North Dakota Soybean Council
Technical Report – December 2020

Pyrethroid Resistant Soybean Aphids, Drones for Insect Scouting and Detection of Invasive Soybean Gall Midge

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Situation

Pyrethroid Resistant Soybean Aphids. Insect resistance to pesticides is a worldwide problem. The United Nations Environmental Program has listed pesticide resistance as the third most serious threat to global agriculture behind soil erosion and water pollution. In the United States, annual losses due to pesticide resistance are estimated at $1.4 billion. Resistance influences pesticide application costs and crop yields, affecting the level and stability of farm income. Several pyrethroid and organophosphate insecticides are commonly used as foliar applications to manage soybean aphids, and insecticides continue to be the primary control strategy throughout the Upper Midwest. Soybean aphids could develop resistance to these chemistries. Based on the 2012 pesticide survey in ND, the top four insecticides used for insect control in soybeans included:

- Pyrethroids: lambda-cyhalothrin (Warrior and generics); bifenthrin (Brigade and generics); esfenvalerate (Asana XL)
- Organophosphates: chlorpyrifos (Lorsban and generics).

Hanson et al. reported that soybean aphids had partial to complete pyrethroid resistance in soybean fields located in Iowa, Minnesota, North Dakota, South Dakota, and Manitoba (Canada), which resulted in growers having to re-spray with another mode of action like chlorpyrifos. As a result of these findings, the goal of this research was to survey for populations of soybean aphids in eastern ND that may be developing insecticide resistance using a standardized laboratory bioassay, and to determine the best pest management strategies for insecticide resistant soybean aphids.

Soybean gall midge. In late June 2018, entomologists in Iowa, Nebraska, and South Dakota received reports of soybean fields with visible signs of dead or dying plants found to be associated with an infestation of cecidomyiid (gall midge) larvae at the base of the stem. These gall midges were recently identified as a new species, *Resseliella maxima,* by Dr. Gagné, a taxonomy expert on cecidomyiidae. The name *maxima* was chosen because of the host, *Glycine*

max, and the potential damage that the insect can cause to soybean. This was the first report of a species in the genus *Resseliella* on soybean in North America.

Yield losses from soybean gall midge were most extensive at the field edges. Round table discussions in Nebraska with 85 producers found an average yield loss of 78% for the first 100 ft from the field edges and 15% on the remainder of the field (McMechan, UNE). The widespread damage associated with this pest and its identification as a new species has left researchers and producers with significant gaps in knowledge that need to be addressed to develop a viable IPM program.

Soybean gall midge continues to be an important new pest of soybeans and has increased it's presence in Iowa, Minnesota, Nebraska, and South Dakota from a total of 67 counties in 2018 to 93 counties in 2019. Soybean gall midge also was detected in a new state in 2019, northwest Missouri. Since it's populations are increasing in our neighboring states of Minnesota and South Dakota, it is imperative that pest managers' survey for soybean gall midge in North Dakota.

Research Objectives are:

1) To determine the level of pyrethroid insecticide resistance in populations of soybean aphids in North Dakota and where pyrethroid resistance exists in the major soybean producing counties of North Dakota.
2) To determine which insecticides and modes of action are the best tools for managing pyrethroid resistant soybean aphids.
3) To determine the feasibility of using a new drone with improved cameras to scout for soybean aphids and other insect pests of soybean.
4) To survey for the invasive soybean gall midge in southeastern North Dakota.

Materials and Methods

<u>Objective 1</u>: Screening populations of soybean aphids for insecticide resistance.

A standard experimental procedure called the 'diagnostic dose glass-vial bioassay' was utilized to test for resistance to lambda-cyhalothrin and bifenthrin. Each assay consisted of three replications of three insecticide concentrations in 20-ml glass vials that were coated internally with a solution of technical grade insecticide diluted in acetone at concentrations expected to provide 99% mortality (LC99), twice the concentration expected to provide 99% mortality (2 x LC99), and an acetone control.

We assessed the mortality of 10 wingless (apterous) adult soybean aphids per vial after 4 hours and 24 hours of exposure to the inner surfaces of the vials.

<u>Objective 2</u>: Insecticide Study.

Soybeans were planted at two locations with a history of pyrethroid resistant soybean aphids in eastern ND: June 5 at Harwood, and June 6 at Emerado. Research plots were monitored weekly for soybean aphid populations from June through August. Insecticide applications for 17 different products were made at Emerado, regardless of the low soybean aphid populations were. Plots were harvested at Emerado. Harwood was too wet to spray and harvest. We plan to repeat this study in the 2020 summer.

Objective 3: Testing drones for insect scouting in soybean fields.

Due to the low populations of soybean aphid in 2019, we were not able to conduct the drone work. In addition, the drone with the autonomous probe needed for this objective was not available again from the company in 2019.

Objective 4: To survey for the invasive soybean gall midge in southeastern North Dakota.

Scouting for soybean gall midge focused on the bordering counties where populations may be moving from infested counties in neighboring Minnesota and South Dakota into North Dakota. Midge was scouted for by randomly examining 25 stems in 4 spots (total of 100 plants per field) while walking a transect on the field edges. Stems with darkened areas near the stem's base were dissected for white or orange larvae by peeling back the stem's epidermis.

Results and Discussion

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

In 2019, soybean aphids were low and present at non-economic populations in soybeans in ND (Figure 1). However, a few aphids were collected from a soybean field near Emerado in Grand Forks County for the pyrethroid resistance bioassay. These aphids were sent to Dr. Koch's laboratory at the University of Minnesota for rearing and testing for pyrethroid resistance.

Results indicated that this population was fairly resistant to bifenthrin (Brigade 2EC and generics) with 60-70% survivorship. Resistance to lambda-cyhalothrin (Warrior II and generics) ranged up to 50% survivorship.

This suggests that the pyrethroid resistant soybean aphids are mobile and may have migrated from other resistant areas in 2019, such as south central Minnesota where the resistance first occurred in 2015. Since pyrethroid resistant soybean aphids can vary by year

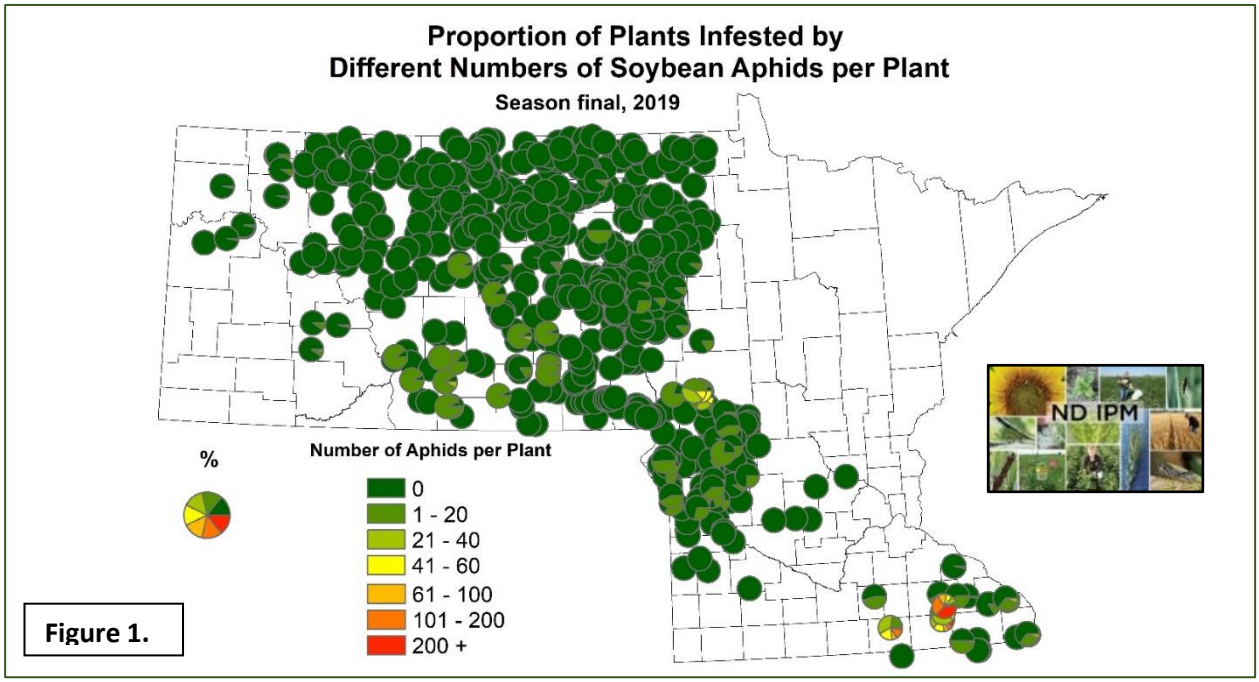

Figure 1.

and location, screening more populations of soybean aphids in ND is key to determine their presence or absence, and their resistance status. These findings will be essential for soybean growers, so they can wisely decide which insecticide to use when soybean aphid populations are above the E.T. level.

Outputs:

Menger, J., P. Beauzay, A. Chirumamilla, C. Dierks, J. Gavloski, P. Glogoza, K. Hamilton, E.W. Hodgson, J.J. Knodel, I.V. MacRae, D.T. Pezzini, B.D. Potter, A.J. Varenhorst and R.L. Koch. 2020. Implementation of a diagnostic-concentration bioassay for detection of susceptibility to pyrethroids in soybean aphid (Hemiptera: Aphididae). Journal of Economic Entomology: 1-8. https://doi.org/10.1093/jee/toz351

Knodel, J.J. 2019. Pyrethroid Resistant Soybean Aphids in ND. NDSU Extension *Crop and Pest Report* #15 (August 29, 2019).

Multistate Activities with NCSRP. The multistate extension publication was updated and reprinted in 2019 to include two new insecticides labeled for soybean aphid control in soybeans (Sefina from BASF and Transform from Corteva).

Koch, R., E. Hodgson, J. Knodel and A. Varenhorst. 2019. Management of Insecticide-resistant Soybean Aphids E1878 (revised). Multistate publication with University of Minnesota Extension, Iowa State University Extension and Outreach, NDSU Extension and SDSU Extension.

Objective 2: Foliar insecticide trial.

Due to the complete lack of soybean aphids in research plots at Emerado following foliar applications, even in the untreated checks, we were not able examine insecticide efficacy for different products for control of pyrethroid resistant soybean aphids. Also, there were no significant differences among all treatments for yield at Emerado. We plan to repeat this study in 2020 at three locations.

Objective 3: Testing drones for insect scouting in soybean fields.

Due to difficulties in conducting the drone scouting for soybean insect pests, we decided to drop this objective for future insect research.

Objective 4: To survey for the invasive soybean gall midge in southeastern North Dakota

A total of 78 soybean fields were inspected for soybean gall midge in 10 counties in southeastern and east central North Dakota (Figure 2). Result of our 2019 soybean gall midge survey were negative for all soybean fields surveyed in North Dakota.

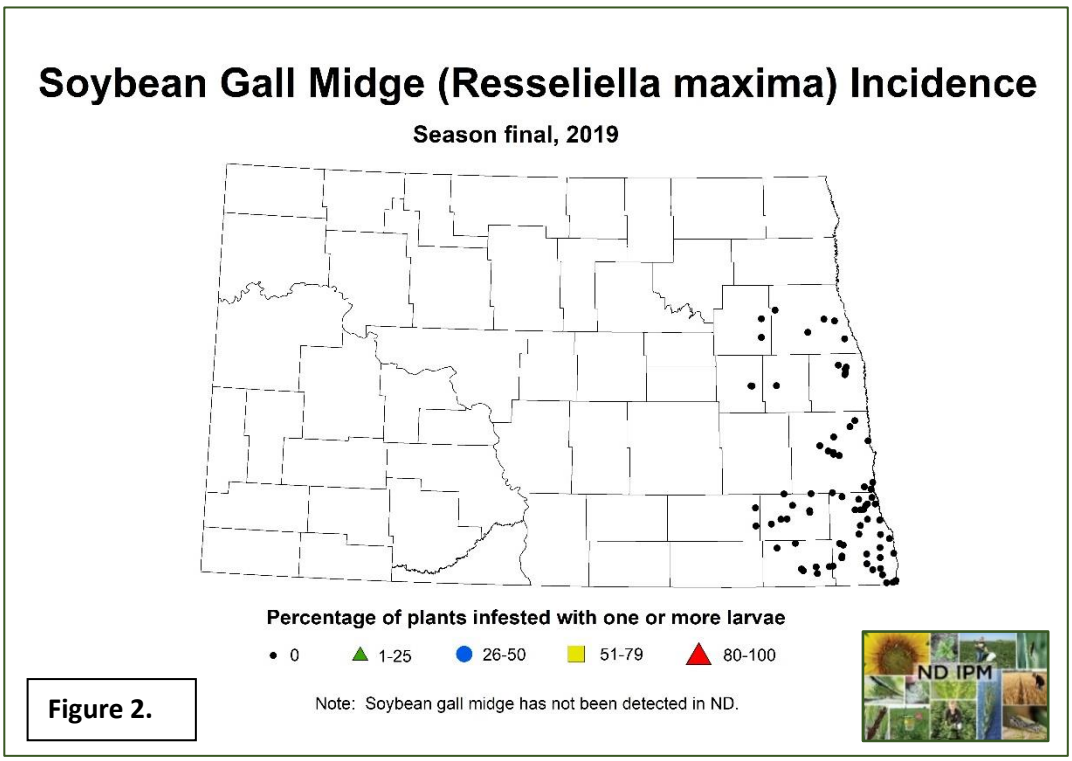

Figure 2.

Outputs:

Koch, R. L., B.D. Potter, J. Moisan-De Serres, J. Knodel, V. Calles-Torrez, J. Gavloski, T. Cira, M. Bartz, and R. Gagné. 2020. *Karshomyia caulicola* (Diptera: Cecidomyiidae) associated with Sclerotinia-infected soybean in the United State and Canada. The Great Lakes Entomologist.

Calles-Torrez, V., A.H. Knudson, J. Ostrander, P.B. Beauzay and J.J. Knodel. 2020. New gall midges (Diptera: Cecidomyiidae) in soybean in Midwest. NPDN News 15(1): 1-2 (January/February 2020).

Knodel, J.J. 2019. Soybean gall midge. NDSU Extension *Crop and Pest Report* #12 (July 25, 2019).

Knodel, J.J. 2019. No soybean gall midge detected in ND. NDSU Extension *Crop and Pest Report* #15 (August 29, 2019).

Research Presentations / Posters:

Presentations

Knodel, J., V. Calles-Torrez and P. Beauzay. 2019. Detection of Gall Midges (Diptera: Cecidomyiidae) in Soybeans in North Dakota. *In* ESA Forum: Soybean Gall Midge, J. McMechan (organizer). Entomological Society of American Annual Meeting. 17-20 Nov. 2019, St. Louis, MO.

Work to be completed:

For Objective 4, a new soybean aphid and soybean gall midge extension publication will be completed and published in 2021. A grant extension was requested to complete this objective by December 31, 2020. Due to COVID19, Ag Comm has limited workers working on publications, so it is taking longer about 2-3 months for editing, layout and printing. Approximately 3,000 copies of each publication will be printed in color and made available on the NDSU Extension website and to the NDSC for growers and crop managers.