North Dakota Soybean Council
Technical Report – June 30, 2021

Pyrethroid Resistant Soybean Aphids and Soybean Gall Midge Survey

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Research Objectives are:

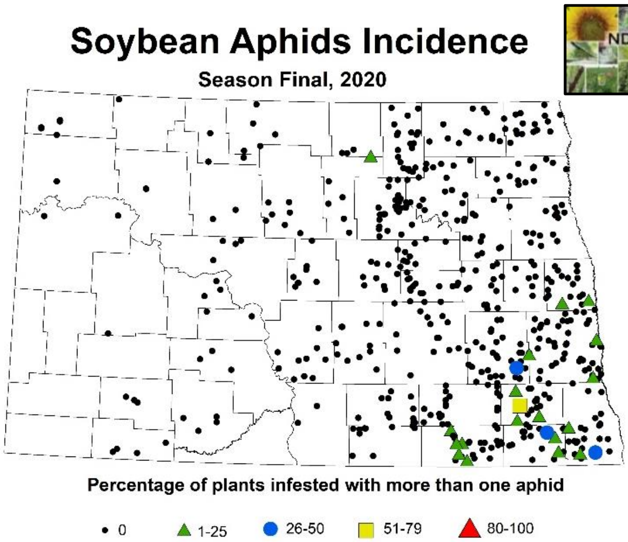
Objective One: To determine which insecticides and mode of actions are the best tools for management of pyrethroid resistant soybean aphids.

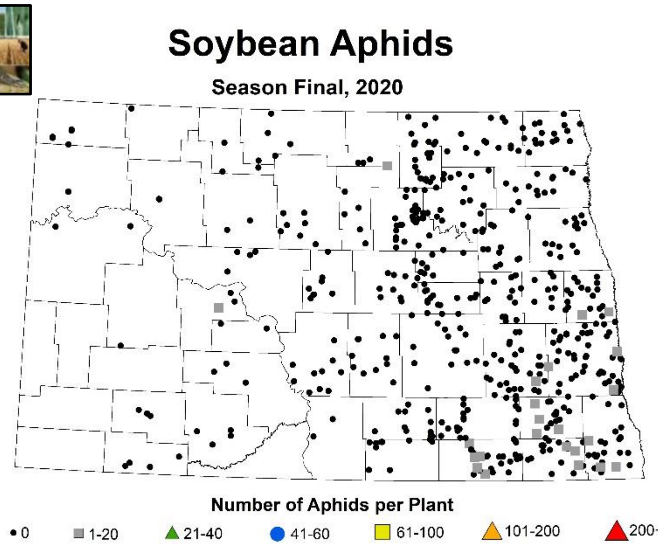
Objective Two: To conduct survey work for the detection of the invasive soybean gall midge.

Completed Work & Preliminary Results:

Objective One: Foliar insecticide trial

Soybean aphids were not an economic pest problem in 2020. Results of the IPM Crop Survey indicated that no soybean aphids were observed in 96% of the soybean fields surveyed. The percent of plants infested with soybean aphids in fields was very low with an average of 14% of plants infested and ranged from 2 to 58% of plants infested. The average number of aphids per plant was only 2 aphids per plant and ranged from 1 to 11 aphids per plant. Most of the positive fields were located in southeastern ND (Cass, Dickey, Ransom, Richland, Sargent, Traill Counties). Soybean aphids never reached the economic threshold (E.T.) level (average of 250 aphids per plant, 80% of plants infested with one or more aphids and increasing population





levels) in any of the fields during 2020.

Since soybean aphid was not a pest problem in 2020 and grasshoppers were increasing late in the season, we decided to conduct an insecticide efficacy trial on **"Pyrethroid Insecticides for Control of Grasshoppers in Soybean."**

Low and high labeled rates of pyrethroid insecticides were tested for control of grasshoppers in late growth stage soybeans at the NDSU Agronomy Farm, Casselton, ND. Insecticide products, active ingredients, and application rates are listed in Table 1.

Table 1. Treatment list.

Treatment Number	Insecticide	Active Ingredient(s)	Application Rate
1	Untreated Check 1	---	---
2	Untreated Check 2	---	---
3	Warrior II low rate	lambda-cyhalothrin	1.6 fl oz/acre
4	Warrior II high rate	lambda-cyhalothrin	1.92 fl oz/acre
5	Cobalt Advanced low rate	lambda-cyhalothrin + chlorpyrifos	6 fl oz/acre
6	Cobalt Advanced high rate	lambda-cyhalothrin + chlorpyrifos	13 fl oz/acre
7	Brigade low rate	bifenthrin	2.1 fl oz/acre
8	Brigade high rate	bifenthrin	6.4 fl oz/acre
9	Mustang Maxx low rate	zeta-cypermethrin	3.2 fl oz/acre
10	Mustang Maxx high rate	zeta-cypermethrin	4 fl oz/acre
11	Hero low rate	bifenthrin + zeta-cypermethrin	2.6 fl oz/acre
12	Hero high rate	bifenthrin + zeta-cypermethrin	6.1 fl oz/acre
13	Fastac CS low rate	alpha-cypermethrin	3.2 fl oz/acre
14	Fastac CS high rate	alpha-cypermethrin	3.8 fl oz/acre
15	Asana XL low rate	esfenvalerate	5.8 fl oz/acre
16	Asana XL high rate	esfenvalerate	9.6 fl oz/acre
17	Baythroid XL low rate	beta-cyfluthrin	2 fl oz/acre
18	Baythroid XL high rate	beta-cyfluthrin	2.8 fl oz/acre

Materials and Methods

The trial was arranged in a randomized complete block design with four replicates. Plots were 10 feet wide (four 30-inch rows) x 20 feet long, with five-foot alleys separating replicates and two guard rows between each plot to minimize spray drift between plots. The trial was planted on May 19 at a seeding rate of 140,000 seeds per acre. The soybean variety used was NDSU 607RR. The previous crop was hard red spring wheat. Weeds were controlled using pre- and post-emergence herbicides, and by hand as needed.

Grasshoppers were sampled by slowly walking and counting grasshoppers in the center two rows of each plot. Grasshopper count data were converted to grasshoppers/yard^2. Percent defoliation was visually estimated on a whole plot basis. Grasshoppers were counted and percent defoliation was measured immediately prior to application, and again at one, three and seven days after treatment (DAT). Insecticide applications were made on August 20 when soybean plots were at the R5 growth stage. Applications were made using a CO2 sprayer equipped with TeeJet 11002 flat-fan air induction nozzles at 40 psi and using a carrier volume of 20 GPA. The center two rows of each plot were harvested on October 6. Grain weight, grain moisture (percent) and grain test weight (lbs/bu) were recorded, and yield (bu/acre) was calculated for each plot. Yield was adjusted to 13.5% grain moisture. All data were analyzed using PROC GLM in SAS statistical software. Because of the large number of treatments, two untreated checks were included and treatment means were compared using Tukey's HSD test.

Results

Grasshopper counts averaged 3.9 grasshoppers/yd^2 and percent defoliation averaged 14.7% across all treatments immediately prior to insecticide application. There were no significant differences among treatments for pre-spray grasshopper counts or percent defoliation, indicating that grasshoppers were evenly distributed across the trial and were at a population density great enough to threaten economic yield loss (Table 2).

At 1 DAT, the untreated checks had significantly more grasshoppers/yd^2 than all insecticide treatments, and there were no significant differences among insecticide treatments (Table 2). There were no significant differences among all treatments for percent defoliation at 1 DAT (Table 2). At 3 DAT the untreated checks had significantly more grasshoppers/yd^2 than all insecticide treatments, and there were no significant differences among insecticide treatments (Table 2). Percent defoliation increased in the untreated checks, and for the most part had significantly greater defoliation compared to the insecticide treatments (Table 2). At 7 DAT, the untreated checks had significantly more grasshoppers/yd^2 and greater defoliation than all insecticide treatments (Table 3). All insecticide treatments had higher grain yield compared to the untreated checks, and there were no significant differences among insecticide treatments (Table 3).

Our results indicate that all low and high labeled rates of all insecticides tested provided control of grasshoppers, and prevented economic yield loss. Percent defoliation increased in the untreated checks, while remaining steady in the insecticide treatments. Additionally, substantial pod feeding was noticed in the untreated checks compared to the insecticide treatments. Yield loss in the untreated checks was likely due to a combination of defoliation and pod feeding during the critical pod-filling period between the R5 and R6 growth stages.

Table 2. Treat means for grasshoppers per yd^2 and percent defoliation at pre-spray, 1 DAT and 3 DAT at Casselton, 2020.

	Pre-spray			1 DAT			3 DAT	
Trt No.	Grass-hoppers per yd^2	Percent Defoliation	Trt No.	Grass-hoppers per yd^2	Percent Defoliation	Trt No.	Grass-hoppers per yd^2	Percent Defoliation
1	4.1a	15.0a	2	4.2a	17.5a	2	4.2a	23.8a
2	4.1a	18.8a	1	3.7a	18.8a	1	4.0a	23.8a
3	3.7a	13.8a	14	1.9b	12.5a	13	1.8b	13.8b
4	3.8a	16.3a	13	1.8b	13.8a	7	1.6b	13.8b
5	3.6a	17.5a	9	1.7b	15.0a	11	1.4b	15.0b
6	3.5a	13.8a	3	1.6b	13.8a	4	1.3b	16.3ab
7	4.0a	13.8a	17	1.6b	15.0a	14	1.3b	12.5b
8	3.8a	12.5a	7	1.6b	13.8a	10	1.3b	12.5b
9	3.9a	15.0a	15	1.4b	17.5a	16	1.2b	13.8b
10	3.7a	12.5a	4	1.3b	16.3a	17	1.2b	15.0b
11	3.9a	15.0a	11	1.3b	15.0a	12	1.1b	16.3ab
12	3.9a	16.3a	18	1.2b	11.3a	15	1.1b	17.5ab
13	4.1a	13.8a	16	1.1b	13.8a	9	1.1b	15.0b
14	4.0a	12.5a	8	1.1b	12.5a	8	1.0b	12.5b
15	3.8a	17.5a	12	1.1b	16.3a	18	1.0b	11.3b
16	3.7a	13.8a	5	1.0b	17.5a	5	0.9b	17.5ab
17	4.0a	15.0a	6	0.9b	13.8a	6	0.9b	13.8b
18	4.1a	11.3a	10	0.8b	12.5a	3	0.8b	13.8b
F-value	**0.61**	**1.52**		**16.65**	**1.63**		**37.85**	**4.87**
P-value	**0.8647**	**0.1244**		**<0.0001**	**0.0919**		**<0.0001**	**<0.0001**
HSD	**1.2**	**8.4**		**1.2**	**8.6**		**1.0**	**8.2**
DF	**17, 51**	**17, 51**		**17, 51**	**17, 51**		**17, 51**	**17, 51**

Means within a column that share the same letter are not significantly different (P = 0.05).

Table 3. Treat means for grasshoppers per yd^2 and percent defoliation at pre-spray 7 DAT, and grain yield at Casselton, 2020.

Trt No.	7 DAT		Trt No.	Yield bu/acre
	Grasshoppers per yd^2	Percent Defoliation		
2	4.0a	26.3a	17	40.3a
1	3.7a	26.3a	13	39.6a
17	1.1b	15.0b	15	38.7a
13	1.0b	13.8b	14	38.5a
7	1.0b	13.8b	9	37.6a
18	1.0b	11.3b	16	37.4a
15	0.9b	17.5b	12	37.2a
9	0.9b	15.0b	10	37.1a
10	0.9b	12.5b	6	37.1a
11	0.9b	15.0b	18	36.6a
12	0.9b	16.3b	4	36.4a
8	0.9b	12.5b	3	35.6a
14	0.9b	12.5b	7	35.5a
16	0.9b	13.8b	11	35.3a
3	0.8b	13.8b	5	34.4a
5	0.8b	17.5b	8	33.7a
4	0.7b	16.3b	2	26.3b
6	0.7b	13.8b	1	25.7b
F-value	**77.31**	**7.10**		**8.02**
P-value	**<0.0001**	**<0.0001**		**<0.0001**
HSD	**0.6**	**8.2**		**7.2**
DF	**17, 51**	**17, 51**		**17, 51**

Means within a column that share the same letter are not significantly different (P = 0.05).

Objective Two: Survey for the invasive soybean gall midge in soybean fields of ND

A total of 605 soybean fields was surveyed to detect soybean gall midge larvae in most counties of North Dakota, except for six counties (Sioux, Bowman, Slope, Stark, Billings, and Golden Valley). A more intense survey was focus in the eastern part of the state (Figure 1). Soybean fields were sampled from early June to mid-August. Soybean crop stages were between the VE (cotyledons emergence) and R6 (full seed set formation). Soybean farmers also reported suspect soybean gall midge in their soybean fields to their local County Extension Agents, so these additional fields were also surveyed in Cass, Dickey and Steele Counties.

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.

Fortunately, our results from the 2020 soybean gall midge survey were negative for all soybean fields surveyed in North Dakota (Fig. 1). Suspected soybean gall midge larva reported by farmers were also negative and confirmed as the white-mold gall midge, *Karshomyia caulicola*, at two of the fields. Negative results from suspected fields were confirmed by Dr. J. McMechan's lab (Dept. Entomology, University of Nebraska) who performed the DNA tests and Dr. R. Gagné (Systematic Entomology Laboratory, USDA-ARS, Washington D.C., USA) who examined the larva.

Data were mapped using ArcMap to show its absence. Maps were posted weekly on the IPM website under soybean. A new NDSU Extension publication on the soybean gall midge and the white-mold gall midge was written to help ND soybean farmers know how to scout and identify these two species.

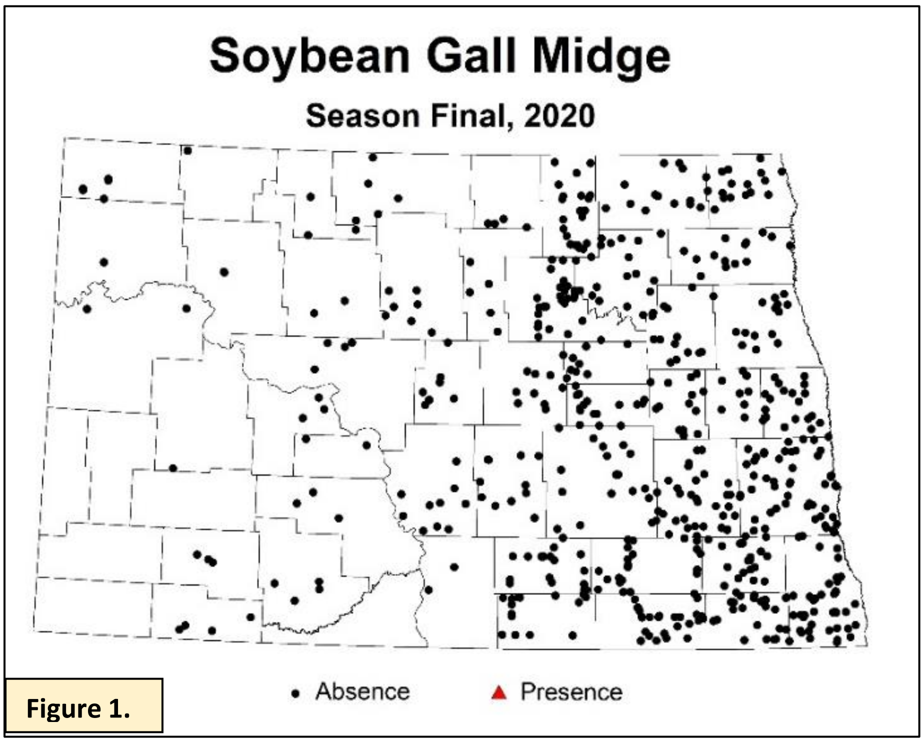


Figure 1.

Outputs:

Refereed Journal articles:

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 53(1): 59-63.

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). JEE: 1-8. https://doi.org/10.1093/jee/toz351

Popular Press articles:

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 (National Plant Diagnostic Network) News 15 (1): 1-2. https://www.npdn.org/system/files/NPDN_Jan-Feb20.pdf

NDSU Extension publication:

Calles-Torrez, V., P.B. Beauzay, A.H. Knudson and J.J. Knodel. 2020. Soybean Gall Midge and White-mold Gall Midge in Soybean E2006. NDSU Extension, Fargo, ND.

Knodel, J.J. and V. Calles-Torrez, V. 2020. Common Arthropod Pests of Soybean E2005. NDSU Extension, Fargo, ND.

NDSU Extension *Crop & Pest Report*:

Knodel, J.J. 2020. Scout for soybean aphids. NDSU Extension *Crop & Pest Report* #9 (June 25, 2020).

Knodel, J.J. 2020. Soybean aphid low. NDSU Extension *Crop and Pest Report* #10 (July 2, 2020).

Knodel, J.J. 2020. No soybean aphids. NDSU Extension *Crop and Pest Report* #13 (July 23, 2020).

Knodel, J.J., and Calles-Torrez, V. 2020. Soybean gall midge. NDSU Extension *Crop and Pest Report* #14 (July 30, 2020).

Knodel, J.J. 2020. Gall midges in soybeans. NDSU Extension *Crop and Pest Report* #18 (September 10, 2020).

Knodel, J.J., Friskop, A., Beauzay, P.B., and Markell, S. 2020. 2020 soybean and sunflower IPM survey. NDSU Extension *Crop and Pest Report* #19 (September 24, 2020).