Educate farmers, industry, colleagues, general public, and agricultural professionals using traditional tools and innovative methods.

Our Working Group works extensively with stakeholders at all levels. For our clientele, we represent one of the only unbiased sources of information for decision-making of IPM strategies.

Short Summary:

A two-part webinar on soybean gall midge was held in February with over 400 live participants. This is the second year we've held this event. In addition, the soybeangallmidge.org website and alert system continue to grower in users.



Website metrics expanded significantly in 2022 with over 7,313 unique visitors *(+57% increase over 2021)* and 16,110 pageviews *(+60% increase over 2021)* from participants in 47 states (Fig. 1) within the U.S.A as well as 57 countries. Communication on SGM emergence and management with clientele during the season was achieved through an alert system on blackboard connect. The system can deliver an automated phone call, text message, and email to a total of 507 clientele across eight states and Canada. Participation in the alert network grew by 12% this past year.

Peer reviewed pubs:

Professional presentations:

Extension presentations:

McMechan et al. 2022

- Topics: Soybean gall midge, Dectes stem borer, defoliators, and spider mites
- 19 presentations on soybean insect pests
- 1,926 participants

Hunt, T., 2022 Farm Progress 365 Virtual Session, Farm Progress, Webinar, ~200 participants, "Corn and Soybean Insects 2022:Usual and Unusual Suspects in the North Central Region".

Hunt, T., Wright, R., Brummels Crop Shop, Corteva, Osmond, NE, "Dectes Stem Borer -a new soybean insect pest to the area!".

Hunt, T., McMechan, A., Brummels Crop Shop, Corteva, Osmond, NE, "Gall Midge -update on its spread and management options".

Hunt, T., Wright, R., Frahm Crop Shop, Corteva, Plainview, NE, "Dectes Stem Borer -a new soybean insect pest to the area!".

Hunt, T., McMechan, A., Frahm Crop Shop, Corteva, Plainview, NE, "Gall Midge -update on its spread and management options".

Hunt, T., Wright, R., Wilken Crop Shop, Corteva, Tilden, NE, "Dectes Stem Borer -a new soybean insect pest to the area!".

Hunt, T., McMechan, A., Wilken Crop Shop, Corteva, Tilden, NE, "Gall Midge -update on its spread and management options".

Hunt, T., 2022 Midwest Soybean Production In-Field Clinic, University of Nebraska, ENREEC Ithaca, NE, "Soybean Insect Management".

Spider mite damage and control with Dr. Bob Wright. August 2022. CropWatch podcast. https://t.co/J2zqvpVWjx

Soybean aphid IPM. 2022. A. Hanson and R. Wright. Michigan State University. https://feeds.buzzsprout.com/2039018/11196659-university-of-minnesota-ipm50

Wright, R. J., W. Ohnesorg & J. McMechan. 2022. Insect Management, pp. 309-348, in 2022 Guide for Weed, Disease, and Insect Management in Nebraska, EC 130, University of Nebraska-Lincoln Extension. https://marketplace.unl.edu/extension/ec130.html

Impact statements:

Ohio Report

S1080

March 12, 2023

Prepared by: Kelley Tilmon, Department of Entomology, Ohio State University

Recognition

Awards

Jasinski, J. B. Bergefurd, A. Wilson, B. Philip, J. Pierzynski, D. Ellsworth, M. Gardiner, A. Michel, K. Tilmon, F. Becker, A. Stone, B. Butler, A. Dorrance, L. Lindsey, C. Welty and P. Paul. 2022. CFAES Extension Team Award. OSU Extension Annual Awards.

Undergraduate Programs

Provided 3undergraduate internships for spring, summer and fall work experience in entomology field research

- Jessie Raubenolt (Ashland University)
- Bridger Cline (Heidelberg University)
- Jessica McWattters (Ohio State University)

Research & Graduate Education Related to S1080 Objectives

Grants funded in 2022:

Tilmon, K. J. and A. Michel. 10/2021 – 9/2022. Monitoring and management of soybean insect pests FY23. Ohio Soybean Council. $60,000.

Tilmon, K. J. and A. Michel. 4/2022 – 3/2023. 3D printing to create education tools for pest man. Ohio Soybean Council. $15,000.

Other grants active in 2022:

Tilmon, K. J. and J. McMechan. 10/2021 – 9/2024. Research and Extension on Emerging Soybean Pests in the North Central Region. North Central Soybean Research Program. $1,709,837.

Jasinski, J. et al. 2021-23. **Ohio Extension Implementation Program 2021-23. USDA-NIFA. $797,622 [Tilmon is one of 4 collaborators in the agronomic crops sub-group with a combined shared budget of $120,000]**

Tilmon, K. J. and A. Michel. 10/2021 – 9/2022. Monitoring and management of soybean insect pests FY22. Ohio Soybean Council. $59,000.

Peer-reviewed journal publications in 2022 related to S1080 objectives:

<u>Published</u>

Overmyer, K., W. Looker, A. E. Dorrance, **K. J. Tilmon** and L. E. Lindsey. 2022. Influence of rye/oat cover crop in a two-year soybean production system. Agronomy Journal 115: 303-313.

Hesler, L. S., **K. J. Tilmon**, A. J. Varenhorst, S. R. Conzemius, E. Taliercio and E. A. Beckendorf. 2022. Challenges and Prospects of Wild Soybean as a Resistance Source Against Soybean Aphid (Hemiptera: Aphididae). *Annals of the Entomological Society of America* 115: 25-38.

Zhang, Z., S. Khanal, A. Raudenbush, **K. Tilmon** and C. Stewart. 2022. Assessing the efficacy of machine learning techniques to characterize soybean defoliation from unmanned aerial vehicles. Computers and Electronics in Agriculture 193: doi.org/10.1016/j.compag.2021.106682

Musser, F.R., A. L. Catchot, Jr., J. A. Davis, C. DiFonzo, S. H. Graham, J. K. Greene, B. Jensen, D. L. Kerns, R. L. Koch, D. Owens, D. D. Reisig, P. M. Roberts, T. A. Royer, N. J. Seiter, S. D. Stewart, S. V. Taylor, B. C. Thrash, **K. J. Tilmon** and R. T. Villanueva. 2022. 2021 Soybean Insect Losses in the United States. Midsouth Entomologist 15: 39-63.

Research Presentations in 2022 related to S1080 objectives:

Kesheimer, K. and **K. Tilmon**. 2022. Recent history and future trends in extension entomology. In: Recent Trends and Prospects for the Future in Several Key Plant-Insect Ecosystems Sub-Disciplines. Entomological Society of America Annual Meeting, Vancouver Canada.

Rice, K., **K. Tilmon** and A. Raudenbush. 2022. Current status and research on brown marmorated stink bug. In: Highlights of field crop insect pest management: Invasive and resistant pests. Entomological Society of Americal North Central Branch, Minneapolis.

Tilmon, K. J. 2022. Sociological dimensions and public perception of classical biological control. 15th International Symposium on the Ecology of Aphidophaga. Lleida, Spain.

Outreach and Extension Reporting Related to S1080 Objectives

Outreach presentations (presentations given to any group other than university peers):

Tilmon, K. J. 2022. Seed treatments. OSU Pesticide Applicator Recertification Training, Akron. January 2022.

Tilmon, K. J. 2022. Agronomic insect pest update. OSU Pesticide Applicator Recertification Training, Akron. January 2022.

Tilmon, K. J. 2022. Agronomic insect pest update. OSU Pesticide Applicator Recertification Training, Columbus. February 2022.

Tilmon, K. J. 2022. Insect updates for cereal crops and soybeans. Ohio Seed Improvement Association 87th Annual Ohio Professional Seed Grower's School. February 2022.

Tilmon, K. J. 2022. Fall armyworm and other insect gotchas. OSU Field Crops Webinar Series. February, 2022.

Tilmon, K. J. 2022. Agronomic insect pest update. OSU Private Applicator Training, Webinar. March 2022.

Tilmon, K. J. 2022. Seed treatments. OSU Pesticide Applicator Recertification Training, Webinar. March 2022.

Tilmon, K. J. 2022. Soybean insect management. OSU Virtual Pesticide Applicator Training. March 2022.

Tilmon, K. J. 2022. Field crop pest update in corn and soybean. Muskingum County Field Day. August, 2022.

Tilmon, K. J. 2022. Agronomic pest insect update. OSU Extension Educator Inservice. December 2022.

List of extension bulletins published (provide citations):

<u>Proceedings Papers</u>

Tilmon, K. J. and A. Michel. 2022. Update on field crop insects. Proceedings of the Ohio Private Pesticide Applicator Recertification Conference. Ohio State University Extension.

Tilmon, K. J. and A. Michel. 2022. Update on field crop insects. Proceedings of the Ohio Commercial Pesticide Applicator Recertification Conference. Ohio State University Extension.

Field guides

Raudenbush, A. and **K. Tilmon**. 2022. Field guide to stink bugs on soybean in the North Central Region, Second Edition. North Central Research Program.

Raudenbush, A. and **K. Tilmon**. 2022. Field guide to stink bugs on soybean in Ohio, Second Edition. OSU Extension.

Extension ID/Alert Cards

Raudenbush, A., **K. Tilmon** and N. Seiter. 2022. Soybean defoliators of Ohio. Quick ID Card. https://aginsects.osu.edu/sites/aginsects/files/imce/Soybean%20defoliation%20draft%208_4_22.pdf 10,000 printed and online distribution

Multimedia

Bhasanal, S., K. Tilmon and A. Michel. 2022. Updates soybean defoliation 3-D printed keychain with threshold information and URL.

- Impact: The program for this keychain was shared with the Soybean Research Information Network who printed 3,000 copies for distribution in the Midwest. A colleague at Purdue reported this to us: "Purdue recently hosted the Regional High School Scouting Competition. For the insect station, I had the teams determine the amount of soybean defoliation from pressed/laminated leaves. One team from Iowa, pulled out the 3D printed defoliated leaves that the NC Regional sponsored. This really helped the team, so I thought you might like a picture of them in use, see below. BTW, the Iowa kids' team coach is Suzanne Shirbroun, Iowa Soybean Association's president-elect!"

Extension Website Development

Tilmon, K. J. and A. Raudenbush. 2021. OSU Agronomic Crop Insects Website. OSU College of Food, Agriculture, and Environmental Science. Continuous updating in 2021. https://aginsects.osu.edu/

Contributions to Trade Journals, Popular Press, and Public Media

Conducted filmed interview for Grow Next Gen: Career Videos – Entomology Research. https://grownextgen.org/career-videos

Interview for a featured article "Developing a new method to monitor stink bugs in soybeans" (Laura Temple). Soybean Research and Information Network.

Contributed interview/information for "Unspoken truths about Japanese beetles" (Sara Schaefer). Farm Journal.

Contributed interview/information for “Early season pests of corn and soybean” (Chris Torres). American Agriculturalist/Ohio Farmer.

Newsletter Articles

1) **Tilmon, K.,** A. Michel. “Watch for Slug Damage on Seedling Plants” CORN Newsletter: 16-2022. May 31-June 6, 2022. Watch for Slug Damage on Seedling Plants | Agronomic Crops Network (osu.edu)
2) Michel, A., **K. Tilmon**. “Summer Crop Insects – What to Watch For” CORN Newsletter: 19-2022. June 21-27, 2022. https://agcrops.osu.edu/newsletter/corn-newsletter/2022-19/summer-crop-insects-%E2%80%93-what-watch
3) **Tilmon, K**., A. Michel. “Defoliation in Soybean and Corn” CORN Newsletter: 24-2022. July 26-August 1, 2022. https://agcrops.osu.edu/newsletter/corn-newsletter/2022-24/defoliation-soybean-and-corn
4) **Tilmon, K**., A. Michel. “Stink Bugs in Soybean” CORN Newsletter: 25-2022. August 2-8, 2022. https://agcrops.osu.edu/newsletter/corn-newsletter/2022-25/stink-bugs-soybean
5) **Tilmon, K.** and A. Michel. “Late-Season Soybeans Can Be Pest Magnets” CORN Newsletter: 29-2022. August 30 – September 5, 2022. https://agcrops.osu.edu/newsletter/corn-newsletter/2022-29/late-season-soybeans-can-be-pest-magnets

List of Engagements with External Constituents (e.g., individual clients/citizens; business/industry; commodity groups; government agencies; non-profits):

- Ohio Soybean Council
    - Organized OSU faculty meeting with Tom Fontana, Research Director for the Ohio Soybean Council, May 2022.

- Ohio Agribusiness Association

- Ohio Seed Improvement Association

- Ohio Pesticide Advisory Board
- North Central Soybean Research Program

List of external partners engaged in developing and implementing Extension and Outreach programs (including faculty and staff serving on partner advisory councils and committees, and other advisory roles as appropriate):

- Ohio Soybean Council
- North Central Soybean Research Program

List Extension Teams that you are involved in, including role and contributions:

- Ohio Agronomic Crops Team (State Specialist) (2016 to present)
- North Central Field Crop Entomologist Working Group (2009 to present)

S1080 Working Group

S-1080 : Improving Soybean Arthropod Pest Management in the U.S.

"USDA-ARS, South Dakota, State Report 2022"

Louis Hesler

USDA-ARS, Brookings, SD

Overview: USDA-ARS, Brookings, South Dakota

Report summary –

The USDA-ARS North Central Agricultural Research Lab in Brookings, South Dakota participated as one site in a multi-location project funded by the North Central Soybean Regional Project on advancing aphid resistant soybeans through a public-private partnership. As part of that project, soybean plots were planted near Brookings, SD, with an experimental soybean line that had two resistant genes for managing soybean aphid. The levels of soybean aphids on the resistant plants within the plots were very low, even near zero. In contrast, soybean aphid levels in alternating buffer strips of aphid-susceptible soybean were very high, causing yellowing and curling of soybean leaves and extensive amounts of sooty mold on soybean foliage. Other insect pests such as defoliators and stink bugs were monitored on the aphid-resistant plants in the plots, but levels of these other pests were quite low.

In addition to the NCSRP project, we published a report about a newly described species of long-legged fly, *Chrysotus soya* (Diptera: Dolichopodidae), from soybean plots near Brookings, SD.

Peer reviewed pubs:

Runyon, J.B., E. Beckendorf, and L.S. Hesler. A new species of *Chrysotus* Meigen (Diptera, Dolichopodidae) from soybean fields in South Dakota, USA. ZooKeys 1135: 171-180. https://doi.org/10.3897/zookeys.1135.95026. 2022.

Extension presentations:

None related to soybean pest management.

Tennessee State Update

1.8 million acres in 2022

Early: Slugs were an inconsistent problem, majority of problems were behind poor burndown or cover crops. TCAH were also inconsistent with numbers being problematic behind legume cover crops and late burndown.

Mid Season: TN experienced severe drought that hurt growing conditions. Spider mites were an issue in several fields due to droughty conditions.

Late Season: Kudzu bugs and brown marmorated stink bug appeared late in the growing season. Threshold numbers of both pests were found in several fields. Soybean loopers impacted the far west Mississippi River Counties, no other notable defoliators really built in high numbers.

Scout School:

Trained 125 people at three scout schools across Tennessee.