2019-2020 MN Soybean Research and Promotion Council

Title: ***Understanding spatial and temporal changes in Minnesota soybean pests (Year IV)***

Bruce Potter and Dean Malvick

Final Progress May 1, 2019- April 30, 2020

Objective I. ***Develop a framework for long-term monitoring of soybean pests and pathogens.***
(Team: Bruce Potter, Dean Malvick, Angie Peltier)

Progress

Sentinel plots containing varieties believed susceptible to several pathogens and to SCN were planted at University of Minnesota Research and Outreach Centers located at Lamberton, Waseca, Rosemount, Morris and Crookston.

The plot size, row spacing, and varieties at the Crookston site are dissimilar from the southern sites. Some of the varieties planted at Morris were dissimilar to other sites as well.

- Initial soybean stand, disease and insect assessments of seedling stage soybeans were made at all locations. Little disease was observed on vegetative soybeans at the four southern sites, the exception being bacterial blight. Sentinel plots were also assessed at the time of fungicide application and at or near the R6 stage.
- Fungal disease pressure remained relatively low at all locations at the time of fungicide application. The exception was the presence of significant symptoms of brown spot (*Septoria*), in the lower canopy of R2-R3 stage soybeans at the Rosemount site. This foliar fungal disease was also prevalent at other southern locations.
- White mold was observed at low incidence at all but the Crookston site. White mold gall midge larvae, *Karshomyia caulicola,* were associated with the mycelia of white mold infected plants at the Morris and Waseca sites and in a bulk planted soybean field near the Lamberton study site. This fungal feeding insect is not a pest. However, it resembles and can be confused with the soybean gall midge, *Resseliella maxima*, a new pest of soybean in the Midwest.
- Frogeye leaf spot was observed at the three southern sites and Morris. We do not yet have good long-term data for this disease. However, anecdotally, this disease appears to be more prevalent the past two Minnesota growing seasons.

- Brown stem rot was observed at low incidence at Rosemount and Lamberton but was not observed at the later planted Waseca or Morris sites in 2019.
- At all study sites, multiple generations of thistle caterpillar and green cloverworm were observed. Late in the season, defoliation from green cloverworm reached 20% within individual plots at Morris. Although this level of damage is unlikely to decrease soybean yield, populations of this insect at economic threshold levels were found in some WC and NW Minnesota fields. Economic threshold populations of thistle caterpillar occurred in scattered fields across Minnesota.
- In August, soybean aphids reached economic threshold levels and were treated with Endigo (Syngenta) insecticide at Lamberton and Rosemount.
- Japanese beetles and their highly visible defoliation were observed only at Rosemount.
- An historical perspective of pest pressures at these sentinel sites for 2019 and previous years can be viewed in ***Appendix II*.**

Frogeye leafspot and soybean gall midge provided two examples where networking with growers and ag-industry has helped provide qualitative information on pest severity and distribution during 2019.

Challenges

Wet weather delayed planting at all locations, particularly Waseca and Morris. These delays, however, were somewhat reflective of local planting conditions.

Objective II a. *Develop a framework for testing pesticide efficacy in an ongoing, systematic way.* *(Team: Bruce Potter, Dean Malvick, and Angie Peltier with additional University and Industry collaboration).*

Progress

Fungicide trial studies were planted at the same time and adjacent to sentinel studies. Stands, early season, mid and late season diseases and insects were rated at all sites.

During 2019, Priaxor (BASF) and Delaro (Bayer Crop Science) fungicides were sprayed on three soybean varieties at University of Minnesota Research and Outreach Centers at Lamberton, Waseca, Rosemount, Morris between July 24 and August 2. The same Fungicides were sprayed on two varieties at Crookston on July 16. Diseases and insects were rated early season, at the time of fungicide applications and near soybean maturity. Fungal disease pressure was low at all locations in 2019. However, by the R3 soybean stage, *Septoria* brown spot symptoms were pronounced in the lower canopy at Rosemount.

Results from 2019 and data summarized across the four years of this study are shown in ***Appendix I*.**

Challenges The Morris location was extremely wet late in the season. Excess moisture delayed harvest until November 15 and affected yield of individual plots. Data from this site should be viewed as less than robust.

Objective II b. ***Since weed management can greatly influence pest populations (e.g. soybean cyst nematode, soybean aphid, and corn rootworm), a weed research and demonstration component at a SW MN location will include volunteer corn and volunteer soybean control***.

Progress
Even more so than 2018, the soybean weed management study was planted very late due to wet soil conditions and chronic rainfall. The late planting conditions would have limited any usefulness of data and the volunteer corn and soybean studies were eliminated. However, additional soybean weed management and insect studies were conducted that were supported in part with this funding.

As part of a multi-site herbicide study, the performance of preemergence herbicides on grass and broadleaf weeds as components of glyphosate, glufosinate, 2,4-D choline and dicamba tolerant soybean systems were evaluated. Because of late planting, barnyard grass and other grassy weeds were dominant. The results from Lamberton site are presented in ***Appendix III***.

In addition to the soybean herbicide performance, soybean aphid insecticides were evaluated in two small studies at the SWROC near Lamberton, Minnesota. The results can be viewed at: https://swroc.cfans.umn.edu/sites/swroc.cfans.umn.edu/files/2019_aphid_insecticide_final_report.pdf and https://swroc.cfans.umn.edu/sites/swroc.cfans.umn.edu/files/2019_aphid_insecticide_final_report.pdf.

These 2019 soybean aphid data highlight several points with respect to soybean aphid management:

- A proportion of the soybean aphids within any Minnesota soybean field should be assumed resistant to pyrethroid insecticides.
- Insecticide resistance can go unnoticed when yield is the only criteria for evaluating the success of an insecticide application.
- Several insecticide groups (1A, 4A, 4D, 9D) alone, and in mixes, including with pyrethroids, controlled pyrethroid-resistant soybean aphids. This is helpful from a resistance management perspective because winged aphids moving between fields make it difficult to know whether a field’s aphid population was previously exposed to an insecticide(s).
- Good growing conditions and later reproductive stages limit yield response to a given aphid/plant population density. Improvements in scouting efficiency and understanding late-season economic injury levels would improve grower profitability and encourage adoption of IPM.

Challenges

Because of the greatly delayed planning, data from the soybean herbicide study at Lamberton are limited in utility. Most broadleaf weeds, including waterhemp were removed with tillage and treatment efficacy was based primarily on how effectively the postemergence herbicide application controlled barnyard grass and foxtails

Early season colonization of soybean by soybean aphids was very low and the development of treatable populations did not occur until the arrival of large numbers of migrants in early August. Aggregated soybean aphid populations and late-season lodging of soybeans limited areas suitable for soybean aphid research.

Tech Transfer 2019-20

Potter and Malvick presented results from this project at meetings attended by more than 700 soybean producers and the crop consultants, seed agronomists and other agricultural professionals that advise them. Covid-19 restrictions curtailed in-person meeting activities in March and beyond.

A display presentation at the 2020 Ag Expo in Mankato covered the fungicide efficacy study: https://swroc.cfans.umn.edu/sites/swroc.cfans.umn.edu/files/2019_soybean_ag_expo_for_web.pdf. These data will be converted to an MN Extension newsletter in June 2020.

Portions of the fungicide study data have been previously submitted for reviewed publications.

Manuscript preparation on multi-year/multi-site fungicide results is in the early stages.

APPENDIX I

Develop a framework for testing pesticide efficacy in an ongoing, systematic way.
Multi-site fungicide studies.

Background:

Soybean growers and their advisors are faced with a bewildering array of information from many sources and it can be hard to separate science from marketing. Growers are most concerned with whether a pesticide treatment will pay but this is not easy to answer with individual trials. Yield impacts from pesticide applications can change as insect, disease and weed populations change with environmental conditions and tolerant or resistant populations are selected.

This study, ongoing since 2016, was based on the premise that over time, a network of standardized fungicide studies can provide Minnesota soybean farmers and their advisors information to better understand:

- Return on pesticide investments.
- Yield impacts from plant disease.
- Evidence that disease prevalence or soybean susceptibility has changed.

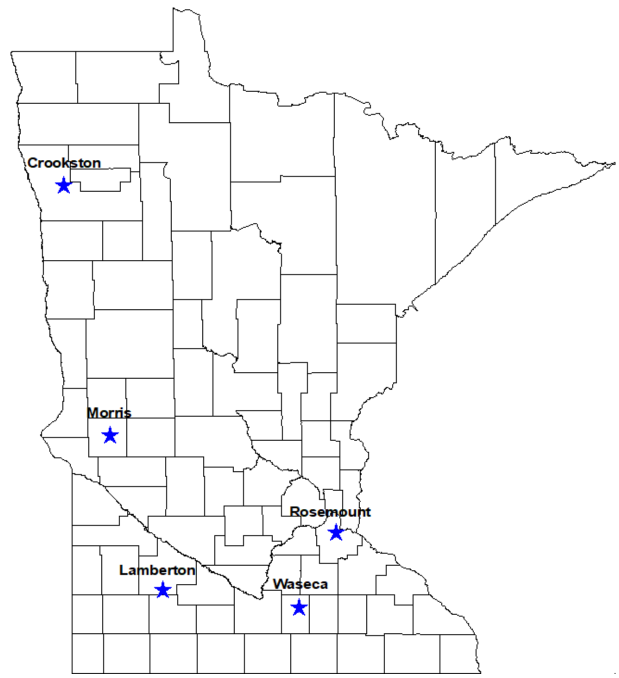


Figure 1. Locations of Minnesota uniform fungicide trials.

Materials and methods:

During the 2016-19 growing seasons, a strobilurin fungicide and/or mixes of a strobilurin with a triazole or SDHI fungicide (*Table 1*) were applied to multiple soybean varieties (*Table 2*) at several University of Minnesota Research and Outreach Centers (*Figure 1*).

The Morris site (2017-19) and the Crookston site (2018-2019) had varieties dissimilar to the three southern sites (Lamberton, Waseca and Rosemount) planted in 2016-2019. The Crookston site also used an alternative row spacing and plot size than other sites. Additionally, portions of the initial 2018 Lamberton study were damaged by water, the study location moved and fungicides applied to a different variety.

Studies were planted in a randomized block design. With the exception of the Crookston location, soybeans were seeded at 160,000 seeds/acre in 30 inch rows and 10 foot x 30 foot plots. At all locations, soybeans were grown in a corn/soybean rotation with conventional tillage and sites were not selected based on expected disease.

Fungicides were applied at labeled rates and 15 GPA to R2-R3 stage soybean. Applications were not targeted at white mold. Depending on soybean size at the time of application, treatments were applied with a hand boom or tractor-mounted sprayer pressurized with CO_2 or compressed air, respectively, and 8002 flat fan nozzles.

Diseases and insects were assessed during the seedling, R3 and R6 soybean growth stages.

At each location, a plot combine was used to harvest the center two of four rows. Yields were adjusted to 13.5% moisture. Data were analyzed as a variety x fungicide factorial with the exception of the 2018 Lamberton site.

Results

Yield data and factorial analysis of variance for 2019 study sites with yield and moisture data summarized across the three southern Minnesota locations utilizing the same varieties are summarized in *Figure 2* and *Table 3*.

Disease pressure was relatively low during all site-years. Bacterial leaf spot and *Septoria* brown spot were ubiquitous at all southern locations but with the exception of Rosemount, remained mostly confined to the lower canopy. The fungicides used in these studies were not expected to control white mold. White mold was observed at very low levels during 2017 at Rosemount and Waseca and in these same sites and Morris during 2018 and Rosemount, Waseca and Morris during 2019. Pod and stem blight was present at Rosemount and Waseca during 2016 and could be found at very low levels in all years for the four southernmost sites. Brown stem rot was observed in the earlier planted Lamberton and Rosemount sites in 2017 and at low levels at Lamberton and Rosemount during 2019. Frogeye leaf spot was prevalent at Morris and Lamberton during 2018 and found at Lamberton, Rosemount and Morris in 2019. The incidence and severity of diseases, as assessed at the end of the season (R6 stage), were not apparently related to fungicide treatment at any site.

Varieties differed in yield at the three southern sites. Varieties differed in moisture at all locations but Crookston. Fungicide provided a significant ($\alpha = 0.10$) yield response at Lamberton, Rosemount and Waseca but not at Morris or Crookston (Table 3, Figure 2). Averaged across the three southern MN sites and three varieties, fungicide treated soybeans yielded more but were also higher in harvest moisture (Figure 2).

Fungicide treated plots were higher in moisture at Lamberton and Rosemount and varieties differed in fungicide effects on moisture at Waseca. Higher grain moisture correlations with yield benefits from foliar fungicide continue to suggest these responses may be, in part, due to less shatter of higher moisture soybeans or other aspects of harvestability.

Yield benefits, both positive and negative, for 2019 were included with those from 2016-18. When the yield difference from the no fungicide treatment were statistically significant, potential economic benefits were calculated at three potential soybean prices. During the study period, southern Minnesota yields trend higher when fungicides are applied although the benefits do not always exceed a fungicide application's added input cost (Table 4).

Fungicides provided a positive yield response in 8 of 12 site-years (66.6%) at the three southern sites. Responses varied by site and year. Fungicide affected yield and moisture at Morris only during 2017. Fungicides did not affect yield or moisture at Crookston. *Overall, 9 of 17 site-years showed higher yield with fungicide*. Moisture differences may be influencing yield response and these effects might change with harvest timing.

Summary

- Fungicides can maintain soybean yield in some environments and provide economic benefit when used selectively.
- Profitable responses to fungicide were not consistent in these low to moderate disease pressure sites.
- Moisture and harvestability may be influencing fungicide yield responses.
- It is unlikely that applications of foliar fungicides on an insurance basis can overcome poor variety selection and other agronomic decisions.

Table 1. FUNGICIDES EVALUATED

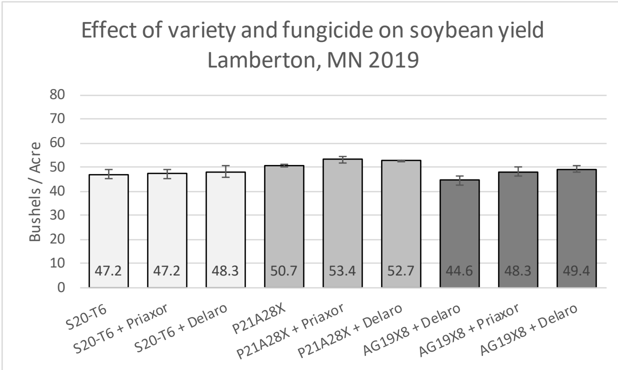
TRADE NAME	FUNGICIDE and GROUP*	YEARS
Headline® BASF	pyraclostrobin (11)	2016-18
Stratego® YLD BAYER	prothioconazole (3) + trifloxystrobin (11)	2016
Delaro™ BAYER	prothioconazole (3) + trifloxystrobin (11)	2017-19
Priaxor® BASF	fluxapyroxad(7) + pyraclostrobin 11)	2016, 2019

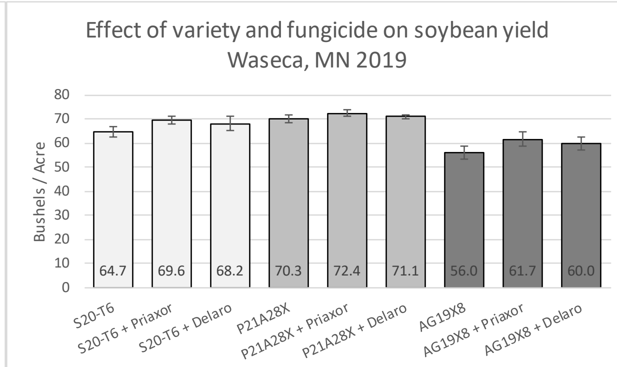
** (11) strobilurin (3) triazole (7) SDHI*

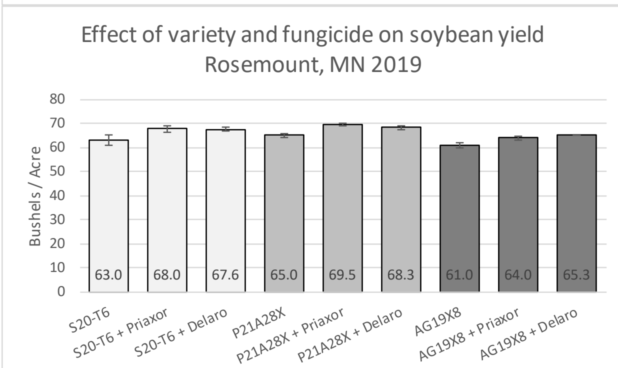
Table 2. YEAR and SOYBEAN VARIETIES INCLUDED

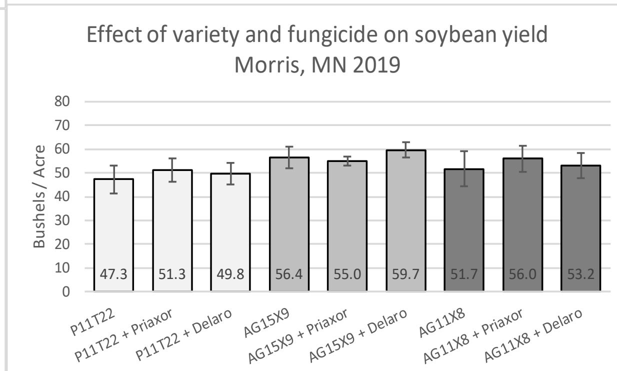
SITE	2016	2017	2018	2019
Lamberton			AG14X8	S20-T6 P21A28X AG19X8
Waseca	AG1832 AG2035 P22T69	S20-T6 S20-T6* AG2035	S20-T6 P20T79R AG21X7	S20-T6 P21A28X AG19X8
Rosemount			S20-T6 P20T79R AG21X7	S20-T6 P21A28X AG19X8
Morris		P1091 AG1435 CH1216 R2X	AG1435 AG11X8 P21A59	
Crookston			CH 0518 R2X P03T68 R2	AG02X8 AG03X7

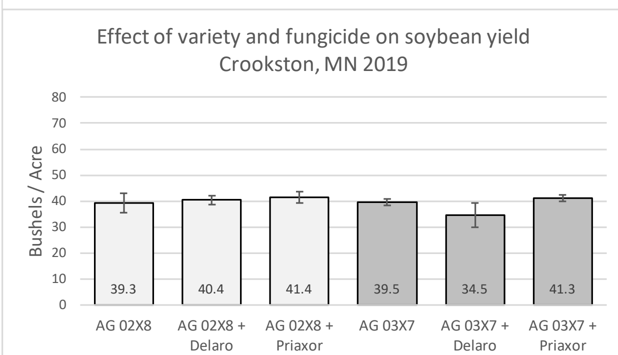
* With Cruiser Maxx Insecticide/Fungicide seed treatment

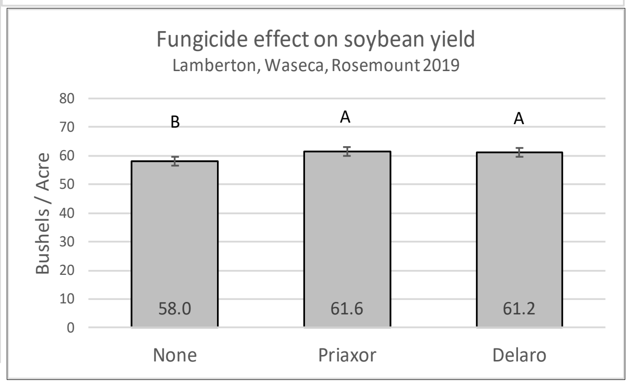












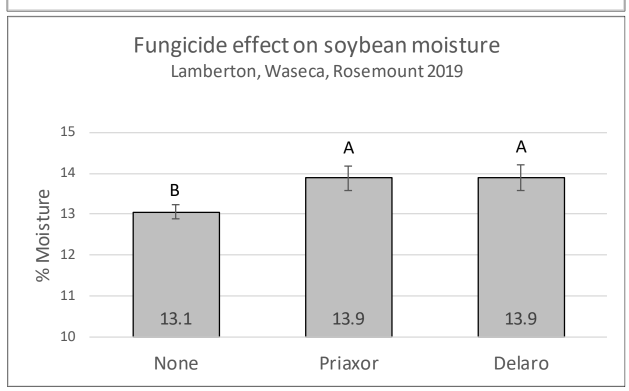


Figure 2.

Effect of fungicide on soybean yields for 2019 uniform fungicide trial sites and combined yield and moisture of three southern sites.

Table 3. Factorial Analysis of Variance 2019

YIELD @13.5% moisture and 60 lb./bu.

Source	**Prob > F**					
	COMBINED§	LAMBERTON	WASECA	ROSEMOUNT	MORRIS	CROOKSTON
Site	0.9902 [a]					
Variety	**< 0.0001** ****	**< 0.0001** ****	**< 0.0001** ****	**0.0003** ****	0.2398	0.4011
Fungicide	**<0.0001** ****	**0.0068** ****	0.0667 **	**0.0001** ****	0.8216	0.4061
Variety * Fungicide	0.7450	0.2678	0.9199	0.7624	0.9576	0.4131
Site * Variety	**0.0001** ****					
Site * Fungicide	0.8602					
Site * Variety * Fungicide	0.9074					

% MOISTURE

Source	**Prob > F**					
	COMBINED§	LAMBERTON	WASECA	ROSEMOUNT	MORRIS	CROOKSTON
Site	0.8192					
Variety	< 0.0001 ****	**< 0.0001** ****	**< 0.0001** ****	**0.0002** ***	**0.0035** ****	0.7760
Fungicide	**< 0.0001** ****	**< 0.0001** ****	0.0001 ****	0.1366 *	0.8326	0.6359
Variety * Fungicide	**0.0001** ****	0.1407 *	0.0153 ***	0.0583 **	0.5199	0.1188 *
Site * Variety	**0.0001** ****					
Site * Fungicide	**0.0001** ****					
Site * Variety * Fungicide	**0.0211** ***					

[a]Combined site Analysis of Variance (ANOVA) based on normalized yields and moistures (plot/site mean)

§ Due to unique varieties - Morris, and Crookston not included in combined sites

Significant at alpha: ** 0.20, ** 0.10, ***0.05 ,****0.01*

Table 4. Yield benefit and projected yield and economic benefits** for fungicide application in Minnesota 2016-19.

		Yield benefit [1] ***(Bu/A)***			***Soybean value ($/Bushel)***								
					$8.00			***$10.00***			***$12.00***		
Location	***Year***	***ST*** [2]	***ST+TR*** [3]	***S+SDHI*** [4]	***ST*** [2]	***ST+TR*** [3]	***S+SDHI*** [4]	***ST*** [2]	***ST+TR*** [3]	***S+SDHI*** [4]	***ST*** [2]	***ST+TR*** [3]	***S+SDHI*** [4]
Lamberton	***2016***	*1.7*	***2.5***	***3.5***	NSYB	**$20.00**	**$28.00**	NSYB	**$25.00**	**$35.00**	NSYB	**$30.00**	**$42.00**
Waseca	***2016***	*2.2*	*1.4*	*3.1*	NSYB	NSYB	NSYB	NSYB	NSYB	NSYB	NSYB	NSYB	NSYB
Rosemount	***2016***	***4.8***	*2.7*	***4.3***	**$38.40**	NSYB	**$34.40**	**$48.00**	NSYB	**$43.00**	**$57.60**	NSYB	**$51.60**
Average	***2016***	***2.9***	***2.2***	***3.6***	**$23.20**	**$17.60**	**$29.07**	**$29.00**	**$22.00**	**$36.33**	**$34.80**	**$26.40**	**$42.00**
Lamberton	***2017***	*1.4*	*4.7*		NSYB	NSYB		NSYB	NSYB		NSYB	NSYB	
Waseca	***2017***	*-0.9*	*-1.5*		NSYB	NSYB		NSYB	NSYB		NSYB	NSYB	
Rosemount	***2017***	*-0.2*	***4.9***		NSYB	**$39.20**		NSYB	**$49.00**		NSYB	**$58.80**	
Average	***2017***	*0.1*	*2.7*		$0.80	$21.60		$1.00	$27.00		$1.20	$32.40	
Lamberton [5]	***2018***	***5.5***	***5.4***		**$13.50**	**$43.20**		**$55.00**	**$54.00**		**$66.00**	**$64.80**	
Waseca	***2018***	***5.4***	***3.9***		**$13.40**	**$31.20**		**$54.00**	**$39.00**		**$64.80**	**$46.80**	
Rosemount	***2018***	***6.2***	***6.0***		**$14.20**	**$48.00**		**$62.00**	**$60.00**		**$74.40**	**$72.00**	
Average	***2018***	***5.1***	***5.4***		**$13.10**	**$43.20**		**$51.00**	**$54.00**		**$61.20**	**$64.80**	
Lamberton	***2019***		***2.7***	***2.2***		**$21.60**	**$17.60**		**$27.00**	**$22.00**		**$32.40**	**$26.40**
Waseca	***2019***		***4.3***	***2.8***		**$34.40**	**$22.40**		**$43.00**	**$28.00**		**$51.60**	**$33.60**
Rosemount	***2019***		***4.1***	***4.2***		**$32.80**	**$33.60**		**$41.00**	**$42.00**		**$49.20**	**$50.40**
Average	***2019***		***3.7***	***3.1***		**$29.60**	**$24.53**		**$37.00**	**$30.67**		**$44.40**	**$36.80**
Average 2016-19		***2.9***	***3.4***	***3.4***									
Morris	***2017***	***4.7***	2.8		**$37.60**	NSYB		**$47.00**	NSYB		**$56.40**	NSYB	
Morris	***2018***	***2.2***	***1.7***		NSYB	NSYB		NSYB	NSYB		NSYB	NSYB	
Crookston	***2018***	***-0.7***	***2.6***		NSYB	NSYB		NSYB	NSYB		NSYB	NSYB	
Morris	***2019***												
Crookston	***2019***		***-2.2***	***1.7***		NSYB	NSYB		NSYB	NSYB		NSYB	NSYB

[1] The yields in the unshaded cells were not statistically different *(p = 0.10)* from untreated (NSYB no significant yield benefit)

[2] Headline [3] 2016 Stratego YLD, 2017-19 Delaro [4] Priaxor [5] Single variety evaluated

Morris, Crookston and 2018 Lamberton not included in combined averages due to the use of different varietities.

*** Economic benefits are based on yield differences and three crop values. They reflect a break-even values for the cost of fungicide + application.*

Appendix II. **Pest levels at study sites**	**Lamberton**				**Waseca**				**Rosemount**				**Morris**			**Crookston**
Insects	**2016**	**2017**	**2018**	**2019**	**2016**	**2017**	**2018**	**2019**	**2016**	**< 2017**	**2018**	**2019**	**2017**	**2018**	**2019**	**2018**
Soybean Aphid	> 250/plant	> 250/plant	> 250/plant	> 250/plant	<50/plant	< 50/Plant	> 250/plant	< 250/plant	<50/plant	< 50/plant	> 250/plant	> 250/plant	> 250/plant	> 250/plant	< 250/plant	< 250/plant
Japanese Beetle	-	-	-	-	-	-	-	-	< 5% defol.	< 10% defol.	< 10% defol.	<10% defol	-	-	< 1% plants	-
Bean Leaf Beetle (overwinter)	-	-	-	-	-	-	-	-	-	< 1% defol.	< 1% defol.	< 1% defol.	-	< 1% defol.	< 1% defol.	-
Green Cloverworm	< 1% defol.	< 1% defol.	< 1% defol.	5% defol.	< 1% defol.	< 1% defol.	< 1% defol.	1% defol	< 1% defol.	< 1% defol.	< 1% defol.	< 5% defol.	< 1% defol.	< 1% defol.	15% defol.	-
Thistle Caterpillar	-	-	-	<1% plants	-	-	-	< 1% plants	-	-	-	< 1% plants	-	-	< 1% plants	-
Disease	**% plants infected**															
Brown Stem Rot (stem symptoms)	7.5	95	0	19.5	6.6	0	0	2	15	96	10	4.1	<1	0	0	0
White mold	2.5	0	0	0	0	< 1	0	< 1	2.5	< 1	0	< 1	<1	0	< 1%	0
Pod and stem blight	0	2.5	0	0	27	0	0	0	12.5	0	0	15.7	0	0	< 1	80
Stem canker	0	0	0	0	0	0	0	0	25	< 1	0	0	0	0	0	0
Phytopthora	0	3	0	0	0	2.5	0	0	0	0	0	0	3	0	< 1	0
Rhizoctonia (stem lesions)	10	2.5	0	0	10	0	0	0	2.5	< 1	0	0	0	0	< 1	0
Sudden Death Syndrome	0	0	0	0	0	0	0	0	5	0	0	<1	0	0	0	0
Brown spot (mid-upper canopy)	<10	100	100	30	<10	25	100	22.7	< 1	< 1	100	0	40	100	54.5	0
Bacterial blight (mid-upper canopy)	50	100	100	< 10	<10	100	100	13.6	< 1	< 1	40	0	25	0	0	0
Cercospora Blight	0	0	0	<10	0	0	100	11.3	0	0	0		0	0	0	60
Frogeye Leaf Spot	0	0	100	57	0	0	100	100	0	0	0		0	100	9.1	0

Disease scores are based on late season samples and represent the most severely affected sentinel variety or fungicides study plot for each year, at each location.

Insect ratings reflect abundance and economic status. The yellow cells highlight interesting temporal and spatial pest differences.

Appendix III. 2019 Soybean Weed Management Trial Lamberton - Analysis by Tom Hoversted, University of Minnseota Southern Research and Outreach Center

Treatment		Pre			Final					
Name	Rate	Bygr	Tawh	Colq	Bygr	Tawh	Colq	Yield	Cost	Returns
		% control						bu/A	$/A	
Pre/ Engenia + Roundup PowerMax + Class Act Ridion + Intact 12.8 oz/A + 32 oz/A + 0.5% + 0.5% Post (4" weeds)										
Authority First	6.4 oz	63	99	99	8	99	99	51.6	89.24	362
Surveil	3 oz	73	99	99	18	98	99	55.5	72.19	413
Fierce MTZ	16 oz	73	99	99	45	99	99	56.0	80.93	409
ZIDUA PRO	5 oz	55	99	99	50	99	99	55.4	73.61	411
Enlite	2.8 oz	71	99	99	5	99	99	48.6	70.32	355
Warrant Ultra	3 pt	88	99	99	51	99	99	55.6	73.91	412
None	-	0	0	0	0	99	99	49.4	45.64	386
Pre / Post (4" weeds)										
Engenia PRO /	16 oz /									
Engenia + Roundup PowerMax + Class Act Ridion + Intact	12.8 oz + 32 oz + 0.5% + 0.5%	90	99	99	55	99	99	56.4	78.04	415
Prefix /	32 oz /									
Tavium + Roundup PowerMax + Class Act Ridion + Intact	56.5 oz + 32 oz + 0.5% + 0.5%	76	99	99	95	99	99	55.6	78.79	408
Prefix /	32 oz /									
Warrant + Extendimax + Roundup PowerMax + Class Act Ridion + Intact	4 pt + 22 oz + 32 oz + 0.5% + 0.5%	61	99	99	56	99	99	54.8	79.76	399
Mauler /	32 oz /									
Warrant Ultra + Extendimax + Roundup PowerMax + Class Act Ridion + Intact	4 pt + 22 oz + 32 oz + 0.5% + 0.5%	75	99	99	85	99	99	51.5	81.92	369
Warrant + Extendimax /	4 pt + 22 oz /									
Warrant Ultra + Roundup PowerMax + Class Act Ridion	50 oz + 32 oz + 0.5%	64	99	99	99	99	99	55.9	88.35	400
Pre/ Enlist Duo+ AMS 4.75 pt + 3 pt Post (4" weeds)										
Authority First	6.4 oz	8	99	99	99	99	99	54.3	84.90	390
Surveil	3 oz	39	99	99	99	99	99	55.0	67.86	414
Fierce MTZ	16 oz	78	99	99	99	99	99	54.8	76.59	402
ZIDUA PRO	5 oz	69	99	99	99	99	99	56.0	69.27	421
Enlite	2.8 oz	13	99	99	99	99	99	57.9	65.98	440
Warrant Ultra	3 pt	73	99	99	99	99	99	54.6	69.57	408
None	-	0	0	0	99	99	99	53.5	41.30	426
Pre / Post (4" weeds)										
Boundary /	1.75 pt /									
Flexstar GT 3.5 + MSO + AMS	3.5 pt + 1% + 3 pt	90	99	99	99	99	99	53.1	76.86	388
BroadAxe XC /	25 oz /									
Flexstar GT + Dual Magnum + MSO + AMS	3.5 pt + 16 oz + 1% + 3 pt	60	99	99	99	99	99	52.8	98.84	363
Zidua PRO /	5 oz /									
Liberty + AMS	32 oz + 3 pt	56	99	99	99	99	99	55.9	81.89	407
Zidua PRO /	5 oz /									
Liberty + AMS / Roundup PowerMax + AMS	32 oz + 3 pt / 32 oz + 3 pt	30	99	99	97	99	99	55.6	98.79	388
Zidua PRO / Flexstar + Select + MSO + AMS	43 pt/32 oz + 1pt + 3 pt	45	99	99	99	98	99	53.5	65.31	403