South Dakota State University
South Dakota Agricultural Experiment Station

ANNUAL PROGRESS REPORT 2019

SOUTHEAST SOUTH DAKOTA EXPERIMENT FARM

SOUTH DAKOTA AGRICULTURAL EXPERIMENT STATION

Southeast Research Farm
Growing Ideas

SOUTH DAKOTA STATE UNIVERSITY

This is an annual report of the research program at the Southeast South Dakota Research Farm in cooperation with South Dakota Agricultural Experiment Station and the SDSU College of Agriculture, Food, and Environmental Sciences and has special significance for those engaged in agriculture and the agriculturally related businesses in the ten county area of Southeast South Dakota. The results shown are not necessarily complete or conclusive. Interpretations given are tentative because additional data resulting from continuation of these experiments may result in conclusions different from those based on any one year.

Trade names are used in this publication merely to provide specific information. A trade name quoted here does not constitute a guarantee or warranty and does not signify that the product is approved to the exclusion of other comparable products. Some herbicide treatments may be experimental and not labeled. Read and follow the entire label before using.

The Southeast Farm is located at 29974 University Road, Beresford, SD 57004. Telephone 605-563-2989; Fax 605-563-2941; Farm Supervisor, Peter Sexton; email (peter.sexton@sdstate.edu).

Report available on web https://openprairie.sdstate.edu/agexperimentsta_rsp/

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South Dakota State University, South Dakota Counties and U.S. Department of Agriculture Cooperating.

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ACKNOWLEDGEMENTS

The Southeast Farm would not get very far in terms of research work done without the good work of the staff – Garold Williamson, Ruth Stevens, Brad Rops, Scott Bird, and Chelsea Sweeter. We also want to acknowledge all those from SDSU campus at Brookings and SDSU Extension that contribute toward the work done at the farm including Sandeep Kumar, Péter Kovács, Jason Clark, Sara Bauder, Anthony Bly, David Karki, Paul O. Johnson, Dave Vos, Jill Alms, Emmanual Byamukama, Dalitso Yabwalo, Jonathan Kleinjan, Kevin Kirby, Graig Reicks, Sharon, Clay, Shin-Yi Marzano, Melanie Caffe, Adam Varenhorst, John McMaine, Gared Shaffer, Febina Mathew, Julie Walker, Warren Rusche, Zachary Smith, Crystal Levesque, and many more. The Nutrient Research and Education Council, the South Dakota Oilseed Council, the Soybean Council, and the Corn Council, support the farm through research grants and need to be acknowledged for their help. Our friends at the USDA/NRCS also support research at the farm and work with us on outreach activities – so I want to acknowledge them as well.

The members of the farm board – Al Novak, Gordon Anderson, David Ostrem, John Fahlberg, Jonathan Hagena, Craig Jepsen, Les Mehlhaff, Travis Machmiller, Norm Uherka, Chuck Wirth, Shane Merrill, Shane Nelson, Greg Kleinhans, and Harley Lerseth need to be acknowledged for their critical contribution to the research farm and its continued success. They play an important role in guiding the farm's research work and allocation of resources.

Support of the Ag Experiment Station at SDSU lead by Dr. Bill Gibbons, and David Wright, Dept. Head Agronomy, Hort. and Plant Science, and Joe Cassidy, Dept. Head Animal Science, have also been important for the farm's operation. We look forward to continuing and expanding our interaction with SDSU faculty and college administrators in the coming year.

As always, we are thankful to God for yet another year that we can move forward with work, and we look forward with a good hope and a good will that this coming season will be a productive one.

This publication was edited and compiled by Ruth Stevens and Peter Sexton. The 2019 Annual Report, as well as Annual Reports from other years, are available on website: https://openprairie.sdstate.edu/agexperimentsta_rsp/

OUTREACH ACTIVITIES

Seminars at Dakota Farm Show; January

Field Days

Field Days

Annual Meeting; January

INTRODUCTION …..………………………………………………………………………..Pete Sexton
Farm Supervisor

Before mentioning anything else, I want to invite everyone to our summer and fall field days. This is a good time to see plot-work first hand, listen to some good speakers, and visit with other farmers and folks in the ag. community. The dates are as follows - consider yourself invited:

SUMMER FIELD DAY - JULY 7th
FALL FIELD DAY - SEPT. 17TH (tentative date)

Among other things, there will be some interesting work to discuss with a new crop for our area - hybrid rye. Hybrid rye has the virtue of being robust with good yield potential. The seed is expensive, but the other inputs are modest. It is out of sync with our other crops, so it will spread out labor and equipment costs. It is very competitive with weeds. Also, and perhaps most importantly, it would add needed diversity to our corn/soybean cropping system. Other than being a contaminant in winter wheat, it really doesn't have many negatives in terms of production - and for a corn/soybean farmer contamination would be a non-issue. It remains to be seen how strong the market will be, but it looks like this crop has some potential and for our part we plan to push forward with research on this type of rye. We are also doing work with forage testing, along with work on corn and soybean production. If you are farming in southeast South Dakota, I am confident you will find something of interest at our field day.

As everyone in this area knows, the 2019 season was a rough one with excessive moisture. We had over 32" of rainfall recorded at the farm - more than 7" above average, and to make things worse we started the year with saturated soil from a wet fall the year before. With the exception of a couple of wet spots (about 15 acres total), we were able to get most all of the research farm planted. One of the big factors that contributed to this was the improved soil strength / aggregate stability that comes with no-till cropping systems. This supported traffic for field operations that would have been marginal or worse under tilled conditions. This is another plus for no-till systems.

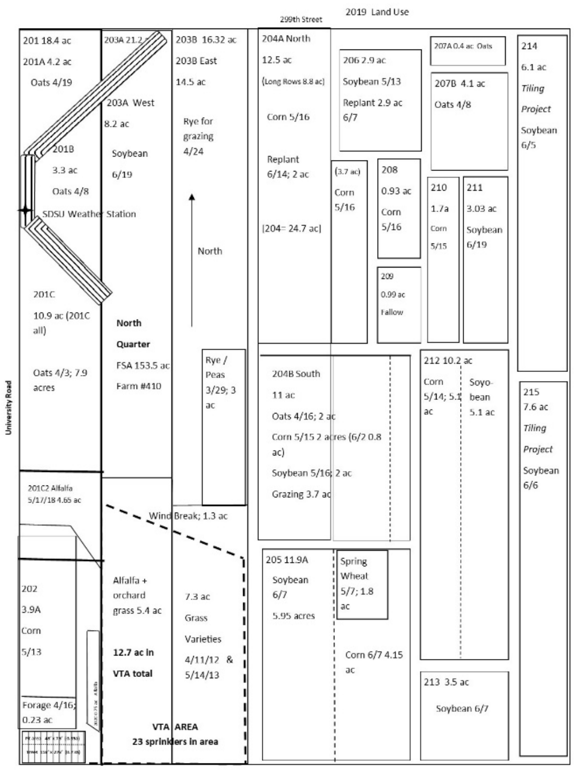
The strategic goals of the farm, as set by our Farm Board, continue to be:

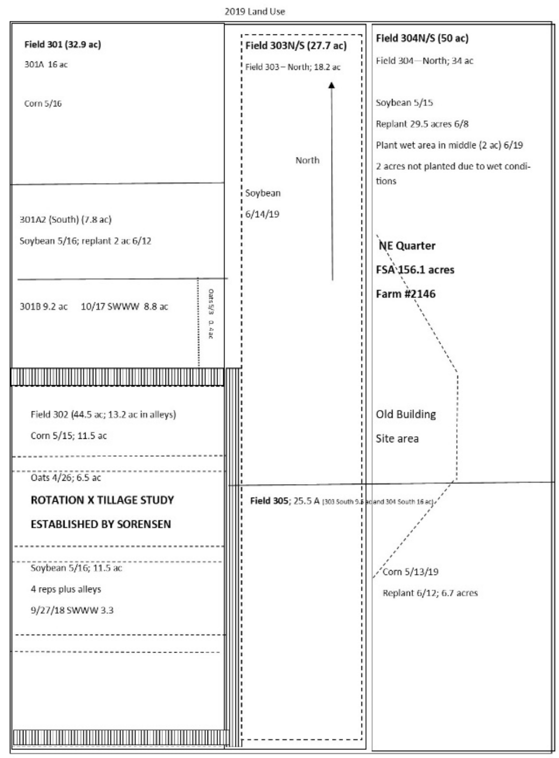
1) *Improve character of the soil (soil quality);*
2) *Achieve grain yield goals and optimize cost of production and profitability;*
3) *Optimize livestock production including use of novel approaches in integrating livestock and crop production;*
4) *Increase association membership and improve public relations and outreach;*
5) *Broaden scope of research to include small-scale and beginning farmers and horticulture work as opportunity permits.*

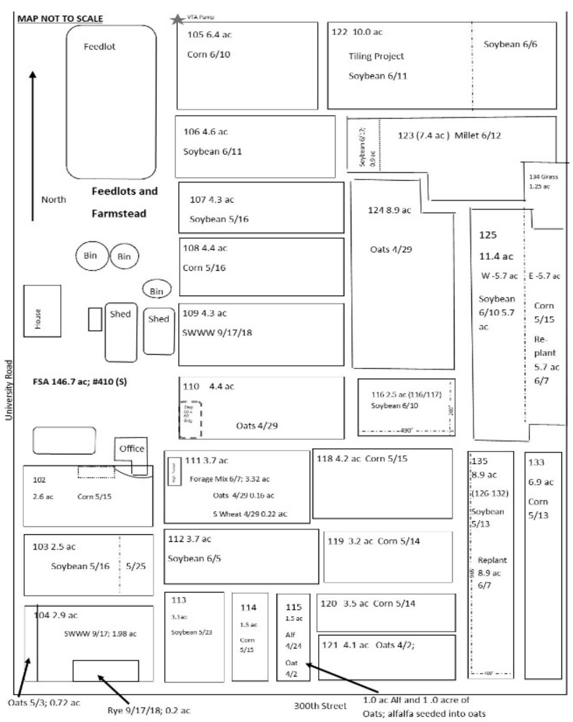
Of course, we plan to carry on with our collaborators at SDSU to facilitate their work with livestock and crop research. We are always looking to improve on our efforts and like to listen to new ideas - please feel free to stop in and visit or call to share suggestions and comments about our research. We hope you have a good year ahead.

2019 Land Use Map (maps not drawn to scale)

SDSU Southeast Research Farm, Beresford, SD







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Weather and Climate Summary; SDSU Southeast Farm Beresford, SD 2019

Ruth Stevens*, Peter Sexton,
Brad Rops, Scott Bird, Garold Williamson,
Chelsea Sweeter, and Dr. Rueben Behnke[2]

Moisture received at the SDSU Southeast Research Farm (SERF) in 2019 was above average. The farm received 32.86 inches of precipitation in 2019 (7.08 in. above average). 2019 was the second year with above average rainfall which created a full soil profile that caused problems establishing plots in the spring. Well drained soils that were able to be planted in a timely manner had good yields, while the areas that were water logged suffered from prevent planting or yield loss from the excess moisture.

The 2019 weather and climate information for the Southeast Farm is summarized in tables and figures found on pages 2 thru 7.

Average temperatures compared to daily temperatures are highlighted in Figure 1. Daily maximum temperatures were below average except for June and December. Minimum temperatures were above average for seven months (March, May, June, July, Aug, Sept, Dec) in 2019. Monthly temperature averages are shown in Table 1.

Annual precipitation and growing season precipitation was 128% of normal, (Table 2 and 3). Growing season precipitation measured from April through September was 24.79”. SERF had eight months in 2019 that received above average precipitation (+0.08” to +2.95”), and four months with below normal precipitation (-0.03” to -0.85”). The farm received 36” of snowfall in 2019; 21” in first half of year, and 13” in November and December.

The coldest and hottest temperatures of the year were recorded on January 30 (-22°F) and July 1 (97°F) respectively, a 119-degree temperature range (Table 3). Frost-free season at the farm in 2019 was 167 days on a 32°F basis and 178 days on a 28°F-basis. The last spring frost was on April 28 (31°F) and last freeze was on April 19 (27˚ F). The first fall frost was on October 12 (29˚F) and a freeze occurred on October 14 (23˚F). The average annual high temperature was 54°F and average annual low temperature was 35°F; which were both below average (-4.0 and -0.3 degrees, respectively).

The 2019 growing season (April – October) accumulation of growing degree units (GDU’s) was 2943 units (99% of average). July and September had above normal GDU’s in 2019 (Fig. 3 & 4). Evaporation recorded at the SERF from May through September 2019 was 30.6” (Fig. 6 & 7). Southeast Farm received 21.3” of rainfall during the same period of time.

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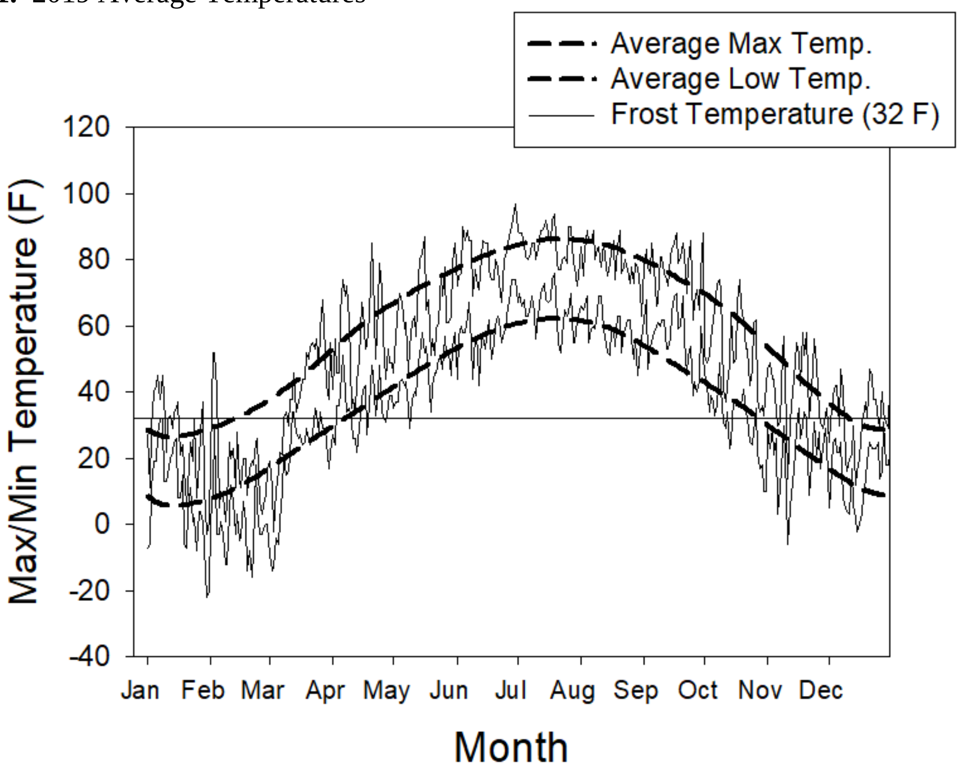
[2]*Mesonet Research Climatologist, mesonet.sdstate.edu*

Table 1. Temperatures[a] at the Southeast Research Farm - 2019

	2019 Average Air Temps. (°F)		67-year Average Air Temps. (˚F)		Departure from 67-year Average (˚F)	
	Maximum	Minimum	Maximum	Minimum	Maximum	Minimum
January	25.6	8.0	26.6	5.8	-0.8	-1.6
February	18.1	0.0	31.9	11.0	-7.5	-8.8
March	37.3	18.5	44.1	22.9	-2.4	+3.6
April	57.2	35.0	59.9	35.1	-12.8	-9.2
May	64.0	45.0	71.9	47.3	-4.1	+6.0
June	80.4	65.0	81.5	57.9	+1.2	+5.7
July	84.6	65.0	86.0	62.1	-2.4	+0.2
August	80.3	59.2	83.8	59.4	-3.6	+0.2
September	76.6	56.3	75.6	49.4	-0.8	+5.9
October	54.8	32.9	63.2	37.5	-7.6	-3.7
November	41.7	20.8	45.2	23.7	-6.3	-5.8
December	31.7	14.9	30.7	11.6	+0.5	+3.3

[a] Computed from daily observations

Figure 1. 2019 Average Temperatures



ACKNOWLEDGEMENT

Weather data is compiled from daily observations collected by SDSU Southeast Farm Personnel in cooperation with South Dakota State Climatologist, South Dakota Office of Climatology, and the National Weather Service, Sioux Falls, SD. More climate information available at South Dakota Mesonet - South Dakota State University: *mesonet.sdstate.edu*

Table 2. Precipitation at the Southeast Research Farm - 2019

Month	Precipitation 2019 (inches)	67-year Average (inches)	Departure from Avg. (inches)
January	0.09	0.45	-0.36
February	0.77	0.80	-0.03
March	2.28	1.43	+0.85
April	3.48	2.57	+0.91
May	6.52	3.57	+2.95
June	3.35	4.20	-0.85
July	4.41	3.10	+1.31
August	3.15	3.07	+0.08
September	3.88	2.85	+1.03
October	3.01	1.93	+1.08
November	0.79	1.14	-0.35
December	1.13	0.67	+0.46
Totals	32.86	25.78	+7.08

Table 3. 2019 Climate Summary Southeast Research Farm, Beresford, SD

Annual Precipitation (inch)	32.86	128%* (+7.09)
Growing Season Precip (Apr-Sep, inch)	24.79	128% (+5.44)
Jan-Mar	3.14	117% (+0.46)
Apr-Jun	13.35	129% (+3.01)
Jul-Sep	11.44	127% (+2.42)
Oct-Dec	4.93	132% (+1.19)
Annual Snow (inch); (Jan-Jun/Jul-Dec)	36	21 /13
Growing Degree Units (GDU); Apr – Oct (50 degree basis)	2943	99% (-23)
Minimum / Maximum Air Temp, ºF	-22°F Jan 30	97°F July 1
Last Spring Frost; 32º / 28º basis	31°F Apr 28	27°F Apr 19
First Fall Frost; 32º / 28º basis	29°F Oct 12	23°F Oct 14
Frost Free Period (days); 32º / 28º basis	167	178
Average Annual High / Low	54 / 35	-4.0 / -0.3

* % of Normal

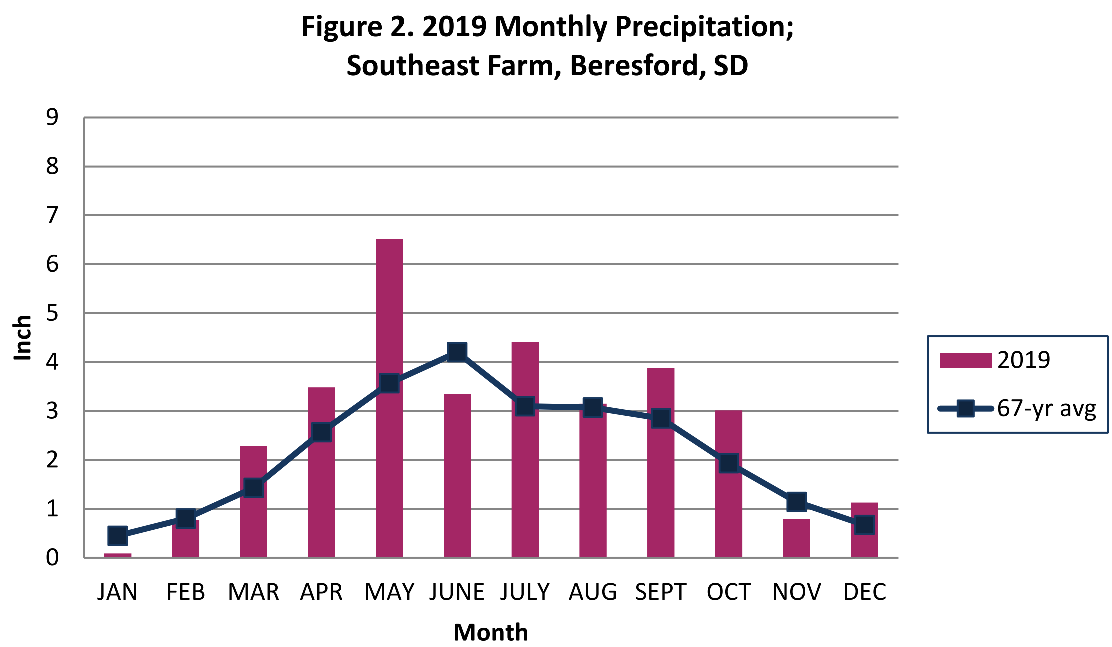


Figure 2. 2019 Monthly Precipitation;
Southeast Farm, Beresford, SD
Inch
9
8
7
6
5
4
3
2
1
0
JAN FEB MAR APR MAY JUNE JULY AUG SEPT OCT NOV DEC
Month
2019
67-yr avg

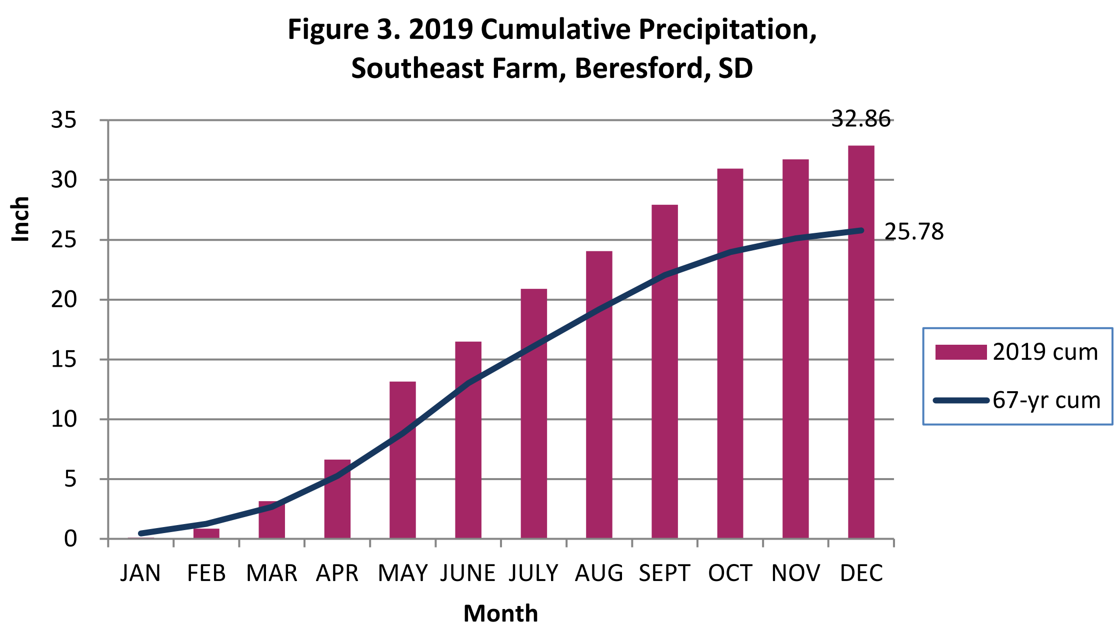


Figure 3. 2019 Cumulative Precipitation,
Southeast Farm, Beresford, SD
Inch
35
30
25
20
15
10
5
0
32.86
25.78
JAN FEB MAR APR MAY JUNE JULY AUG SEPT OCT NOV DEC
Month
2019 cum
67-yr cum

Figure 4. 2019 Growing Degree Units (GDU's); Southeast Farm, Beresford SD

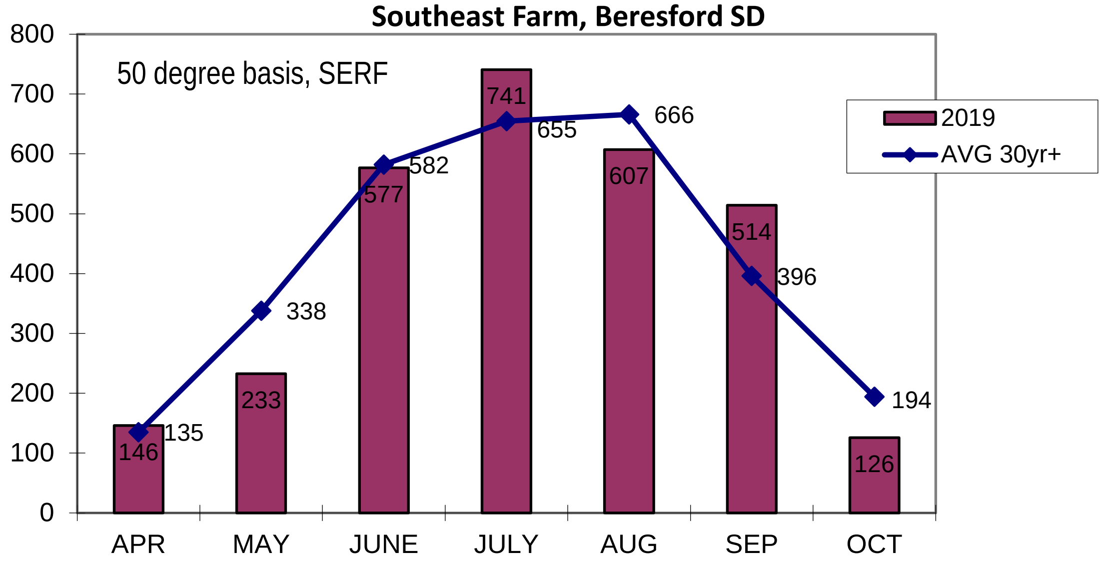


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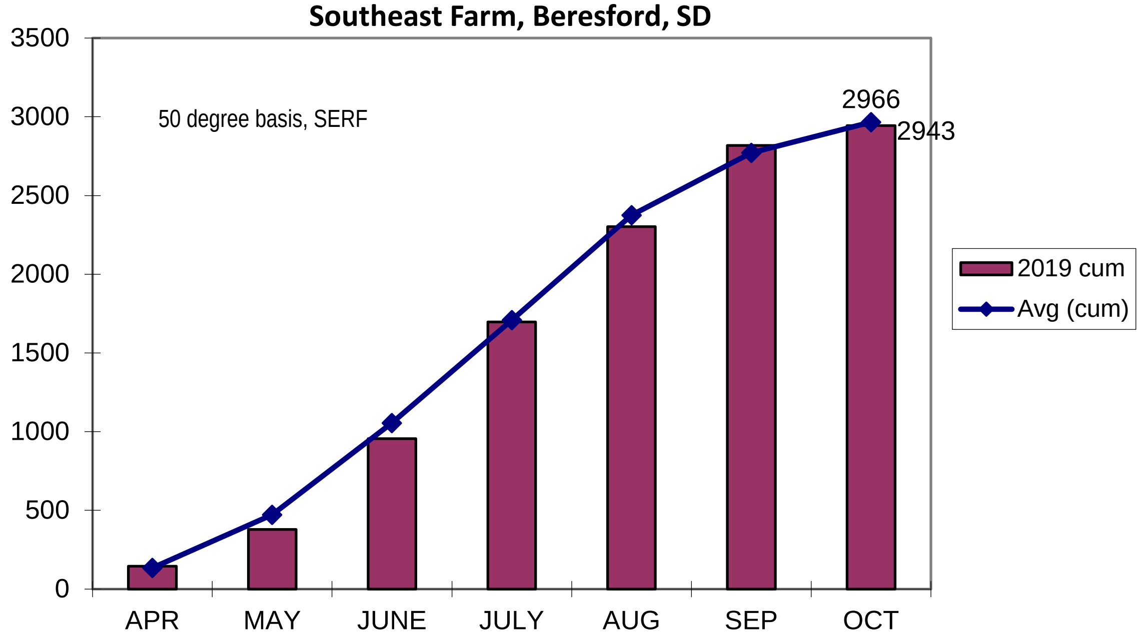
Figure 5. 2019 Cummulative Growing Degree Units (GDU's); Southeast Farm, Beresford, SD



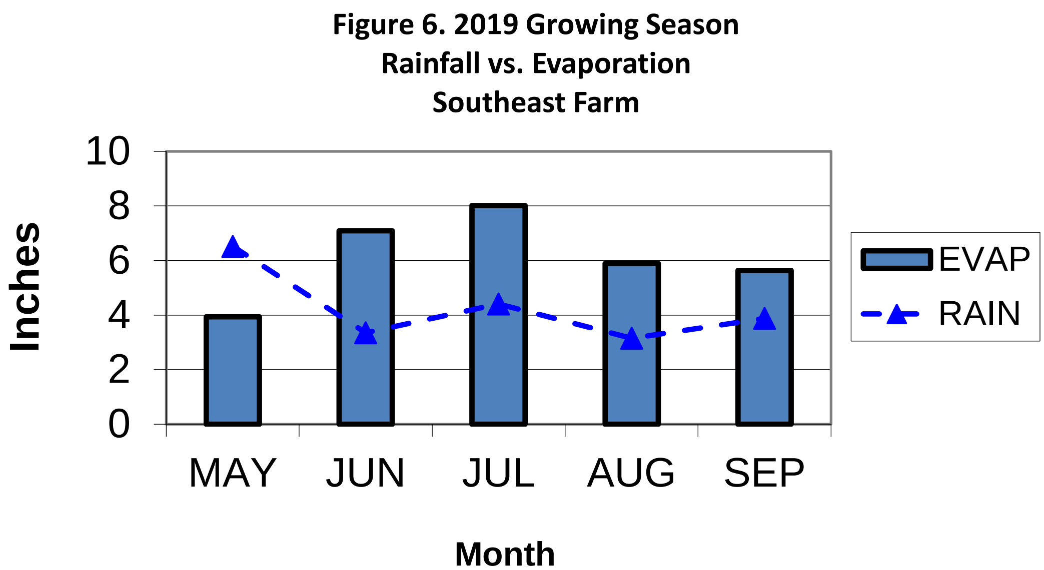


Figure 6. 2019 Growing Season
Rainfall vs. Evaporation
Southeast Farm
Inches
10
8
6
4
2
0
MAY
JUN
JUL
AUG
SEP
Month
EVAP
RAIN

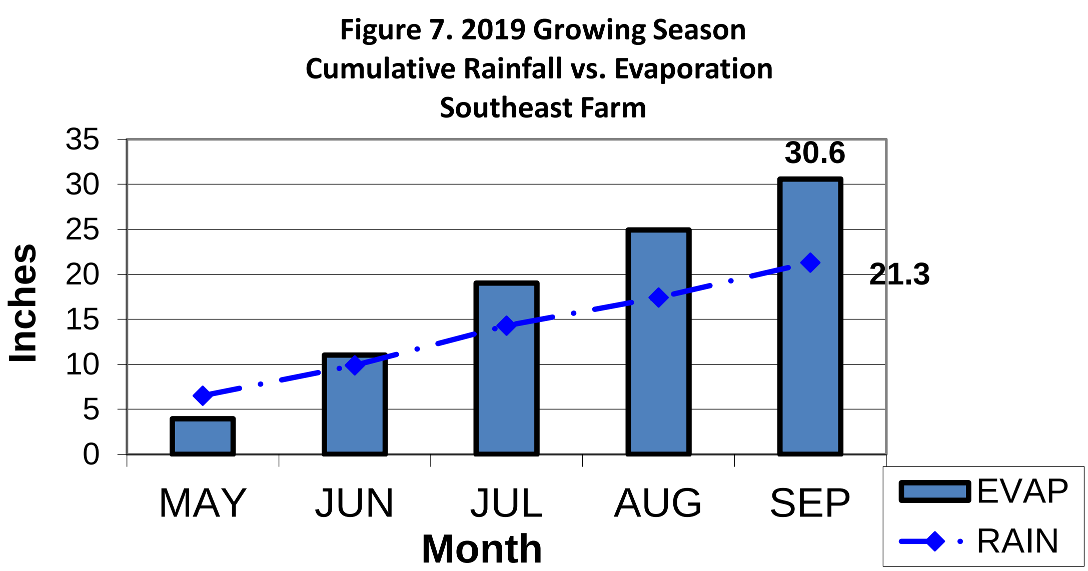
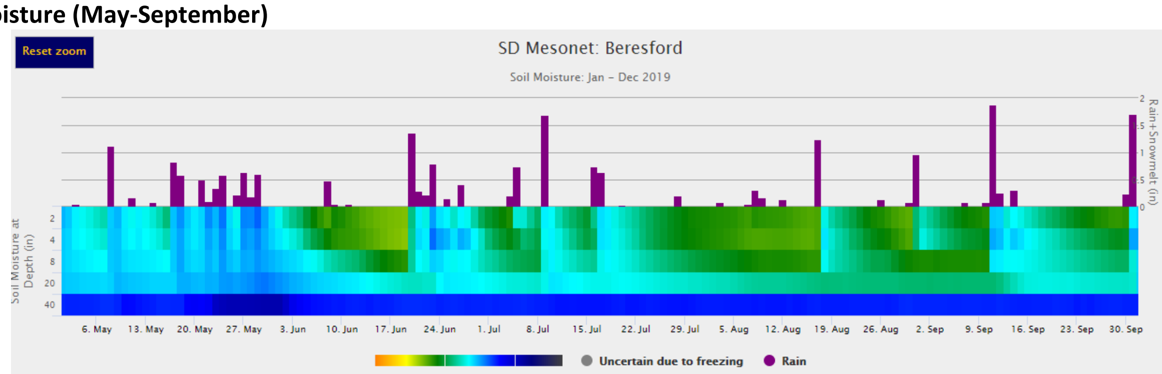


Figure 7. 2019 Growing Season
Cumulative Rainfall vs. Evaporation
Southeast Farm
Inches
35
30
25
20
15
10
5
0
30.6
21.3
MAY
JUN
JUL
AUG
SEP
Month
EVAP
RAIN

2019 Ag Weather Summary

Precipitation (May-September)	
Total	20.50 in
Departure from Normal	+3.44 in
Greatest	1.88 in, Sep 11
Days with Precipitation	59 of 153
Reference Evapotranspiration	
Total	24.00 in
Growing Season	
Growing Degree Days	2673
Departure from Normal	+23
Stress Degree Days	92
Frost-Free Season	May 11 to Oct 10 (153 days)
Normal Season Frost-Free Season	Apr 9 to Oct 27 (202 days)
Air Temperature	
Average	45°F
Departure from Normal	-2°F
Maximum	97°F, Jun 30
Minimum	-22°F, Jan 30
Frost Days	165
Soil Temperature	
Average (4 in, bare)	51°F
Maximum (4 in, bare)	94°F, Jul 19
Minimum (4 in, bare)	20°F, Jan 30
First ≥ 40°F Daily Average (4 in, bare)	Mar 24
First ≥ 50°F Daily Average (4 in, bare)	Apr 6
Max Frost Depth (sod)	24 in, Feb 18
Frost-Free Season	Apr 6 to Nov 12 (221 days)
Wind	
Maximum Gust (3 second)	50 mph, Mar 14
Maximum Speed (5 minute)	33 mph, Jan 28

Soil Moisture (May-September)



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Corn Maturity Study – 2019 Season

Peter Sexton*, Peter Kovacs,
Chelsea Sweeter, and Brad Rops

INTRODUCTION

Maturity is obviously a major factor in variety and line selection. For corn, we are trying to use as much of the season as possible to maximize yield, and at the same time allow a sufficient period for the grain to dry down to acceptable levels for storage. By studying the relationship between yield and maturity in our environment, we can better estimate how much yield, if any, one is losing by choosing an earlier maturing line. Also, one can better estimate how much adjustment should be made in corn maturity when one has to plant late. To put things in perspective, in Beresford there are on average about 2640 GDD for corn (50 F base temperature) from May through September. If we allow 24.5 GDD per relative maturity day, this corresponds to about 108 days relative maturity.

METHODS

The following lines were seeded at a target rate of 35,000 seeds per acre on May 15 and June 12, 2019.

Maturity	Line	First Date	Second Date
75	P7527AM	15-May	12-Jun
79	P7907AM	15-May	12-Jun
85	P8542AM	15-May	12-Jun
91	P9188AM	15-May	12-Jun
96	P9608AM	15-May	12-Jun
99	P9929AM	15-May	12-Jun
103	P0339AM	15-May	-----
105	P0547AM	15-May	12-Jun
109	P0919AM	15-May	12-Jun
114	P1498AM	15-May	12-Jun
120	P2089AM	15-May	12-Jun

Plots were 6 rows wide (15’) by 35’ in length laid out in a randomized complete block design with four replications at each date. Plots of each line were sampled once or twice per week (3 ears per plot, at least one replication per week), from the outer rows of the plot, during seed filling. Seed was separated from each cob until a sample of approximately 150 g was obtained. Fresh weight was then determined and the sample placed into an oven (160 F) until dry (i.e. the weight was stable) and then weighed again to allow for calculation of percent moisture. Yield was determined by harvesting the inner two rows from each plot with a Kincaid small

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plot combine. First planting date was harvested on November 13, 2019 and second planting date was harvested on November 19, 2019.

RESULTS

Yields for the two planting dates are shown graphically in Figure 1, and numerically in Table 1. For the first planting date, yields were around 130 bu/ac for the earliest lines, and increased up to about 205 bu/ac for the 103 and 105 day maturity lines, and then declined again at maturities greater than that. For the second planting date, the yields started around 150 bu/ac for the early lines, and then increased up to about 180 bu/ac for the 99 day line, and plateaued after that. The observation at the second planting date that yields did not tend to decline with the later maturing lines suggests that those lines may have responded to late planting by accelerating their development somewhat.

Grain moisture for the two dates is plotted two different ways. Figure 2 shows grain moisture over time for four different lines differing in relative maturity for the first planting date, and Figure 3 shows the same for the second planting date. In Figure 4, grain moisture for all the lines in the May 15 planting date are plotted for three different fall sample dates. Figure 5 shows the same thing for the June 12 planting date. Target grain moisture is going to depend on the individual farmer's ability to aerate and dry grain, and on their market or end-use for the grain. If we take for example, a goal of having corn about 16.5% moisture by Nov. 8th, this would have corresponded with about the 103 day mark for relative maturity with a May 15 planting date, and an 85 day relative maturity for the June 12th planting date this past year. When the plots were harvested, the latest maturity line with less than 16 % moisture was the 105 day line with the first planting date, and the 96 to 99 day line with the second planting date (Table 1). More work needs to be done to fit this data to growing degree day values, and to repeat the study another year or two to get a better measure of how this varies from season to season.

SUMMARY

Yields tended to increase with length of maturity up to 103 to 105 days relative maturity for the May 15 planting date, and up to 96 to 99 days relative maturity for the June 12 planting date in this study from the 2019 growing season. With a mid-November harvest, the grain moisture for these respective maturities would have been less than 16 % in this study (Table 1).

ACKNOWLEDGEMENT

The authors appreciate the contributions of the South Dakota Agricultural Experiment Station to support this research.

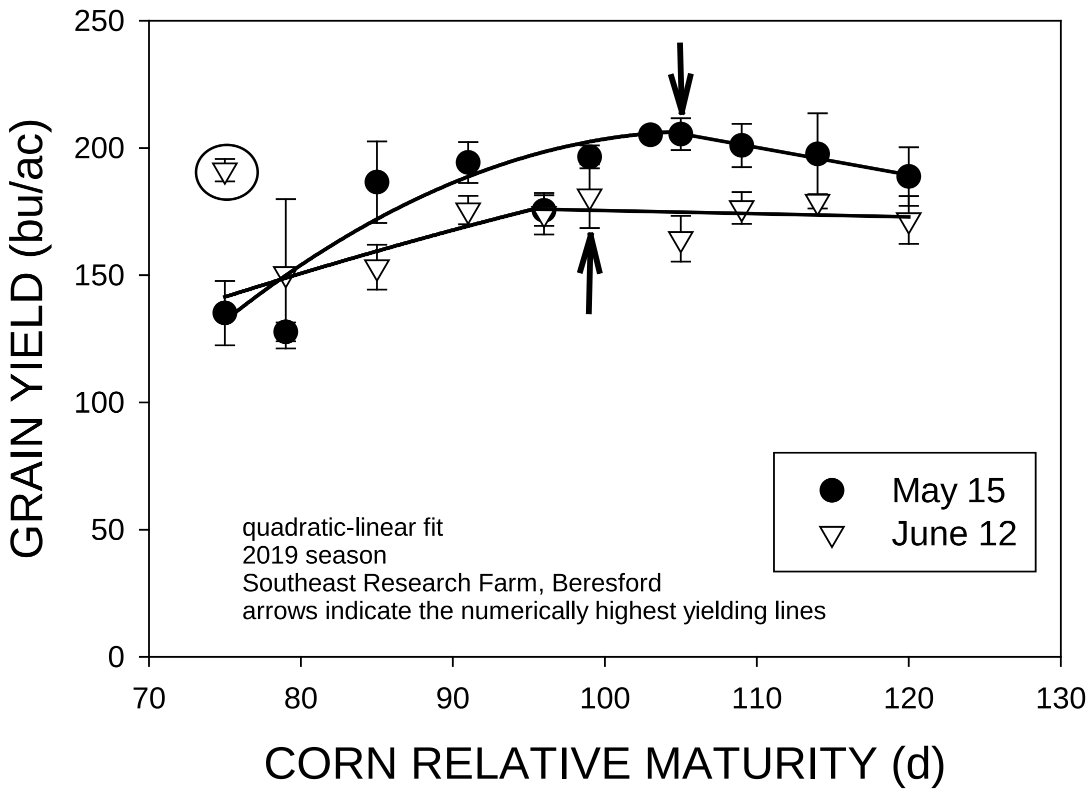

Figure 1. Grain yield of corn lines ranging from 75 to 120 days relative maturity seeded at two different dates at the SDSU Southeast Research Farm in 2019. Arrows indicate the numerically highest yielding lines for each planting date. The yield of the 75 day line on the second planting date is considered an outlier.

Table 1. Stand, moisture, test weight, 100-seed wt., and grain yield for corn hybrids ranging from 75 and 79 days relative maturity up to 120 days relative maturity seeded at two different planting dates (May 15 and June 12) at the Southeast Research Farm in Beresford, South Dakota in 2019. Plots from the May 15 planting date were harvested on Nov. 13th, while the June planted plots were harvested on Nov. 19th.

	Relative Maturity	Stand	Moisture	Test Wt.	100-Seed Wt.	Yield
	(d)	(plts/ac)	(%)	(lb/bu)	(g)	(bu/ac)
5/15/2019	75	32,670	13.9	55.2	29.1	135.1
	79	33,977	15.0	55.8	31.9	127.7
	85	34,413	14.3	57.2	35.4	186.6
	91	32,670	14.6	57.1	36.1	194.3
	96	33,542	15.4	56.6	35.5	175.4
	99	33,977	14.5	56.5	34.6	196.5
	103	34,848	14.8	56.3	31.9	205.1
	105	34,413	14.9	56.1	36.3	205.4
	109	32,234	16.0	56.8	32.4	201.0
	114	32,235	16.2	56.3	33.0	197.6
	120	30,492	17.2	54.8	34.1	188.8
	mean	*33,225*	*15.2*	*56.2*	*33.6*	*182.7*
	CV(%)	*10.2*	*5.0*	*2.3*	*3.3*	*10.1*
	LSD (0.10)	*NS*	*0.9*	*NS*	*1.3*	*25.5*

	Relative Maturity	Stand	Moisture	Test Wt.	100-Seed Wt.	Yield
	(d)	(plts/ac)	(%)	(lb/bu)	(g)	(bu/ac)
6/12/2019	75	36,009	14.7	54.1	28.7	.
	79	31,363	14.4	55.1	31.8	150.6
	85	32,525	15.4	56.3	33.2	153.2
	91	34,848	14.8	55.3	29.5	175.6
	96	37,752	15.7	56.6	30.1	174.2
	99	36,590	15.5	54.9	31.8	181.0
	105	34,848	17.1	53.3	31.1	164.3
	109	36,009	18.8	53.7	26.9	176.5
	114	35,429	21.6	51.0	27.9	179.0
	120	37,752	22.2	49.6	26.6	171.7
	mean	*35,313*	*17.0*	*54.0*	*29.8*	*172.6*
	CV(%)	*6.4*	*6.9*	*1.7*	*3.5*	*9.0*
	LSD (0.10)	*3,181*	*1.7*	*1.3*	*1.5*	*NS*

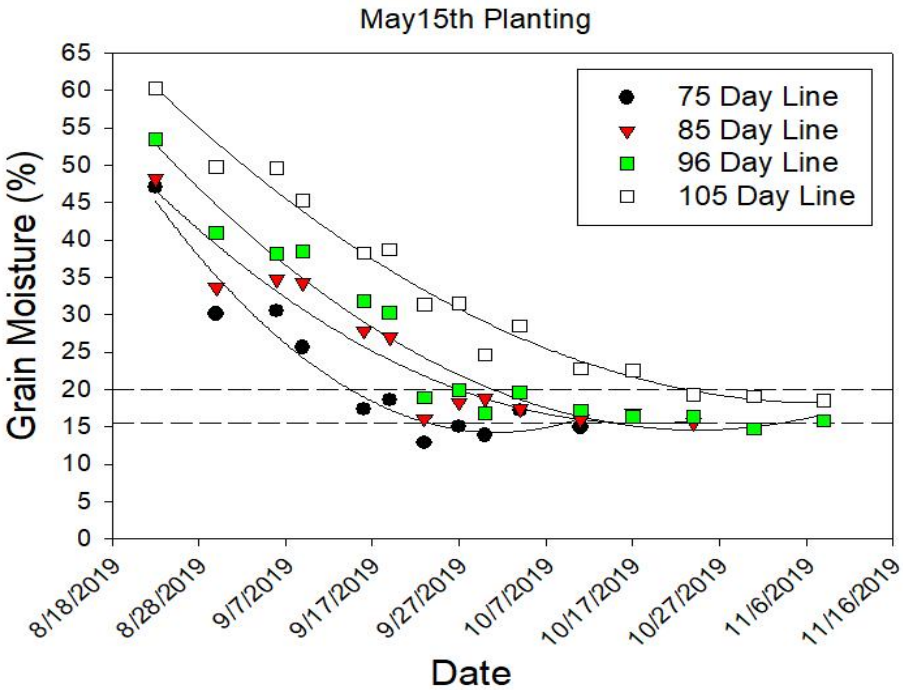

Fig. 2. Grain moisture plotted over time for corn hybrids of 75, 85, 96, and 105 days relative maturity that were part of a larger study planted on 15 May, 2019, at the Southeast Research Farm in Beresford, South Dakota. Dashed horizontal lines correspond to 15.5 and 20 % moisture.

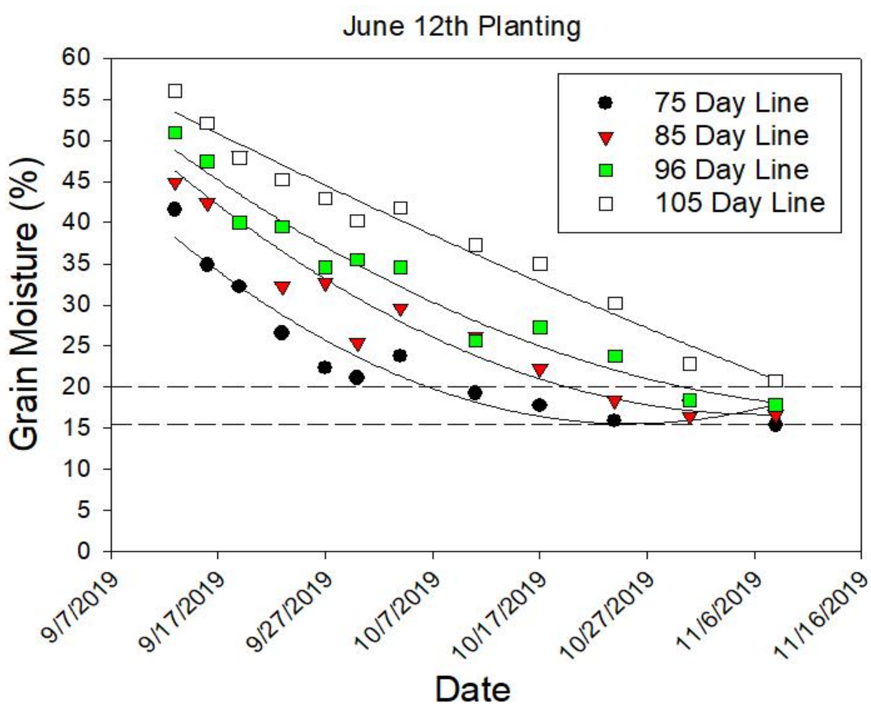

Fig. 3. Grain moisture plotted over time for corn hybrids of 75, 85, 96, and 105 days relative maturity that were part of a larger study planted on 12 June, 2019, at the Southeast Research Farm in Beresford, South Dakota. Dashed horizontal lines correspond to 15.5 and 20 % moisture.

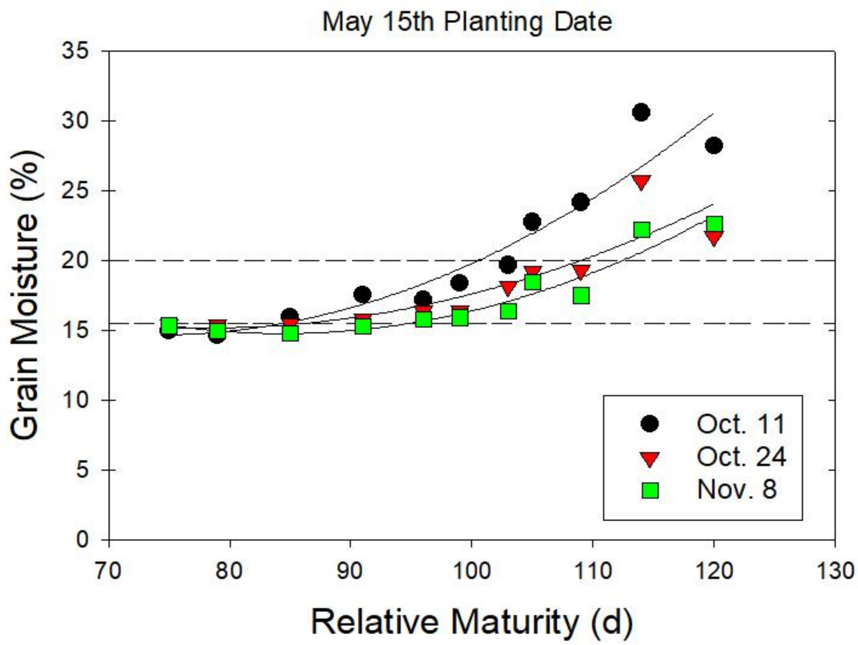

Fig. 4. Grain moisture plotted over time for corn hybrids ranging from 75 to 120 days relative maturity at three different dates in the fall of 2019. These plots were planted on 15 May, 2019, at the Southeast Research Farm in Beresford, South Dakota. Dashed horizontal lines correspond to 15.5 and 20 % moisture.

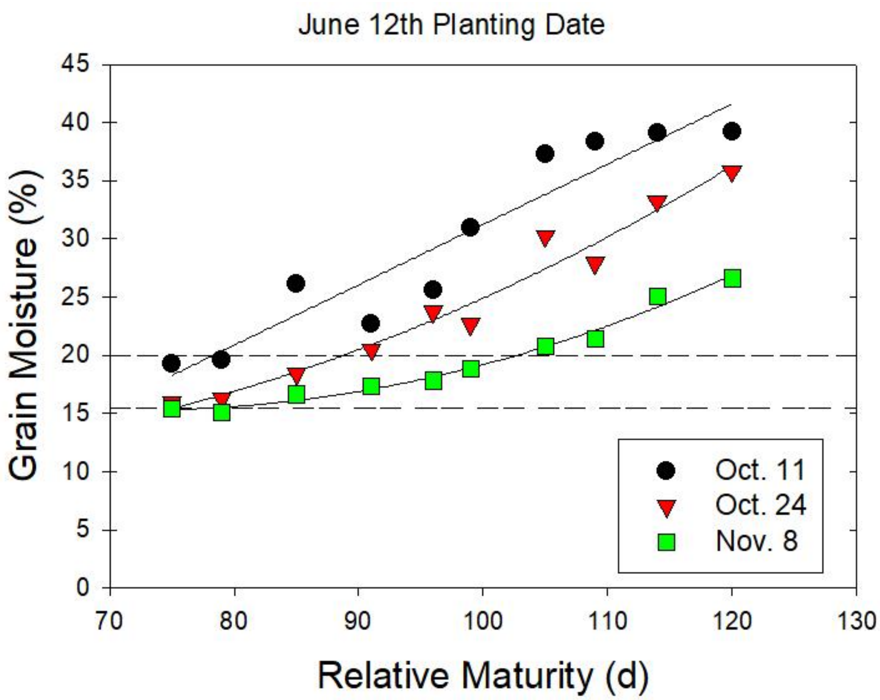

Fig. 5. Grain moisture plotted over time for corn hybrids ranging from 75 to 120 days relative maturity at three different dates in the fall of 2019. These plots were planted on 12 June, 2019, at the Southeast Research Farm in Beresford, South Dakota. Dashed horizontal lines correspond to 15.5 and 20 % moisture.

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Impact of a Rye Cover Crop on Soybean Grain Yield and Drainage Water Quality – 2019 Season, a Work in Progress

Peter Sexton*, Sandeep Kumar, Shannon Osborne, Mike Lehman, Anthony Bly, and Laurent Ahiablame

INTRODUCTION

The purpose of this project is to evaluate the effect of using a winter rye cover crop within a corn/soybean rotation (rye seeded every fall and burned down each spring) on soil and drainage water quality, and on grain yields. Interest in tile drainage has increased dramatically in eastern South Dakota over the last 15 years. Concomitant with this, there is increasing concern about the impact of fertilizer use on drainage water quality. Nationally, concern has grown about the effect of loss of nutrients, particularly nitrate, from fields in drainage systems and its effect on downstream watersheds. Use of a winter rye cover crop to take up available N from the soil profile is a management tool that may help to address this problem while at the same time contributing to improved soil health. Winter rye is very winter hardy and grows aggressively in the early spring, providing a living root system to absorb mobile nutrients in the late fall and spring up until planting. As a cover crop, it cannot only sequester N from leaching, but will add organic matter to the soil. As it grows it will use some moisture and may improve trafficability for spring planting – potentially lessening the need for artificial drainage to allow for crop establishment. With these potential benefits in mind a three year study was initiated to measure the impact of a rye cover crop on nitrate concentrations in tile drainage water, on soil health as indicated by the Haney soil test, and on grain yield. This is the second year of the study and sample analysis is still in progress on soil and water samples from the growing season, so this report is limited to treatment impacts on grain yield in the 2019 season.

METHODS

This trial was conducted at the SDSU Southeast Research Farm in Beresford, South Dakota on a Egan silty clay loam soil. It was set up as a randomized complete block design with two treatments and seven replications in order to minimize problems with soil variability across the study site. The treatments were a control (no cover crop) and a rye cover crop seeded after

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grain harvest. The trial was established in a set of tile drainage plots that had been instrumented to measure depth of water in the tile line with control structures and to allow for weekly acquisition of water samples. All the plots were allowed to drain (none of the control structures were closed). ‘Rymin’ rye was seeded into soybean stubble at a seed rate of 50 lb/ac on October 22, 2018. The rye was sprayed out on June 8, 2019 with a mixture of glyphosate, metribuzin, and metolachlor herbicides. Soybeans were seeded at a rate of 150,000 seeds per acre in 30” rows on June 5, 2019. No fertilizer was applied to this crop. At harvest maturity, an area of 20’ by 180’ was taken from the center of each plot for determination of grain yield.

RESULTS and DISCUSSION

Heavy rain in June resulted in one of the plots being flooded, so that particular block was dropped from the study. The other six replications were in a higher position on the landscape and did not have issues with flooding in 2019. Plant height, 100-seed weight, and yield were all greater in the plots that had a rye cover crop relative to the control (no cover crop) plots. The difference in grain yield was 2.9 bu/ac ($P < 0.05$) in favor of the rye cover crop plots.

This is the second year of this study, so the cover crop plots have had rye during the off-season for two years in a row going into planting in May of 2020. In 2018 (first year of the study) the cover crop plots also showed a small yield “bump” (3.5 bu/ac corn yield, $P < 0.10$) relative to the control. We expect the benefits to soil health to accrue over time, so it will be interesting to see how these plots perform in 2020. The third year of the rye cover crop is in the field now. These plots will be planted to corn in the spring of 2020.

Water samples were drawn weekly from the control structure for each plot for the duration of the season. These samples were frozen within 24 hours of being sampled and are still being analyzed. This data, and data on soil quality (as measured by the Haney test), will be reported once the study is completed and all the data is compiled.

ACKNOWLEDGEMENT

The authors appreciate the contributions of the Nutrient Research and Education Council (NREC), USDA/NRCS, and the South Dakota Agricultural Experiment Station in support of this research.

Table 1. Average height, stand, 100-seed weight, grain moisture, test weight, and yield for soybean plots raised with and without a rye cover crop in a corn/soybean rotation at the SDSU Southeast Research Farm in Beresford, South Dakota in 2020. This trial had six field replications. Plant height and stand counts were taken at harvest.

Treatment	Height	Stand	100-Seed Wt.	Moisture	Test Wt.	Yield
	(in)	(plants/ac)	(g)	(%)	(lb/bu)	(bu/ac)
Rye cover crop	32.4	98155	19.3	12.3	55.0	61.3
Control	30.8	102221	18.7	12.6	55.7	58.4
Mean	*31.6*	*100188*	*19.0*	*12.5*	*55.4*	*59.8*
CV (%)	*2.2*	*6.3*	*1.1*	*4.3*	*1.4*	*3.2*
P-value	*< 0.01*	*NS*	*< 0.01*	*NS*	*NS*	*<0.05*

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Winter Rye Variety Trial – 2019 Season

Peter Sexton*, Ben Brockmueller, Chelsea Sweeter, and Brad Rops

INTRODUCTION

Farmers in our area would greatly benefit from having an additional crop to raise that would be profitable. The corn/soybean system would definitely benefit from diversification, both in terms of grain yields and in terms of soil health and conservation. Having another profitable crop that one can raise is like having another tool in the tool box, you may not use it in every situation, but it's useful to have when it fits the circumstances. Hybrid rye appears to have potential as an alternative crop here, as it has good yield potential. Rye is robust and winter-hardy, very competitive with weeds, and does not require high levels of fertility. From an agronomic point of view, it appears to be a very strong candidate as an alternative crop, which would be useful in and of itself, and also benefit yields of the following corn and soybean crops.

METHODS

Rye was direct-seeded into oat stubble on 17 Sept., 2018. Plots were laid out in a randomized complete block design with four replications. Plot size was 5 by 20'. Plots were fertilized with 110 lb/ac of N as urea and 9 lb/ac of S as AMS on 02 April, 2019. No fungicides or insecticides were applied. Plots were harvested with a small plot combine on August 8 and 14, 2019. Harvest occurred over two days due to a combine breakdown which delayed completion of the work for a few days.

RESULTS

The hybrid lines performed much better than the open pollinated lines, with the better hybrid lines yielding over 100 bu/ac while the best open-pollinated line yielded 61 bu/ac (Table 1). This was not an ideal season for rye production - a good portion of the trial area was briefly flooded with heavy rains that occurred in early March. So one might expect even better results in future years. If a steady market develops for this crop, it looks like it will have a fit here. In the long-term rotation study at the Southeast Farm, including a small grain in the rotation increased no-till corn yield on average by 9 bu/ac over the last 25 years, and in more recent years this yield bump has been on the order of 18 to 22 bu/ac. Soybean yields have not been as responsive to rotation in our studies, the yield gain there was about 2 bu/ac this past season with inclusion of a small grain in the crop rotation. If we assume that inclusion of a small grain were to increase corn yield by 10 bu/ac and soybean yield by 2 bu/ac, this would result in $50 to $60 per acre of added income in the following crops. Also one could expect that rye would be very competitive with weeds, which would be another benefit for

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the overall cropping system. If we assume a yield of 130 bu/ac for hybrid rye, given the benefits to the whole system, it begins to look like a very promising new crop for our area.

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Table 1. Lodging score, height, test weight, and grain yield of eleven rye lines (eight hybrid and three open-pollinated) along with a few lines of winter triticale and a winter wheat line of interest, raised in small-plot variety trial at the Southeast Research Farm in Beresford, South Dakota. Plots were planted 17 Sept., 2018, and harvested on August 8 and 14, 2019.

Line	**Crop**	**Lodge**	**Height**	**Test Wt.**	**Yield**
		(0-10 scale)	(in)	(lb/bu)	(bu/ac)
Tayo	hybrid rye	6.0	46.1	45.8	105
Serafino	hybrid rye	7.5	48.2	44.1	100
Binnitto	hybrid rye	8.5	47.6	44.1	90
Propower	hybrid rye	7.0	50.5	43.6	88
Bono	hybrid rye	8.2	49.6	46.6	87
Progas	hybrid rye	7.0	46.1	44.3	72
Brasetto	hybrid rye	9.4	48.6	42.5	70
Daniello	hybrid rye	8.8	49.4	40.3	63
Hazlet	OP rye	9.5	46.8	48.4	61
Hy-Octane	triticale	9.3	43.7	45.4	50
Fridge	triticale	7.0	44.6	51.9	46
Lon	OP rye	8.3	44.2	42.4	43
Rymin	OP rye	9.3	48.9	48.3	43
719 Flex	triticale	8.5	40.9	49.5	39
Willow Creek	wheat	8.5	49.3	43.0	19
	Mean	*8.3*	*47.0*	*45.3*	*64.2*
	CV (%)	*16.8*	*6.5*	*9.7*	*23.0*
	LSD (0.05)	*NS*	*4.3*	*6.3*	*24.4*

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Soybean Maturity Observation Studies at Yankton and Beresford

Peter Sexton*, Brandon Wagner,
Chelsea Sweeter, and Brad Rops

INTRODUCTION

Soybeans are a short-day, photoperiod sensitive crop. They track day length and as days get shorter they are triggered to begin reproductive growth. The later they are planted, the faster their development is accelerated, so to a point they can automatically compensate for late planting. This raises the question of how much should a person adjust the maturity of their soybean lines when circumstances force late planting. To help gather local data to address this question a set of plots with lines of differing maturity groups were established at the Yankton High School Farm, in collaboration with Brandon Wagner, and at the Southeast Research Farm in Beresford.

METHODS

Soybean lines ranging in maturity group from 0.5 to 2.7 were seeded with a small plot drill on -14 June at Yankton and on 17 June at Beresford. Plot size was 5 by 25’ and the plots were laid out in a randomized complete block design with four replications at each site. The 0.5, 1.0, and 1.5 maturity group plots at Yankton were harvested on Sept 27, 2019 and the remainder of the plots at Yankton were harvested on 16 Oct. 2019. The plots at Beresford were harvested on Oct. 15, 2019.

RESULTS and DISCUSSION

Yields across all the lines in the trial averaged 53.1 bu/ac at Yankton (Table 1). Given the late planting date, this was a good level of production. The lines with the highest yields belonged to the 2.3, and 1.5, maturity groups, yielding 61.5, and 56.6 bu/ac, respectively. The 2.3 maturity group was essentially at the R7 stage (physiological maturity) by Sept. 23 and all the lines at Yankton were at the R8 stage (harvest maturity) by Oct. 9. Among these lines it appears that selecting a line between the 1.5 and 2.3 maturity groups would have been a good fit at this site for this planting date. Later lines still matured, but didn’t show better yield and would have incurred more risk of getting green seed with an early frost.

The trial area at Beresford was in a low-lying part of the farm and was affected by flooding after planting. Some plots were lost entirely, and some were partially damaged. For this reason only the growth stage data is presented for these plots (Table 2). Similar to the Yankton site, by Sept. 23 the 2.3 maturity group was practically at the R7 stage (6.9), and all lines

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earlier than that were past the R7 stage. By Oct. 9, all these plots (MG 2.3 and earlier) were at the R8 stage which is harvest maturity. So for this site and a June 17 planting date, a line with 2.3 maturity group rating was adequate for achieving R8 maturity by Oct. 9.

ACKNOWLEDGEMENTS

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Table 1. Soybean growth stage at three different dates, harvest date, height, moisture, test weight, 100-seed weight, and yield for soybean lines ranging from 0.5 to 2.7 maturity group at the Yankton High School Farm in Yankton, South Dakota. Plots were seeded on 14 June 2019 using a small plot drill.

Line	**Sept. 18 R-Stage**	**Sept. 23 R-Stage**	**Oct. 9 R-Stage**	**Harvest Date**	**Height**	**Moisture**	**Test Wt.**	**100-Seed Wt.**	**Yield**
(MG)					(in.)	(%)	(lb/bu)	(g)	(bu/ac)
0.5	8.0	8.0	.	Sept 27	28.0	12.1	59.6	16.2	51.6
1.0	7.0	8.0	.	Sept 27	24.5	15.1	59.4	19.7	56.3
1.5	7.0	8.0	.	Sept 27	30.5	12.9	59.8	15.5	56.6
1.9	6.8	7.5	8.0	Oct. 16	29.4	11.5	59.4	17.5	51.2
2.1	6.6	7.2	8.0	Oct. 16	31.4	11.6	60.8	15.5	50.0
2.3	6.5	6.9	8.0	Oct. 16	33.3	12.1	60.1	15.7	61.5
2.5	6.3	6.8	8.0	Oct. 16	29.3	13.3	59.0	16.8	43.6
2.7	6.2	6.8	8.0	Oct. 16	28.9	12.2	60.0	15.7	56.0
mean	*6.8*	*7.4*	*8.0*	---	*29.4*	*12.6*	*59.7*	*16.6*	*53.1*
CV (%)	*1.3*	*1.7*	---	---	*17.8*	*8.3*	*1.6*	*3.3*	*6.6*
LSD (0.05)	*0.1*	*0.2*	---	---	*NS*	*1.5*	*NS*	*0.8*	*5.0*

Table 2. Soybean growth stage at three different dates for soybean lines ranging from 0.5 to a 2.7 maturity group at the Southeast Research Farm in Beresford, South Dakota. Plots were seeded on 17 June 2019 using a small plot drill. Subsequent flooding damaged a number of the plots, for this reason only growth stage data are reported in this table.

Line	**Sept. 18 R-Stage**	**Sept. 23 R-Stage**	**Oct. 9 R-Stage**
(MG)			
0.5	7.6	8.0	8.0
1.0	6.9	7.9	8.0
1.5	6.7	7.7	8.0
1.9	6.4	7.1	8.0
2.1	6.2	6.9	8.0
2.3	6.2	6.9	8.0
2.5	6.1	6.7	7.9
2.7	6.0	6.5	7.8
mean	*6.4*	*7.1*	*8.0*
CV (%)	*1.5*	*2.0*	*0.4*
LSD (0.05)	*0.2*	*0.3*	*0.1*

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Soybean P & K Response Trial in Southeast South Dakota – Initial Results

Pete Sexton*, Jason Clark, Anthony Bly, Chelsea Sweeter, and Brad Rops

INTRODUCTION

Soybean yield response to phosphorous and potassium application has been studied in many trials in South Dakota. Nevertheless, both soybean genetics and soil quality are moving targets, so it is prudent to revisit this subject. Soybean yield potential has steadily increased over time – so the demand for nutrients by the crop has increased. On the other hand, the development of reduced tillage and no-till systems have generally led to improved soil quality. No-till in particular supports more active mycorrhizal fungi associations, which in turn make P, K, and other nutrients in the soil more available to plants. So neither plant demand for nutrients, nor the soil's ability to supply nutrients, are static. Hence the need to return to this topic.

METHODS

Plots were laid out in a randomized complete block design with three replications at each site. Plot size was 15' by 30'. Plots were superimposed on soybean fields with farmer-cooperators at the following sites: Baltic, Centerville, Parkston, Springfield, and also at the Southeast Research Farm in Beresford. All materials were broadcast by hand between planting and the V1 growth stage.

Treatments were as follows:

Trt	K rate (lb K_2O/ac)	P rate (lb P_2O_5/ac)	N rate (lb/ac)
1	0	0	0
2	40	0	0
3	80	0	0
4	120	0	0
5	160	0	0
6	0	40	33.85
7	0	80	33.85
8	0	120	33.85
9	0	160	33.85
10	80	80	33.85
11	160	160	33.85
12	0	0	33.85

At maturity, stand counts and plant height were measured. Plots were harvested with a ZÜRN small plot combine; grain moisture, test weight, and 100-seed weights were determined along with grain yield.

Data from each site were subjected to analysis of variance by site. Data on treatments number 1, 10, 11, and 12 were pooled across sites in order to better see if there was a response to N or not. This analysis failed to show a significant difference between these treatments, and site by treatment interactions were non-significant for

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that particular data set. Therefore, at the Centerville site where data on the control was lacking, the yield for the N only application (treatment # 12) was used in place of it for fitting a quadratic response curve to the observed yield data.

Results from each site were plotted and a quadratic curve fit to the data in the range of 0 to 120 lb/ac for P and for K, except for the K response at Parkston where the 160 lb rate was also included. The economic optimum was estimated as the probable point where the last pound of fertilizer applied paid for itself assuming a market value of $8.85 per bushel for soybeans, and a cost of $0.54 per lb for P and $0.31 per lb for K.

RESULTS

For the reader's information, data on plant height, stand at harvest, seed weight, moisture and yield for each site are given in Tables 1 through 5. In order to estimate response functions, the yield data was in turn fitted to quadratic response curves for P (Fig. 1) and K (Fig. 2). There were trends for a slight yield response to P at Parkston, Beresford and Springfield. The estimated yield peak occurred at rates of 57, 61, and 86 lb/ac of P_2O_5 at Parkston, Beresford, and Springfield, respectively (Table 6). The economic optimum rate (the point where the last pound of fertilizer paid for itself) for these three sites was 15, 43, and 0 lb/ac at Parkston, Beresford, and Springfield, respectively. The response at Springfield was so slight that even though there was a trend for yield to increase with applied P, the small amount of yield gain would not pay for the fertilizer used (hence the 0 optimum rate at that site).

There were trends for a slight yield response to K at Centerville, Parkston, and Beresford. The yield peak for K occurred at 62, 125, and 49 lb/ac of K2O at Centerville, Parkston, and Beresford, respectively (Table 7). The economic optimum rate was estimated at 46, 69, and 0 lb K2O per acre at these same three sites, respectively. The apparent response at Beresford was so weak, albeit positive, that it would not have been profitable to use any fertilizer there. Soil analysis for these sites is a work in progress. The results from this trial will be compared to soil P and K levels, and the trial will need to be repeated over several seasons hopefully, in order to develop nutrient response curves in the future.

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Table 1. Soybean plant height, stand, 100-seed weight, moisture, test weight, and grain yield in a P and K response trial conducted at Centerville, South Dakota in 2019. Two of the control plots were lost due to problems at harvest; therefore the N only treatment was used as a control for estimating quadratic response curves at this site.

K rate	**P rate**	**N rate**	**Height**	**Stand**	**100-Seed Wt.**	**Moisture**	**Test Wt.**	**Yield**
(lb/ac)	(lb/ac)	(lb/ac)	(in.)	(plt/ac)	(g)	(%)	(lb/bu)	(bu/ac)
0	0	0	32.7	109,552	16.2	12.3	59.4	.
40	0	0	33.4	106,944	16.0	12.3	59.0	47.4
80	0	0	32.7	105,205	16.1	12.4	59.0	49.5
120	0	0	36.0	99,119	15.5	12.3	58.3	44.9
160	0	0	33.8	100,858	16.0	12.3	58.7	45.7
0	40	33.85	36.1	119,986	15.8	12.2	58.8	47.6
0	80	33.85	36.3	107,813	16.1	12.3	59.2	44.3
0	120	33.85	35.0	107,813	15.0	12.4	58.6	48.0
0	160	33.85	37.2	99,988	15.5	12.4	58.6	47.9
80	80	33.85	35.2	113,030	16.1	12.5	59.0	50.3
160	160	33.85	36.8	115,638	16.2	12.5	58.6	46.2
0	0	33.85	33.3	114,769	15.8	12.3	59.1	45.0
		mean	*35.0*	*108,604*	*15.8*	*12.4*	*58.9*	*47.2*
		CV(%)	*6.0*	*9.1*	*3.2*	*1.2*	*1.1*	*10.7*
		LSD (0.10)	*NS*	*NS*	*NS*	*NS*	*NS*	*NS*

Table 2. Soybean plant height, stand, 100-seed weight, moisture, test weight, and grain yield in a P and K response trial conducted at Parkston, South Dakota in 2019.

K rate	P rate	N rate	Height	Stand	100-Seed Wt.	Moisture	Test Wt.	Yield
(lb/ac)	(lb/ac)	(lb/ac)	(in.)	(plt/ac)	(g)	(%)	(lb/bu)	(bu/ac)
0	0	0	33.9	73,181	19.3	12.8	59.1	63.9
40	0	0	32.0	82,474	19.3	12.6	59.4	63.5
80	0	0	33.8	78,408	19.0	12.6	59.6	**68.8**
120	0	0	32.8	78,989	18.7	12.7	58.9	**68.1**
160	0	0	31.9	77,827	18.8	12.7	59.3	67.3
0	40	33.85	31.8	72,600	19.5	13.2	59.0	67.2
0	80	33.85	33.8	82,474	19.0	12.8	59.7	65.4
0	120	33.85	34.3	82,474	18.9	13.0	59.2	63.9
0	160	33.85	35.6	78,989	19.3	12.7	59.3	**69.3**
80	80	33.85	33.6	80,731	18.8	12.8	59.6	64.7
160	160	33.85	33.8	81,312	19.1	12.6	59.8	**68.0**
0	0	33.85	33.7	80,150	18.8	12.6	59.2	65.0
		mean	*33.4*	*79,134*	*2.5*	*12.8*	*59.3*	*66.3*
		CV(%)	*6.2*	*8.1*	*19.0*	*1.4*	*1.0*	*3.9*
		LSD (0.10)	*NS*	*NS*	*NS*	*0.3*	*NS*	*3.6*

Table 3. Soybean plant height, stand, 100-seed weight, moisture, test weight, and grain yield in a P and K response trial conducted at the Southeast Research Farm in Beresford, South Dakota in 2019.

K rate	P rate	N rate	Height	Stand	100-Seed Wt.	Moisture	Test Wt.	Yield
(lb/ac)	(lb/ac)	(lb/ac)	(in.)	(plt/ac)	(g)	(%)	(lb/bu)	(bu/ac)
0	0	0	28.9	102,221	16.0	12.5	60.1	58.8
40	0	0	26.8	109,190	16.8	12.9	60.2	58.7
80	0	0	27.1	109,190	16.1	12.4	59.5	59.6
120	0	0	26.2	99,898	16.4	12.8	60.3	57.7
160	0	0	28.8	123,129	16.8	12.8	60.3	62.6
0	40	33.85	30.7	120,807	17.3	12.7	60.3	65.1
0	80	33.85	31.3	102,221	16.4	12.8	60.7	64.1
0	120	33.85	26.8	92,928	16.7	13.0	60.3	59.6
0	160	33.85	29.7	116,160	16.5	12.6	60.2	66.3
80	80	33.85	29.0	102,221	16.7	12.7	60.3	62.2
160	160	33.85	30.0	111,513	17.0	12.9	60.6	66.7
0	0	33.85	29.4	104,544	16.5	12.9	60.1	62.3
		mean	*28.7*	*107,835*	*16.6*	*12.8*	*60.2*	*62.0*
		CV(%)	*5.6*	*16.9*	*2.6*	*1.5*	*1.0*	*7.1*
		LSD (0.10)	*2.3*	*NS*	*NS*	*0.3*	*NS*	*NS*

Table 4. Soybean plant height, stand, 100-seed weight, moisture, test weight, and grain yield in a P and K response trial conducted at Baltic, South Dakota in 2019.

K rate	**P rate**	**N rate**	**Height**	**Stand**	**100-Seed Wt.**	**Moisture**	**Test Wt.**	**Yield**
(lb/ac)	(lb/ac)	(lb/ac)	(in.)	(plt/ac)	(g)	(%)	(lb/bu)	(bu/ac)
0	0	0	.	.	19.3	14.0	53.9	36.8
40	0	0	.	.	18.8	17.0	53.8	31.5
80	0	0	.	.	18.4	12.6	57.8	36.6
120	0	0	.	.	19.7	14.6	53.2	37.8
160	0	0	.	.	19.2	18.5	54.8	36.1
0	40	33.85	.	.	18.0	16.5	55.3	37.9
0	80	33.85	.	.	19.7	18.3	51.7	37.0
0	120	33.85	.	.	19.7	14.5	53.2	42.7
0	160	33.85	.	.	19.4	13.6	56.4	42.3
80	80	33.85	.	.	18.3	13.3	56.9	38.0
160	160	33.85	.	.	19.2	14.7	56.3	41.1
0	0	33.85	.	.	19.3	13.9	55.5	36.2
		mean	---	---	*19.1*	*15.1*	*54.9*	*37.8*
		CV(%)	---	---	*5.6*	*26.5*	*6.7*	*12.0*
		LSD (0.10)	---	---	*NS*	*NS*	*NS*	*NS*

Table 5. Soybean plant height, stand, 100-seed weight, moisture, test weight, and grain yield in a P and K response trial conducted at Springfield, South Dakota in 2019.

K rate	P rate	N rate	Height	Stand	100-Seed Wt.	Moisture	Test Wt.	Yield
(lb/ac)	(lb/ac)	(lb/ac)	(in.)	(plt/ac)	(g)	(%)	(lb/bu)	(bu/ac)
0	0	0	35.3	142,877	16.1	11.9	59.3	57.2
40	0	0	33.6	141,715	15.9	11.9	59.3	55.2
80	0	0	33.9	138,230	15.8	11.7	59.2	50.4
120	0	0	33.0	146,942	15.8	11.7	59.4	52.0
160	0	0	33.7	135,327	16.1	11.8	59.2	55.8
0	40	33.85	34.7	148,104	16.0	11.7	59.5	58.8
0	80	33.85	37.1	141,715	15.9	12.0	59.7	59.3
0	120	33.85	36.9	137,069	16.1	12.0	59.7	59.1
0	160	33.85	35.2	151,589	15.6	11.9	59.7	54.7
80	80	33.85	35.2	143,458	15.7	12.0	59.7	56.5
160	160	33.85	36.4	144,038	15.7	12.0	59.7	56.9
0	0	33.85	34.0	154,493	15.9	11.9	59.5	55.5
		mean	*34.9*	*143,796*	*15.9*	*11.9*	*59.5*	*56.0*
		CV(%)	*4.2*	*11.9*	*2.8*	*2.0*	*1.0*	*7.4*
		LSD (0.10)	*2.0*	*NS*	*NS*	*NS*	*NS*	*NS*

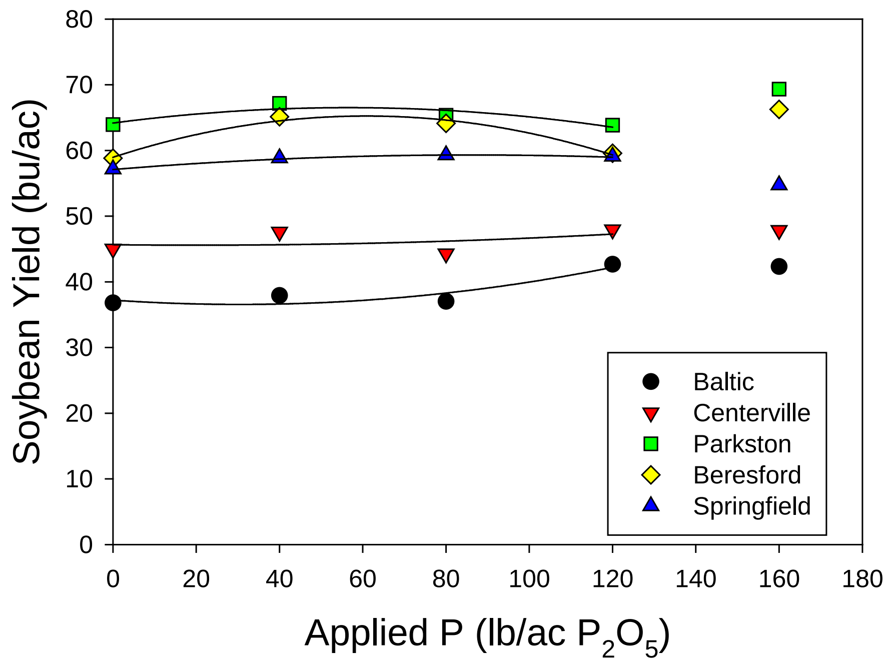

Figure 1. Soybean yield versus rate of applied P at five sites in southeastern South Dakota in the 2019 growing season.

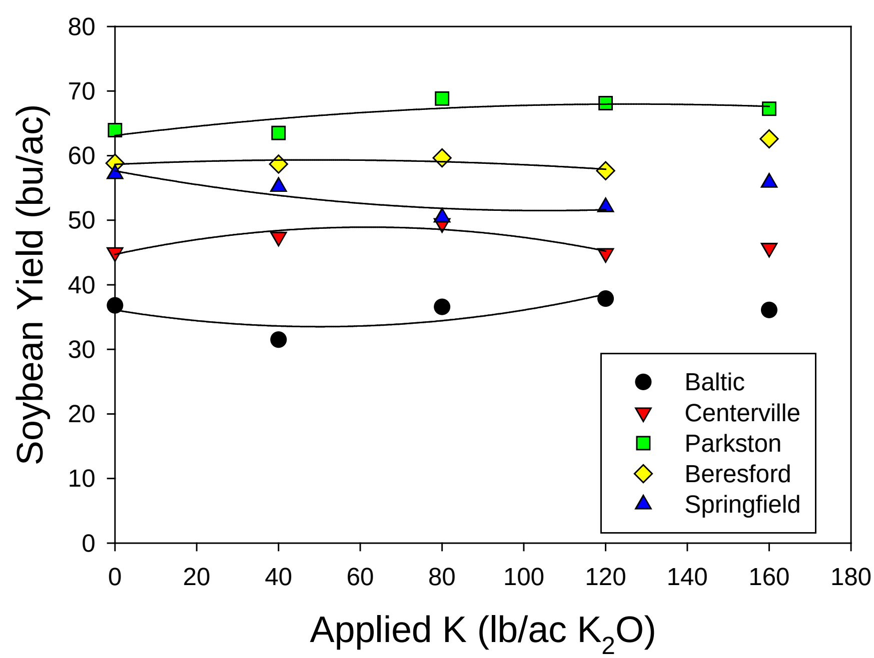

Figure 2. Soybean yield versus rate of applied K at five sites in southeastern South Dakota in the 2019 growing season.

Table 6. Quadratic response formulas for P response fitted for each site in the soybean P and K trials in 2019. Curves were fitted to the 0, 40, 80, and 120 lb rates for each site. The rates for the peak of the curve (highest yield) and economic optimum rate were calculated from these equations. The economic optimum was estimated assuming a cost $0.54 per lb for P and a soybean market price of $8.85 per bushel. Where the initial slope was negative (Baltic and Centerville) the peak and optimum were estimated as no applied P. Soil analysis from these sites is in progress.

Site	**Equation**	**r2**	**peak**	**economic optimum**
			(lb/ac)	(lb/ac)
Baltic	$37.2 - 0.0428X + 0.000705X^2$	0.84	0	0
Centerville	$45.7 - 0.000667X + 0.000169X^2$	0.17	0	0
Parkston	$64.2 + 0.0833X - 0.000737X^2$	0.80	57	15
Beresford	$59.0 + 0.206X - 0.0017X^2$	0.98	61	43
Springfield	$57.2 + 0.0515X - 0.000298X^2$	0.99	86	0

Table 7. Quadratic response formulas for K response fitted for each site in the soybean P and K response trials in 2019. Curves were fitted to the 0, 40, 80, and 120 lb rates for each site; at the Parkston site the 160 lb/ac rate was also included. The rates for the peak of the curve (highest yield) and economic optimum rate were calculated from these equations. The economic optimum was estimated assuming a cost $0.31 per lb for K and a soybean market price of $8.85 per bushel. Where the initial slope was negative (Baltic and Springfield) the peak and optimum were estimated as no applied K. Soil analysis from these sites is in progress.

Site	**Equation**	**r2**	**peak**	**economic optimum**
			(lb/ac)	(lb/ac)
Baltic	$36.1 - 0.103X + 0.00103X^2$	0.59	0	0
Centerville	$44.7 + 0.136X - 0.0011X^2$	0.86	62	46
Parkston	$63.4 + 0.0499X - 0.0000437X^2$	0.69	125	69
Beresford	$58.6 + 0.028X - 0.000286X^2$	0.59	49	0
Springfield	$57.6 - 0.117X + 0.000558X^2$	0.85	0	0

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South Dakota State University, Brookings, SD 57007
Southeast Research Farm, Beresford, SD 57004

Observations on the Impact of Being Inside or Outside a Small Grain Windrow on Corn N Response

Peter Sexton*, Debunker Sanyal, Anthony Bly, and Chelsea Sweeter

INTRODUCTION

Non-uniform distribution of residue behind combines can be a problem in no-till systems. This leaves a windrow of stubble that the next crop has to be seeded into and develop through. In 2018 a decision was made to bale some of the small grain stubble for straw. The baler used did not pick up the straw very well - probably because the combine had cut it up too much, leaving a windrow of fines and short length straw in the field. This occurred in two fields, one of which was grazed and one which was not grazed. The non-grazed field also had plus/minus cover crop strips in it. Taking note of this, it was decided in the spring of 2019 to mark these areas and measure the effect of being inside or outside the windrow on N response in corn in both of these fields.

METHODS

Plots were laid out in two fields. A split-plot design was used in both fields with the main plot being the windrow/cover crop treatment, and the subplot being N rates. Main plots were 10’ by 120’ in size while subplot size was 10’ by 20’. Nitrogen was surface applied by hand as urea at rates of 0, 40, 80, 120, 160, and 200 lb N per acre. In the field that was not grazed there were three main plot treatments: in the windrow, outside the windrow with a broadleaf cover crop blend, and outside the windrow with no cover crop. Each of these treatments were replicated three times in this field. Note that volunteer oats came in with the cover crop, so there was a strong grass component to the mix as well.

The field that was grazed was seeded to a grass-based cover crop which was grazed in the fall. In this field there were only two main plot treatments: in the windrow and outside of the windrow. There were four replications in this trial. The previous crop in both fields was winter wheat.

Plots were harvested with a small-plot combine and results subjected to analysis of variance for a split-plot design for each of the two trials.

RESULTS

There was a significant response to N in both trials, and plots that were in the windrow yielded significantly less than those outside the windrow in both trials (Tables 1 and 2). In the grazed field, corn in the windrow averaged 15 bu/ac less yield than did corn outside the windrow (Table 1). In the non-grazed field, this difference was on the order to 20 to 26 bu/ac (Table 2). In the non-grazed field there was a

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trend for the cover crop plots to have better stand, and to yield a little more (6 bu/ac) than the control plots, but these differences were not statistically significant. The non-grazed field had some problems with excess moisture early in the year, so stands tended to be poorer in that field.

Interactions between N rate and the main plot treatments (inside vs. outside the windrow, and a no cover crop control in the non-grazed field) were not statistically significant. In the grazed field, response to N was linear across all the rates tested with the windrow plots yielding less across the range (Fig. 1). In the non-grazed field the response to N followed a quadratic curve. There was a trend for more separation between the cover crop and the control plots at low N rates, but yield of these two treatments converged at higher N rates (Fig. 2). The plots in the windrow yielded less than the plots outside the windrow across N rates.

ACKNOWLEDGEMENTS

The authors appreciate the contributions of the South Dakota Agricultural Experiment Station to support this research.

Table 1. Stand, grain moisture, test weight, 100-seed weight, and yield for corn grown at different N rates inside and outside the windrow from a trial conducted at the Southeast Research Farm in Beresford, South Dakota is 2019. This field had been in winter wheat in 2018 which was planted to a grass-based cover crop and then grazed later in the fall of that year. The trial was established in the spring of 2019 and was set up in a split plot design (N rates being the subplot).

N Rate	**Stand**	**Moisture**	**Test Wt.**	**100-Seed Wt.**	**Yield**
(lb/ac)	(plt/ac)	(%)	(lb/bu)	(g)	(bu/ac)
0	27,878	18.0	53.9	33.8	167.6
40	27,443	17.9	54.5	36.2	177.7
80	27,443	17.5	54.6	34.6	177.9
120	30,710	17.9	55.0	34.7	205.8
160	29,839	17.4	55.2	36.5	205.0
200	28,096	18.3	55.8	37.1	232.1
Mean	*28,568*	*17.8*	*54.8*	*35.5*	*193.5*
CV (%)	*11*	*4.0*	*1.8*	*5.3*	*9.7*
LSD (0.10)	*NS*	*NS*	*0.8*	*1.6*	*17.2*
	Stand	**Moisture**	**Test Wt.**	**100-Seed Wt.**	**Yield**
Treatment	(plt/ac)	(%)	(lb/bu)	(g)	(bu/ac)
Cover Crop	28,967	17.8	55.1	35.1	201.3
Windrow	28,169	17.9	54.6	35.9	186.1
P-value	*NS*	*NS*	*NS*	*<0.10*	*<0.10*
Interaction					
N * Treatment	NS	NS	NS	NS	NS

Table 2. Stand, grain moisture, test weight, 100-seed weight, and yield for corn grown at different N rates inside and outside the windrow from a trial conducted at the Southeast Research Farm in Beresford, South Dakota is 2019. This field was in winter wheat the previous year and has no history of grazing. The trial was set up in a split plot design (N rates being the subplot).

N Rate	**Stand**	**Moisture**	**Test Wt.**	**100-Seed Wt.**	**Yield**
(lb/ac)	(plt/ac)	(%)	(lb/bu)	(g)	(bu/ac)
0	19941	22.8	58.0	30.4	155.2
40	23619	20.5	58.4	29.9	169.3
80	19360	20.6	57.6	30.6	187.3
120	25362	20.8	58.3	30.8	207.1
160	21490	22.7	58.0	31.8	193.3
200	22264	21.1	51.9	31.9	186.6
Mean	*22005*	*21.4*	*57.0*	*30.9*	*184.1*
CV (%)	*18*	*18.2*	*13.9*	*5.9*	*11.8*
LSD (0.10)	*3176*	*NS*	*NS*	*NS*	*18.7*
	Stand	**Moisture**	**Test Wt.**	**100-Seed Wt.**	**Yield**
Treatment	(plt/ac)	(%)	(lb/bu)	(g)	(bu/ac)
Cover Crop	24490	23.2	58.2	31.4	195.7
No Cover Crop	20812	20.1	54.7	31.3	189.8
Windrow	20715	20.9	58.0	30.1	169.0
LSD (0.10)	*NS*	*NS*	*NS*	*NS*	*11.9*
Interaction					
N Rate * Treatment	NS	NS	NS	NS	NS

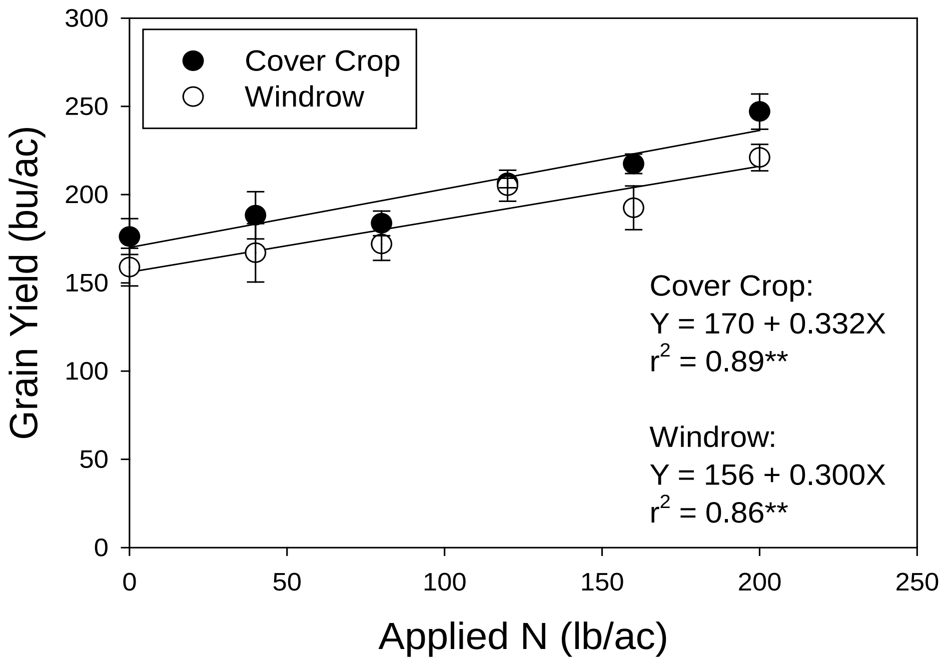

Fig. 1. Corn yield in response to applied N inside and outside a thin windrow from the previous season's small grain crop. This field was grazed in the fall of 2018 and seeded to corn in 2019. The trial was conducted at the Southeast Research Farm in Beresford, South Dakota.

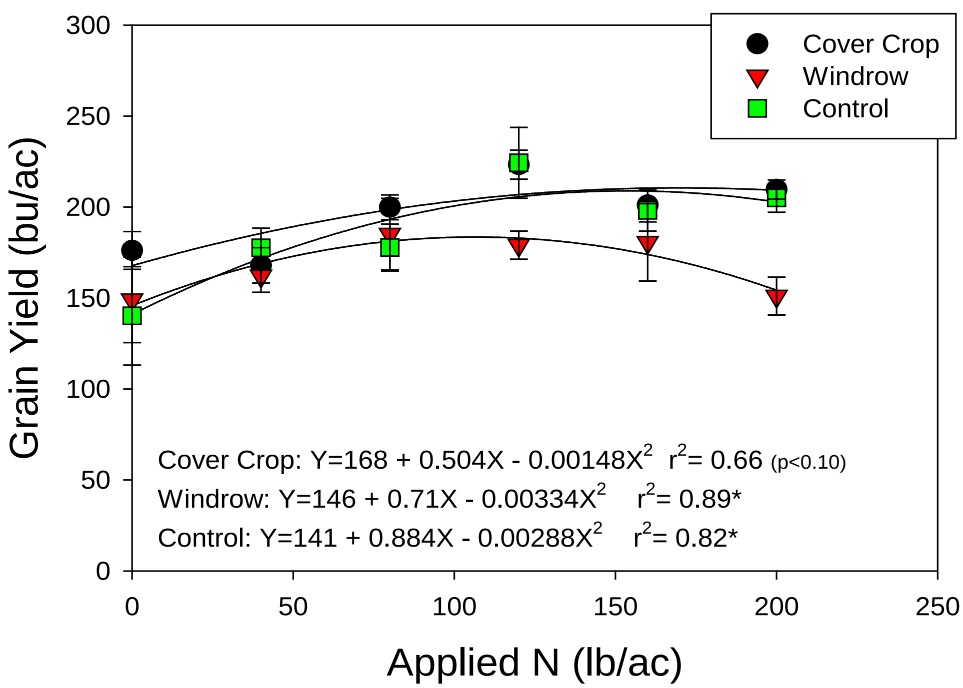

Fig. 2. Corn yield in response to applied N inside and outside a thin windrow from the previous season's small grain crop. This trial was conducted at the Southeast Research Farm in Beresford, South Dakota in 2019. This field has no history of grazing.

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Long-Term Rotation and Tillage Study: Observations on Corn and Soybean Yields – 2019 Season

Peter Sexton*, Brad Rops, Ruth Stevens, Garold Williamson, and Chelsea Sweeter

INTRODUCTION

In 1991 Dale Sorensen initiated a long-term rotation study at the Southeast Farm including comparison of no-till and conventional till under two year (corn-soybean), three year (corn-soybean-small grain or field pea) and a flex rotation (currently corn-soybean-oat-winter wheat) – note the three year and flex rotations have not been constant over the years. The advantages of no-till are many: residue on the surface protects the soil from erosion; it helps to maintain soil organic matter which is important for good tilth; conserves moisture and limits run-off; requires fewer trips across the field. The disadvantages are the loss of tillage as a tool for weed control and slower warming of the soil in the spring. This report provides a short analysis of corn and soybean yield data from the beginning of this trial through the 2016 season. While the rotation component of the trial has varied over the years, the tillage component has not. Therefore this report will discuss the tillage data from this trial more than the rotation element.

METHODS

As mentioned earlier, this set of plots was first established in 1991. The two year corn-soybean has been consistently followed. The three year rotation started with corn, soybean, small grain and then for several years field pea was substituted for small grains, and then it was later switched back to a corn-soybean-small grain pattern. The four year rotation initially included alfalfa, then after some years was changed to include peas, and later was changed again to include two soybean crops (corn-soybean-winter wheat-soybean), which was the case until the 2013 season. Since 2013 the flex rotation has been in a corn-soybean-oat-winter wheat sequence. For this reason the four year rotation is referred to as a 'Flex' rotation in this report.

This trial is laid out in a randomized complete block design with four replications using a split-plot arrangement. Rotation is the main plot, with tillage (plot size was 60 by 300 feet) as the subplot. The no-till plots, as their name implies, have not been tilled since the trial began in 1991. The tilled plots have been chisel plowed in the fall following harvest of corn and small grains, and worked in the spring with a field cultivator. Where wet conditions in the fall prevented chisel plowing corn stubble, the tilled plots were disked in the spring and then field cultivated.

For the past few seasons (since 2013), the tilled plots have been split plus/minus the use of a

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cover crop (sub-subplot size of 30 by 300'). The cover crop treatment currently consists of winter rye after each crop in the two year (corn/soybean) rotation; and winter rye following corn ahead of soybean in the three and four year rotations, with a brassica/legume blend (radish, turnip, lentils, and peas) following small grain going to corn.

Yield was measured from the center 10' of corn plots and from the center 10' of soybean plots, running the whole length of the plot. A sample was kept for determination of moisture and test weight. Data was analyzed as a split-split plot design (main plots being rotation and tillage being the sub-plot with cover crop as the sub-subplot) for corn and soybean yields using the Proc GLM routine in SAS statistical software. This report will only address results from the 2019 growing season.

RESULTS and DISCUSSION

Corn Yields

In the 2019 season in this trial, corn yield showed a response to rotation, but not to tillage (Table 1). Corn yields averaged 173 bu/ac in the two-year rotation, and 196 bu/ac in the three and four year rotations – an increase of 23 bu/ac. No significant differences from use of a cover crop were observed for corn yield in trial for the 2019 season (Table 1). One factor with this is that a large component of the cover crop biomass following small grain was volunteer cereals (oats and winter wheat) in these plots. Previous work at the Southeast Farm suggests that cool-season broadleaves, such as radishes and peas, tend to benefit corn yield, while grass-based cover crops tend to have no effect on yield of the following corn crop. The large presence of volunteer cereals may limit the corn yield response to cover crops in our environment.

Soybean Yields In 2019, neither tillage nor rotation showed significant effects on soybean yield (Table 2). In previous years, we have seen that the no-till plots often out-yield the tilled plots for soybean production. However, in 2019 with all the high amounts of rainfall received, this effect was not observed. Stand at maturity tended to increase with longer rotation length, but this was not reflected in greater yields. Because the soybean part of the rotation has not been consistently managed over the course of the study, this data on soybean response to rotation needs to be viewed with caution.

Plots that had a cover crop showed a slightly greater plant height and yield versus plots that did not have a cover crop (0.9 bu/ac; $P<0.10$). There was a significant interaction of rotation length on the yield response to a cover crop (Table 2). In a two-year corn/soybean rotation, the soybeans showed a 3 bu/ac yield response ($P < 0.01$) to use of a rye cover crop in the 2019 season (Table 3). In the three and four year rotations, on the other hand, there was no discernible impact of a rye cover crop on soybean yields (Tables 4 and 5). This may be because the three and four year rotations already include a cool-season grass in the rotation, so adding winter rye as a cover crop doesn't really add as much diversity to that system. Whereas in the two year corn/soybean rotation there are no cool-season grasses in the system (corn being a warm-season grass, and soybean being a warm-season legume), so adding winter rye to that rotation does add another level of diversity, and in 2019 the soybean crop responded to it. In another separate study with winter rye at the Southeast Farm looking at effects of rye on drainage water quality ('Impact of a rye cover crop on soybean grain yield and drainage water quality – a work in progress'), a similar soybean yield bump (2.9 bu/ac; $P < 0.05$) was observed with use of a rye cover crop.

SUMMARY

In the 2019 season, there was no positive or negative effect of tillage observed on either corn or soybean yields in the long-term rotation study. Corn yields showed a strong response to rotation length, yielding about 22 bu/ac more going from a two year to a three year rotation. Soybean in a two year corn/soybean rotation showed a significant yield increase (3 bu/ac) with addition of a rye cover crop to the system in 2019; however, there was no yield response observed with the rye cover crop when it was used in longer three and four-year rotations that already include cool-season grasses in their production cycle.

ACKNOWLEDGEMENTS

The author appreciate the contribution of the South Dakota Agricultural Experiment Station to support this research.

Table 1. Grain moisture, test weight, stand at harvest, and yield of corn in the 2019 season raised with conventional and no-till management in two, three, and four year rotations at the Southeast Research Farm in Beresford, South Dakota. This is part of a long-term study that was initiated in 1991. The other crops in the rotations have changed sometimes over the years, but corn has always been raised on the given two, three or four year cycle.

Rotation	**Tillage**	**Cover Crop**	**Moisture**	**Test Wt.**	**Stand**	**Yield [a/]**
			(%)	(lb/bu)	(plts/ac)	(bu/ac)
2	CT	Cover	16.0	56.9	26,572	171.9
2	CT	None	15.7	58.3	27,443	172.2
2	NT	Cover	15.9	56.7	27,878	174.9
2	NT	None	15.8	57.2	29,185	174.4
3	CT	Cover	15.6	56.2	26,572	194.4
3	CT	None	15.9	56.9	28,314	200.9
3	NT	Cover	16.3	55.3	26,136	196.5
3	NT	None	16.2	56.1	30,928	192.0
4	CT	Cover	16.4	57.7	28,749	196.3
4	CT	None	16.6	57.5	27,443	196.1
4	NT	Cover	17.0	56.1	29,185	197.7
4	NT	None	17.2	56.3	30,057	193.0
		mean	*16.2*	*56.8*	*28,205*	*188.2*

Main Effects

		Moisture	**Test Wt**	**Stand**	**Yield [a/]**
	Rotation	(%)	(lb/bu)	(plts/ac)	(bu/ac)
	2	15.8	57.3	27,769	173.3
A	3	16.0	56.1	27,987	195.9
	4	16.8	56.9	28,859	195.8
	LSD (0.10)	*0.5*	*NS*	*NS*	*16.4*
	Tillage				
B	CT	16.0	57.2	27,515	188.6
	NT	16.4	56.3	28,895	187.7
	P-value	*0.046*	*0.053*	*0.085*	*NS*
	Cover Crop				
C	Cover Crop	16.2	56.5	27,515	188.3
	No Cover Crop	16.2	57.0	28,895	188.1
	P-value	*NS*	*0.028*	*0.024*	*NS*

Table 1. Continued

Rotation	Tillage	Cover Crop	Moisture	Test Wt.	Stand	Yield [a/]
		Interactions	**Moisture**	**Test Wt**	**Stand**	**Yield [a/]**
	A X B	*P-value*	*NS*	*NS*	*NS*	*NS*
	A X C	*P-value*	*NS*	*NS*	*0.059*	*NS*
	B X C	*P-value*	*NS*	*NS*	*NS*	*NS*
	A X B X C	*P-value*	*NS*	*NS*	*NS*	*NS*
		Mean	16.2	56.8	28,205	188.2
		CV (%) Cover Crop	1.8	1.4	6.8	3.1

a/ yield for the 3-year no-till plots were adjusted for N application using a N response observed from a nearby field because it appears they did not receive N topdressing.

Table 2. Grain moisture, test weight, stand at harvest, height, seed weight and yield of soybeans in the 2019 season raised with conventional and no-till management in two, three, and four year (flex) rotations at the Southeast Research Farm in Beresford, South Dakota. This is part of a long-term study that was initiated in 1991. The soybean component of these trials has varied over the years, so rotation differences should be viewed with caution. In the "flex" rotation sometimes soybeans were raised twice in a four year period.

Rotation	**Tillage**	**Cover Crop**	**Moisture**	**Test Wt.**	**Stand**	**Height**	**100-Seed Wt.**	**Yield**
			(%)	(lb/bu)	(plt/ac)	(in.)	(g)	(bu/ac)
2	CT	Cover	12.7	54.6	75,359	32.5	15.7	46.7
2	CT	None	12.8	54.5	82,329	31.6	15.3	42.8
2	NT	Cover	12.6	55.3	89,298	32.2	16.5	47.9
2	NT	None	12.5	55.1	80,586	30.8	15.9	45.8
3	CT	Cover	12.7	54.7	81,457	33.6	16.3	47.8
3	CT	None	12.6	54.6	82,329	33.4	16.4	47.8
3	NT	Cover	12.7	55.4	91,912	31.1	15.9	47.6
3	NT	None	12.5	55.2	85,813	30.3	16.7	47.8
4	CT	Cover	12.9	53.7	87,120	33.5	16.8	47.7
4	CT	None	12.8	54.4	86,249	32.5	16.4	48.9
4	NT	Cover	12.5	55.1	94,961	30.6	16.4	47.9
4	NT	None	12.6	55.6	93,219	30.1	16.0	47.1
		mean	*12.7*	*54.8*	*85,886*	*31.8*	*16.2*	*47.1*

Main Effects

		Moisture	**Test Wt**	**Stand**	**Height**	**100-Seed Wt.**	**Yield**
	Rotation	(%)	(lb/bu)	(plts/ac)	(in.)	(g)	(bu/ac)
	2	12.7	54.9	81,893	31.7	15.8	45.8
A	3	12.6	55.0	85,378	32.1	16.3	47.7
	4	12.7	54.7	90,387	31.7	16.4	47.9
	LSD (0.10)	*NS*	*NS*	*6002*	*NS*	*NS*	*NS*
	Tillage						
B	NT	12.6	55.3	89,298	30.8	16.2	47.3
	CT	12.7	54.4	82,474	32.8	16.1	46.9
	P-value	*0.003*	*0.003*	*NS*	*0.013*	*NS*	*NS*
	Cover Crop						
C	Cover Crop	12.7	54.8	86,685	32.2	16.2	47.6
	None	12.6	54.9	85,087	31.4	16.1	46.7
	P-value	*NS*	*NS*	*NS*	*0.003*	*NS*	*0.083*

Table 2. Continued

Rotation	Tillage	Cover Crop	Moisture	Test Wt.	Stand	Height	100-Seed Wt.	Yield
		Interactions	**Moisture**	**Test Wt**	**Stand**	**Height**	**100-Seed Wt.**	**Yield**
	A X B	*P-value*	*0.079*	*NS*	*NS*	*NS*	*NS*	*NS*
	A X C	*P-value*	*0.081*	*NS*	*NS*	*NS*	*NS*	*0.029*
	B X C	*P-value*	*NS*	*NS*	*NS*	*NS*	*NS*	*NS*
	A X B X C	*P-value*	*NS*	*NS*	*NS*	*NS*	*NS*	*NS*
		Mean	12.7	54.8	85,886	31.8	16.2	47.1
		CV (%) Cover Crop	1.1	1.0	13.1	2.6	5.1	3.7

Table 3. Soybean yields in plots with and without a cover crop under tilled and no-till management in a two year corn/soybean rotation at the Southeast Research Farm. In these plots, the cover crop consists of winter rye raised immediately before the soybean crop.

Tillage	Cover Crop	Moisture	Test Wt	Stand	Height	100-Seed Wt.	Yield
		(%)	(lb/bu)	(plts/ac)	(in.)	(g)	(bu/ac)
CT	Cover	12.7	54.6	75359	32.5	15.7	46.7
CT	None	12.8	54.5	82329	31.6	15.3	42.8
NT	Cover	12.6	55.3	89298	32.2	16.5	47.9
NT	None	12.5	55.1	80586	30.8	15.9	45.8
	CT	12.8	54.5	78844	32.0	15.5	44.7
	NT	12.5	55.2	84942	31.5	16.2	46.8
	P-value	*0.042*	*NS*	*NS*	*NS*	*0.086*	*NS*
	Cover Crop	12.6	54.9	82329	32.3	16.1	47.3
	None	12.7	54.8	81457	31.2	15.6	44.3
	P-value	*NS*	*NS*	*NS*	*0.015*	*NS*	*0.009*
	Tillage X Cover	*NS*	*NS*	*NS*	*NS*	*NS*	*NS*

Table 4. Soybean yields in plots with and without a cover crop under tilled and no-till management in a three year corn/soybean/oat rotation at the Southeast Research Farm. For soybeans, the cover crop consists of winter rye raised immediately before the soybean crop.

Tillage	**Cover Crop**	**Moisture**	**Test Wt**	**Stand**	**Height**	**100-Seed Wt.**	**Yield**
		(%)	(lb/bu)	(plts/ac)	(in.)	(g)	(bu/ac)
CT	Cover	12.7	54.7	81457	33.6	16.3	47.8
CT	None	12.6	54.6	82329	33.4	16.4	47.8
NT	Cover	12.7	55.4	91912	31.1	15.9	47.6
NT	None	12.5	55.2	85813	30.3	16.7	47.8
	CT	12.6	54.7	81893	33.5	16.3	47.8
	NT	12.6	55.3	88863	30.7	16.3	47.7
	P-value	*NS*	*0.001*	*NS*	*0.035*	*NS*	*NS*
	Cover Crop	12.7	55.1	86684	32.4	16.1	47.7
	None	12.5	54.9	84071	31.8	16.6	47.8
	P-value	*0.033*	*NS*	*NS*	*NS*	*NS*	*NS*
	Tillage X Cover	*NS*	*NS*	*NS*	*NS*	*NS*	*NS*

Table 5. Soybean yields in plots with and without a cover crop under tilled and no-till management in a four year corn/soybean/oat/wheat rotation at the Southeast Research Farm. For soybeans, the cover crop consists of winter rye raised immediately before the soybean crop.

Tillage	**Cover Crop**	**Moisture**	**Test Wt**	**Stand**	**Height**	**100-Seed Wt.**	**Yield**
		(%)	(lb/bu)	(plts/ac)	(in.)	(g)	(bu/ac)
CT	Cover	12.9	53.7	87120	33.5	16.8	47.7
CT	None	12.8	54.4	86249	32.5	16.4	48.9
NT	Cover	12.5	55.1	94961	30.6	16.4	47.9
NT	None	12.6	55.6	93219	30.1	16.0	47.1
	CT	12.8	54.0	86685	33.0	16.6	48.3
	NT	12.6	55.3	94090	30.3	16.2	47.5
	P-value	*0.039*	*0.091*	*NS*	*NS*	*NS*	*NS*
	Cover Crop	12.7	54.4	91041	32.1	16.6	47.8
	None	12.7	55.0	89734	31.3	16.2	48.0
	P-value	*NS*	*0.099*	*NS*	*NS*	*NS*	*NS*
	Tillage X Cover	*NS*	*NS*	*NS*	*NS*	*NS*	*NS*

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Evaluation of Late Season Annual Forages Planted as Cover Crops in 2019

Brad Rops[*], Peter Sexton, and Chelsea Sweeter

INTRODUCTION

Cover crops following small grain is beneficial for the soil. Living plants contribute to soil microbiology, recycle nutrients, reduce weed competition, and protect against erosion. In addition, they can provide supplemental forage if grazed or mechanically harvested. This trial evaluated the performance of a variety of annual forages planted in late summer.

METHODS

Twenty-nine annual forages, mostly warm season, were no-till drilled into wheat stubble August 16, 2019. Weed control was 32 ounces of glyphosate and 6 ounces of 2,4-D the day prior to planting. Plot size was 5’ x 25’. The plots were laid out in a randomized complete block design with 4 replications.

Frost occurred on October 12, 2019 and the plots were harvested on November 14, 2019 using a plot-sized forage harvester. The plots were end-trimmed, length recorded, and a 4’ swath was cut and weighed. Subsamples were taken to determine moisture content.

RESULTS AND DISCUSSION

Typically, one would want to plant warm season cover crops as soon after small grain harvest as possible to take advantage of the growing degree days. That does not always happen. These particular plots were established on August 16, two to three weeks later than ideal. The cool season crops of barley, oats, brassicas and peas rose to the top while the warm season sorghums, Sudan grasses, and millets failed to put on much growth before fall temperatures and decreasing day length slowed them down. An October 12 frost basically terminated the warm season crops while the cool season crops persisted. Winter rye and winter barley were in the middle of the group for yield. They would typically put on most of their growth in the spring.

It is important to select cover crops and annual forages that can take advantage of the particular growing season. Last year, forage sorghums planted the first of July produced 2.5 to 3.5 tons of biomass per acre in 7 weeks. In 2019 there were 7 weeks from the August 16 planting date until first frost. Biomass production was 1.5 tons per acre or less. If planting gets delayed into August, it would be prudent to switch to cool season forages, or at least go to a mixture of warm and cool season forages to mitigate the risk of reduced yield.

It should also be noted that the oats in this trial were ‘Saddle’, a variety which is resistant to rust. Planting an unknown or susceptible oat variety can lead to a rust infection. This does not create health issues for livestock that consume it, but it can affect the yield and palatability of the forage. Purchasing certified varieties of oats that have known rust resistance is a wise choice. Purchasing ‘bin run’ seed from a neighbor is not

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only risky from a weed and disease stand point, it is illegal. You may plant oats you produced yourself, but again, be aware of the variety and its tolerance to rust.

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Table 1. Yield of annual forages seeded as cover crops after winter wheat at the Southeast Research Farm in Beresford, South Dakota, in 2019. Plots were seeded on 16 August and forage was harvested on 14 November. The first frost occurred on the 12th of October. Yield is on a dry matter basis.

Forage Species	Stand	Yield
	(%)	(ton/ac)
Forage Barley ('Hayes')	94.5	**2.99**
Grain oat ('Saddle')	95.8	**2.74**
Winifred Brassica	78.3	2.08
Dwarf Essex	90.0	1.99
Forage Peas	81.3	1.97
German Millet	76.3	1.81
Buckwheat	93.8	1.76
Piper Sudan	91.7	1.76
GC-Pearl Millet	86.3	1.72
Sorgo-Sugar BMR Sorg/Sudan	78.3	1.59
Sweet Forever Sorg/Sudan	81.7	1.57
Fava Bean	59.3	1.49
Winter Barley	92.0	1.41
Winter Rye - Hazlet	90.0	1.34
400 BMR F. Sorghum	83.8	1.30
0-220 BMR Organic Sorg/Sudan	89.3	1.27
Bunker Buster II F. Sorghum	68.3	1.27
Later Grazer Sorg/Sudan	80.3	1.26
Italian Ryegrass ('Gulf')	90.0	1.26
MS9000 Sorg/Sudan	77.8	1.25
White Proso Millet	85.0	1.21
Cowpea	61.5	1.14
Ranch King BMR F. Sorghum	67.0	1.14
Super-Sugar Sorg/Sudan	76.7	1.11
Sweet-Six Sorg/Sudan	72.0	1.09
Sunn Hemp	71.0	1.04
Black Oats	87.5	0.95
Crimson Clover	65.0	0.91
Brown-Top Millet	69.0	0.81
mean	*81.5*	*1.52*
CV (%)	*10.9*	*21.5*
LSD (0.05)	*14.4*	*0.53*

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Evaluation of Cool Season Annual Forages in 2019

Brad Rops*, Peter Sexton,
and Chelsea Sweeter,

INTRODUCTION

Pasture can be a hard-to-find commodity in southeast South Dakota. Livestock producers may need to consider using tillable acres to help meet their forage needs, be it in the form of hay, silage, or grazing. This trial looks at spring planted annuals as an option for forage production.

METHODS

Twenty-three cool season forages and/or mixes were no-till drilled into wheat stubble April 16, 2019. Weed control was a 32 ounce application of glyphosate the day prior to planting. Plot size was 5' x 25'. The plots were laid out in a randomized complete block design with 4 replications. Oats was used as a nurse crop where indicated in Table 1.

On July 1, 2019, the plots were harvested using a plot-sized forage harvester. The plots were end-trimmed, length recorded, and a 4' swath was cut and weighed. Subsamples were taken to determine percent moisture and to analyze for nutrient content (nutrient analysis is not replicated). On August 30, 2019, cuttings were taken of under-seeded crops that had considerable regrowth. Subsamples were taken to determine moisture content.

RESULTS AND DISCUSSION

Forage yield expressed in tons of dry matter per acre are shown in Table 1 along with forage quality. The top yielding group (in bold type) included grain oats, forage barley, clovers and ryegrass seeded with oats, and mixes containing 30% or more oats. Composition of the mixes is shown in Table 2. Mixes containing a large seeded legume like pea or fava bean had higher crude protein content than straight oats or oats seeded with clover. The forage oats was just outside the top yielding group and had higher protein and lower fiber than the grain oats. This would be due to the fact that it was later maturing and still in the boot stage while the grain oats was in the milk stage. The height of the forage oats in boot was the same as the headed grain oats, so given more time, the forage oats would likely have yielded more tonnage. If the plan is to take hay or silage and then double crop, an earlier grain-type variety might be best. If grazing, a later maturing forage-type oat might be a better option. The forage oats typically have more leaf area and do not mature as fast providing more days to graze higher quality forage. Forage barley is a good option in areas where soil salinity is a concern.

The winter cereals rye and triticale had high protein levels, but did not progress much beyond tillering and were near the bottom for forage

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yield. The crops with the highest percent of Total Digestible Nutrients (TDN) were Winfred Brassica and Dwarf Essex due to higher protein and lower fiber content. They were just below the plot average for forage yield and are probably best used as part of a mix to increase TDN. An added benefit to using brassicas is the suppression of nematodes.

Regrowth was measured on August 30 where it occurred. Sweet Clover and Red Clover added an additional 2.69 and 2.00 tons of dry matter per acre respectively after being clipped with the oat nurse crops on July 1. Korean Lespedeza, actually a warm season crop, was straight seeded in the spring. While the initial yield was low, the regrowth yielded 2.36 tons per acre. Italian Ryegrass also had significant regrowth at 1.03 tons per acre.

There are several factors to consider when putting together a spring forage mix: harvest method, harvest timing, duration of the stand, forage quality, disease issues, soil salinity, soil pathology, and others. Mixes are always a good choice to help mitigate risk. There should be enough options to help you achieve your forage production goals.

ACKNOWLEDGEMENTS

The authors appreciate the contributions of the South Dakota Agricultural Experiment Station to support this research.

Table 1. Yield of cool season annual forages seeded into wheat stubble at the Southeast Research Farm in Beresford, South Dakota, in 2019. Plots were seeded on 16 April and forage was harvested on 1 July. Regrowth was harvested 30 August.

Treatment	**Nurse Crop**	**Dry Matter Yield**	**Crude Protein**	**ADF**	**aNDF**	**TDN**	**TDN/ac**	**Regrowth**
		(tons/ac)	(%)	(%)	(%)	(%)	(ton/ac)	(ton/ac)
Grain Oat (Saddle)	---	**3.20**	10.8	39.1	61.6	59	1.82	---
Mix 1	---	**3.19**	15.4	36.0	55.9	61	1.95	---
Crimson Clover	w/ oats	**3.08**	11.2	38.5	57.3	60	1.85	---
Sweet Clover	w/ oats	**3.00**	---	---	---	---	---	2.69
Forage Barley	---	**2.86**	9.7	33.6	59.3	60	1.72	---
Red Clover	w/ oats	**2.81**	10.7	38.9	63.2	59	1.66	2.00
Italian Ryegrass	w/ oats	**2.78**	12.1	34.8	56.6	61	1.70	1.03
Mix 2	---	**2.76**	17.5	34.3	46.9	63	1.74	---
Berseem Clover	w/ oats	**2.66**	11.4	38.0	62.6	59	1.57	---
Mix 3	---	2.48	14.1	35.7	54.5	61	1.51	---
Forage Oat	---	2.38	12.1	36.2	57.7	60	1.43	---
Mix 5	---	2.20	13.0	34.0	55.3	61	1.34	---
Mix 4	---	1.76	15.3	36.1	52.1	62	1.09	---
Winfred Brassica	---	1.75	14.5	29.5	31.0	67	1.17	---
Dwarf Essex	---	1.66	18.1	21.0	24.1	70	1.16	---
Forage Peas	---	1.54	28.9	33.8	37.4	66	1.02	---
Fava Bean	---	1.33	19.5	43.9	47.5	63	0.84	---
Winter Triticale	---	1.12	17.2	32.3	53.8	61	0.68	---
Hybrid Rye Progas	---	1.03	17.5	30.3	55.0	61	0.63	---
Winter Rye Hazlet	---	1.02	19.9	26.3	52.7	62	0.63	---
Hybrid Rye Propower	---	0.94	16.6	31.0	53.1	62	0.58	---
Korean Lespedeza	---	0.67	20.0	32.0	41.0	65	0.44	2.37
mean		*2.10*	*15.5*	*34.1*	*51.4*	*62.0*	*1.26*	
CV (%)		*19.8*	---	---	---	---	---	
LSD (0.05)		*0.68*	---	---	---	---	---	

Table 2. Composition of mixtures used in cool season forage plots at the Southeast Research Farm in Beresford, South Dakota, in 2019. Percentage is percent of normal seed rate - it may exceed 100.

Mix 1	Percent
Oat	60
Pea	40

Mix 2	Percent
Oat	30
Barley	30
Dwarf Essex	10
Pea	15
Fava Bean	15

Mix 3	Percent
Oat	10
Barley	10
Fava Bean	10
Pea	10
Ryegrass	70
Crimson Clover	15
Berseem Clover	15

Mix 4	Percent
Oat	10
Barley	10
Fava Bean	10
Pea	10
Ryegrass	70
Crimson Clover	15
Berseem Clover	15

Mix 5	Percent
Oat	7
Barley	7
Dwarf Essex	7
Pea	7
Fava Bean	7
Lespedeza	7
Winter Rye	35
Ryegrass	35
Crimson Clover	15
Berseem Clover	15

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Evaluation of Winter Annual Forages for Spring Harvest in 2019

Brad Rops*, Pete Sexton, Chelsea Sweeter, and Ben Brockmueller

INTRODUCTION

Winter annuals harvested for forage in the spring allows for double cropping. Forage taken as hay, silage, or by grazing, can be followed up with soybeans or warm season forages. In addition to providing a second crop in the same growing season, winter annuals will utilize residual nitrogen in the fall, protect the soil from wind and water erosion, and keep living roots in the soil benefitting soil microbiology. This trial evaluates a number of winter annual species and varieties for spring forage production.

METHODS

Plots were established on oat stubble September 17, 2018 using a no-till plot drill. Plots were randomized in a complete block design with 4 replications. Several varieties of hybrid rye, open pollenated (OP) rye, triticale, forage peas, forage winter wheat, and triticale/pea blends were established. Visual stand ratings were taken in the fall and again in the spring. On May 20, 2019, plant heights were recorded along with growth stage using the Feekes scale (8.0 = flag leaf just visible, 10.0 = boot). When most plots were in boot stage they were end-trimmed, length recorded, and harvested with a small plot forage harvester. Subsamples were taken from each harvested plot and composited by treatment to determine dry matter. Samples were then analyzed for feed quality and nutrient content.

RESULTS AND DISCUSSION

Stand measurements are shown in Table 1 along with the yield per acre on a dry matter basis. The average stand establishment after four weeks was about 85%. On April 8, 2019, the average stand was 60.5%. The month of February had high temperatures that were 7.5°F below average and low temperatures that were 8.8°F below average. None of the peas survived, therefore data on pea plots is not included except where they were part of a blend. As a group, rye had the best survival rates, with most losing about 10% to 15% of stand over winter. The lone wheat entry was reduced by 33.8% and the triticale varieties had stand reductions of 42.5% to 55% while a triticale/pea blend had 60% stand loss. While the rye plots had the best winter survival, they also had the most robust growth in the spring. At harvest time, both the open pollinated and hybrid ryes were at or near boot stage. The wheat and triticale had the flag leaf just emerging.

Table 2 shows forage quality data taken from composite samples of the replicates of each treatment. The rye plots had the most tonnage per acre and well as the most Total Digestible Nutrients (TDN) per acre. The wheat and

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triticale had higher protein and energy levels than the rye due to the fact that they were less mature plants, but the reduced stands and lack of growth left them with TDN totals per acre far below that of the rye. Table 3 has the mineral content for each variety, and again, obvious differences here would be mainly due to the growth stage of the plants at harvest.

Winter annuals are becoming more popular as cover crops, but in addition to soil health benefits they can also produce additional income as part of a double cropping system. Rye appears to be the most bullet proof in terms of winter survivability and spring vigor, even in the harsh conditions of 2019. More rapid spring growth means you can get the forage off and get your second crop planted sooner. Depending on the livestock class you are producing forage for, you may want to harvest at flag leaf which would increase forage quality while forfeiting some tonnage. If tonnage is the goal, harvesting at boot stage or shortly thereafter is critical as rye matures quickly and quality drops rapidly after heading.

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Table 1. Fall and spring stand evaluations, apparent over-wintering stand loss, height, stage and shoot dry weights from a winter annual forage trial conducted at the Southeast Research Farm in 2019. Data is based on observations from four field replicates laid out in a randomized complete block design. Three winter pea lines ('Icicle', 'Wyo', and 'Austrian') were also included in the trial - none of these survived through the winter. Plots were planted on 17 Sept. 2018, and harvested on 20 May 2019.

Line	**Material**	**10/15/18 Stand Count**	**10/15/18 Visual Rating - % stand**	**4/8/19 Visual Rating - % stand**	**Apparent Stand Loss**	**Spring Vigor Rating**	**5/20/19 Height**	**5/20/19 Feekes stage**	**Dry Wt.**
		(plt/sq ft)	*(%)*	*(%)*	*(%)*	*(0-10)*	*(in)*		*(ton/ac)*
Hazlet	OP-rye	18.4	87.5	76.3	11.3	6.8	26.9	10.1	2.36
Rymin	OP-rye	17.9	87.5	77.5	10.0	6.8	25.3	9.5	2.34
Daniello	hybrid-rye	14.8	87.5	71.3	16.3	6.5	21.3	9.3	2.23
Rymin/Icicle (50/50)	OP-rye/pea	11.7	78.8	60.0	18.8	6.3	26.8	10.0	2.15
Binnitto	hybrid-rye	14.5	86.3	76.3	10.0	6.3	25.7	10.0	2.11
Bono	hybrid-rye	14.7	86.3	71.3	15.0	6.3	24.9	9.8	2.10
Lon	OP-rye	15.1	86.3	75.0	11.3	6.5	24.0	10.0	2.07
Rymin/Icicle (75/25)	OP-rye/pea	15.1	83.8	72.5	11.3	6.3	24.3	9.5	2.05
Propower	hybrid-rye	20.9	87.5	75.0	12.5	6.5	26.0	10.0	2.02
Serafino	hybrid-rye	17.9	83.8	72.5	11.3	6.8	25.1	10.0	2.00
Brasetto	hybrid-rye	16.5	86.3	73.8	12.5	6.8	26.4	9.8	1.99
Progas	hybrid-rye	14.9	86.3	75.0	11.3	6.5	23.1	9.5	1.95
Tayo	hybrid-rye	19.3	83.8	75.0	8.8	6.3	23.8	10.0	1.95
Rymin/Icicle (25/75)	OP-rye/pea	9.5	77.5	46.3	31.3	5.8	27.5	10.0	1.67
Sam's DQ Mix	trit/pea/vetch	21.1	86.3	61.3	25.0	5.3	25.2	10.0	1.42
Willow Creek	winter wheat	20.1	83.8	50.0	33.8	2.3	13.3	8.0	0.64
719-Flex/Icicle (50/50)	trit/pea	12.1	81.7	26.7	55.0	2.0	12.2	8.0	0.56
Fridge	triticale	13.2	85.0	42.5	42.5	2.3	16.7	8.5	0.53
719-Flex	triticale	21.5	85.0	30.0	55.0	2.0	12.1	8.0	0.47
719-Flex/Icicle (75/25)	trit/pea	18.3	83.3	23.3	60.0	1.7	12.7	8.0	0.42
Hy-Octane	triticale	18.8	88.8	38.8	50.0	2.8	15.6	8.5	0.38
	mean	*16.5*	*84.9*	*60.5*	*24.4*	*5.2*	*21.8*	*9.4*	*1.59*
	CV (%)	*24.4*	*4.1*	*14.6*	*38.4*	*9.4*	*22.1*	*7.8*	*22.5*
	LSD (0.05)	*6.6*	*5.7*	*14.7*	*14.8*	*0.8*	*8.0*	*1.2*	*0.59*

Table 2. Dry weight and forage quality data from a winter annual forage trial conducted at the Southeast Research Farm in 2019. Lines are ranked by estimated TDN per acre. Dry matter data is based on measurements from four field replicates laid out in a randomized complete block design. Forage quality data is from unreplicated samples bulked by treatment. Data are presented on a dry matter basis.

Line	material	Dry Wt.	CP	ADF	NE-M	TDN	TDN/Acre
		(tons/ac)	*(%)*	*(%)*	*(Mcal)*	*(%)*	*(lb/ac)*
Daniello	hybrid-rye	2.23	12.8	32.7	67.3	65.3	2907
Hazlet	OP-rye	2.36	11.4	37.0	60.0	60.4	2850
Rymin/Icicle (50/50)	OP-rye/pea	2.15	13.2	32.3	67.9	65.7	2820
Rymin	OP-rye	2.34	11.0	37.4	59.3	59.9	2800
Lon	OP-rye	2.07	14.1	31.7	69.0	66.4	2744
Bono	hybrid-rye	2.10	12.4	33.3	66.3	64.6	2707
Binnitto	hybrid-rye	2.11	10.7	34.5	64.2	63.2	2667
Rymin/Icicle (75/25)	OP-rye/pea	2.05	12.0	33.2	66.4	64.7	2655
Propower	hybrid-rye	2.02	12.7	33.0	66.7	64.9	2620
Brasetto	hybrid-rye	1.99	14.0	34.2	64.7	63.6	2527
Tayo	hybrid-rye	1.95	11.2	33.3	66.3	64.6	2513
Serafino	hybrid-rye	2.00	11.5	35.0	63.4	62.7	2506
Progas	hybrid-rye	1.95	10.5	36.1	61.6	61.4	2390
Rymin/Icicle (25/75)	OP-rye/pea	1.67	16.2	31.3	69.6	66.9	2236
Sam's DQ Mix	trit/pea/vetch	1.42	18.2	32.0	68.5	66.1	1876
Willow Creek	winter wheat	0.64	23.0	28.7	73.9	69.8	889
719-Flex/Icicle(50/50)	trit/pea	0.56	20.4	27.1	76.5	71.7	799
Fridge	triticale	0.53	24.0	28.3	74.4	70.2	740
719-Flex	triticale	0.47	20.4	29.7	72.2	68.7	642
719-Flex/Icicle(75/25)	trit/pea	0.42	23.3	25.9	78.5	73.1	617
Hy-Octane	triticale	0.38	22.4	28.8	73.8	69.8	524
	mean	*1.59*	*15.5*	*32.2*	*68.1*	*65.9*	*2049*
	CV (%)	*22.5*	----	----	----	----	----
	LSD (0.05)	*0.59*	----	----	----	----	----

Table 3. Mineral analysis from entries in a winter annual forage trial conducted at the Southeast Research Farm in 2019. Analyses are from unreplicated samples bulked by treatment. Data are presented on a dry matter basis.

Line	Material	N	Ca	P	K	Mg	Zn	Fe	Mn	Cu	S	Na	Mo
		(%)	*(%)*	*(%)*	*(%)*	*(%)*	*(ppm)*	*(ppm)*	*(ppm)*	*(ppm)*	*(%)*	*(%)*	*(ppm)*
Binnitto	hybrid-rye	1.71	0.24	0.37	2.70	0.14	20.3	102	104	5.7	0.16	0.04	0.78
Bono	hybrid-rye	1.98	0.28	0.36	2.69	0.15	17.0	169	88	5.7	0.17	0.04	0.65
Brasetto	hybrid-rye	2.24	0.27	0.40	2.86	0.17	37.0	105	95	5.7	0.17	0.05	0.39
Daniello	hybrid-rye	2.05	0.24	0.36	2.74	0.15	27.9	89	93	4.5	0.17	0.05	0.60
Progas	hybrid-rye	1.68	0.21	0.35	2.47	0.13	.	71	85	3.6	0.15	0.04	0.75
Propower	hybrid-rye	2.03	0.23	0.33	2.60	0.15	21.7	106	89	6.3	0.16	0.04	0.68
Serafino	hybrid-rye	1.84	0.23	0.38	2.73	0.14	31.2	125	99	4.8	0.16	0.04	0.51
Tayo	hybrid-rye	1.79	0.23	0.35	2.81	0.14	20.2	82	94	5.7	0.16	0.03	0.58
Hazlet	OP-rye	1.82	0.28	0.33	2.81	0.15	18.0	111	104	4.1	0.16	0.05	0.46
Lon	OP-rye	2.26	0.31	0.35	2.75	0.17	22.8	102	98	4.4	0.18	0.04	0.53
Rymin	OP-rye	1.76	0.29	0.36	2.74	0.16	22.7	117	102	4.3	0.16	0.06	0.38
719-Flex	triticale	3.26	0.37	0.38	3.41	0.16	22.7	230	132	4.7	0.26	0.05	0.83
Fridge	triticale	3.84	0.35	0.37	3.66	0.16	25.1	247	138	5.8	0.28	0.04	0.65
Hy-Octane	triticale	3.58	0.37	0.35	3.42	0.18	43.3	231	131	5.8	0.28	0.05	0.75
Willow Creek	winter wheat	3.68	0.41	0.38	3.57	0.18	22.7	279	163	5.0	0.29	0.05	1.21
Rymin/Icicle (25/75)	OP-rye/pea	2.59	0.33	0.37	2.79	0.18	49.4	138	81	4.9	0.20	0.05	0.51
Rymin/Icicle (50/50)	OP-rye/pea	2.11	0.29	0.35	2.59	0.15	15.6	110	98	4.7	0.17	0.04	0.72
Rymin/Icicle (75/25)	OP-rye/pea	1.92	0.28	0.35	2.49	0.15	17.2	124	107	4.7	0.17	0.05	0.58
719-Flex/Icicle(50/50)	trit/pea	3.26	0.29	0.43	3.21	0.14	31.0	186	123	6.0	0.24	0.04	0.49
719-Flex/Icicle(75/25)	trit/pea	3.73	0.36	0.39	3.20	0.16	38.9	208	129	5.7	0.29	0.04	0.48
Sam's DQ Mix	trit/pea/vetch	2.91	0.32	0.39	3.21	0.17	28.0	134	117	6.5	0.21	0.04	0.27
	mean	*2.48*	*0.29*	*0.37*	*2.93*	*0.16*	*26.64*	*146.00*	*108.10*	*5.17*	*0.20*	*0.04*	*0.61*

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Performance of Oats under Different Nitrogen Regimes

David Karki, Peter Sexton*
and Chelsea Sweeter

BACKGROUND

South Dakota (SD) is one of the major oat growers in the United States. Among small grains grown in the state, oat is considered to be more susceptible to lodging, often causing significant difficulty during harvest resulting in yield loss. Although varietal differences in stalk strength can play a vital role, lodging can be generally attributed to excess soil nitrogen. The current South Dakota State University recommendation is 1.3 multiplied by reasonable oat yield (minus soil test nitrogen and legume credit), however grain producers in the region have been using lesser (than recommended) N units to avoid lodging without compromising yield. This study evaluated oat performance under various nitrogen levels. The objective is to evaluate yield response of oat at different nitrogen rates. The goal is to conduct several trials over multiple years and locations to adjust the current recommendations.

METHODS

The study was conducted at the SDSU Southeast Research Farm (SERF) near Beresford, SD in 2019 growing season. A total of five N rates (30, 60, 90, 120 and 150 lbs/a) were used in the study with additional ‘control’ treatment which did not receive any nitrogen.

One of the newer varieties ‘Saddle’ was planted on April 3, 2019 and N treatments were applied as urea on April 9, 2019. All treatments were arranged in Randomized Complete Block (RCB) design with four replicates, however, only three replications were used for data analyses due to excess soil salinity in the fourth replication. The plot size was 20’ x 30’.

RESULTS:

The N rate showed significant effects on grain yield and plant height. The average yields ranged from 88 bu/a for control plots to 115 bu/a for the plots that received 150 lbs/a N (Table 1), however, beyond 60 lbs N/a we did not observe significant response of grain yield (Fig. 1). Similarly, average plant height ranged from 36.3 inches (control plots) to 43.5 inches (150 lbs N/a). The applied nitrogen did not show any significant effects on grain moisture content and test weight (Table 1). Figures 1-3 show

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relationship of yield, test weight, and plant height to applied nitrogen rates.

CONCLUSION

The study shows that for the growing environment of 2019 season, 67 lbs of nitrogen was enough to obtain optimum grain yield (109 bu/a). Although the highest average yield was obtained for 150 lbs N/a, the yield response beyond 67 lbs N/a was minimal to none. The yield at economically optimum N rate suggests that it is safe to consider that the current recommendation is higher than needed for current SD growing environment.

ACKNOWLEDGEMENT

The authors appreciate the contributions of the South Dakota Agriculture Experiment Station to support this research.

Table 1. Average Height, Moisture, Test Weight, and Yield for nitrogen rates applied to test response in grain oats grown in 2019 at the SDSU SE Research Farm near Beresford.

N RATE (lb/ac)	Height (in)	Moisture (%)	Test Wt. (lb/bu)	Yield (bu/ac)
150	43.5	10.0	34.3	114.7
90	41.7	11.7	35.9	109.3
120	41.7	11.6	35.8	108.2
60	40.8	11.4	35.8	105.7
30	40.0	12.3	36.3	99.4
0	36.3	12.0	36.1	87.7
mean	40.7	11.5	35.7	104.2
CV (%)	4.1	8.7	2.3	5.6
LSD (0.10)	2.5	NS	NS	8.7

Mean= grand mean of measured traits
C.V.= coefficient of variability
LSD (0.10)= least significant difference index to separate means within each column for each measured trait at 0.10 probability level.

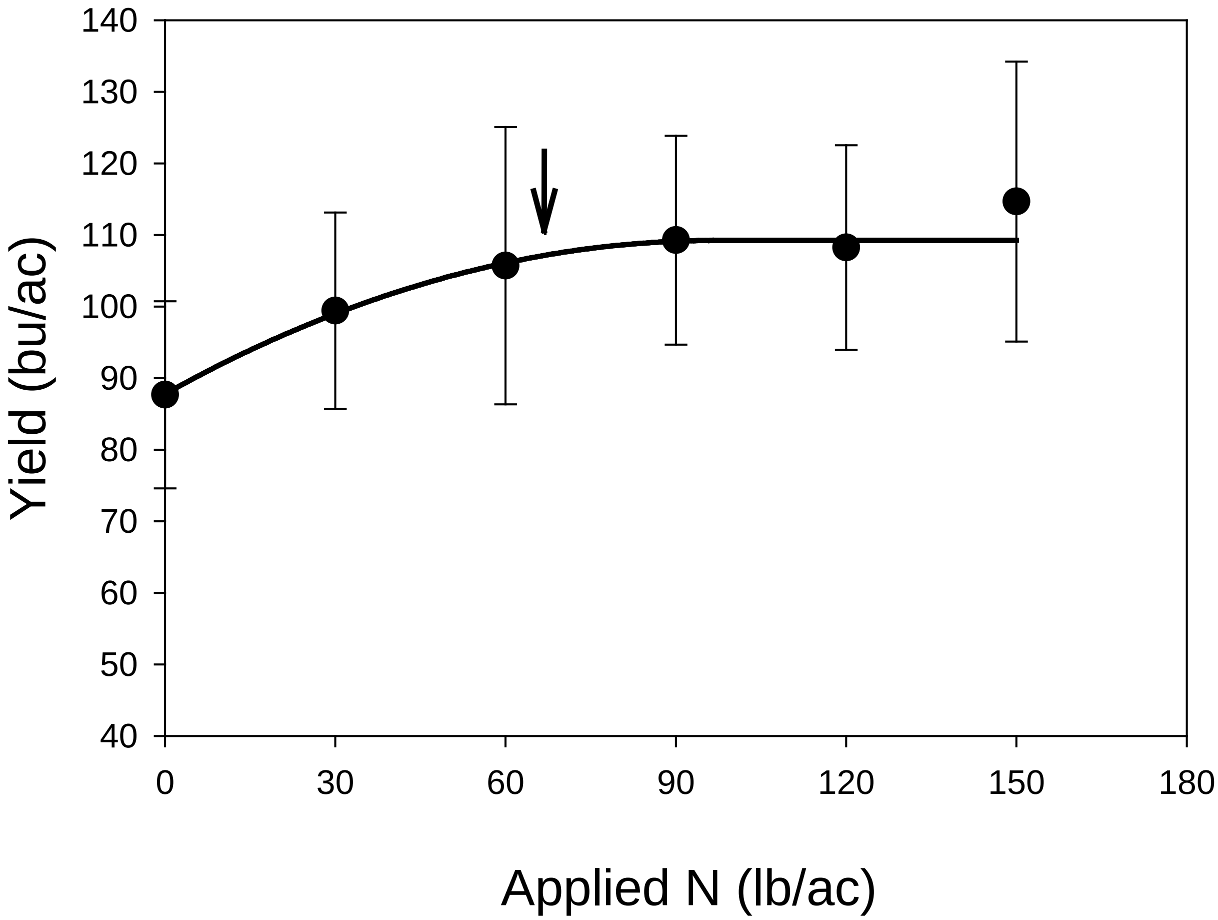

Fig 1. Oat Yield response to various applied nitrogen levels in 2019 growing season at the SDSU SE Research Farm. The arrow indicates the economic optimum N rate (67 lbs/a) assuming N= $0.45/lb and oat price at $3.25/bu

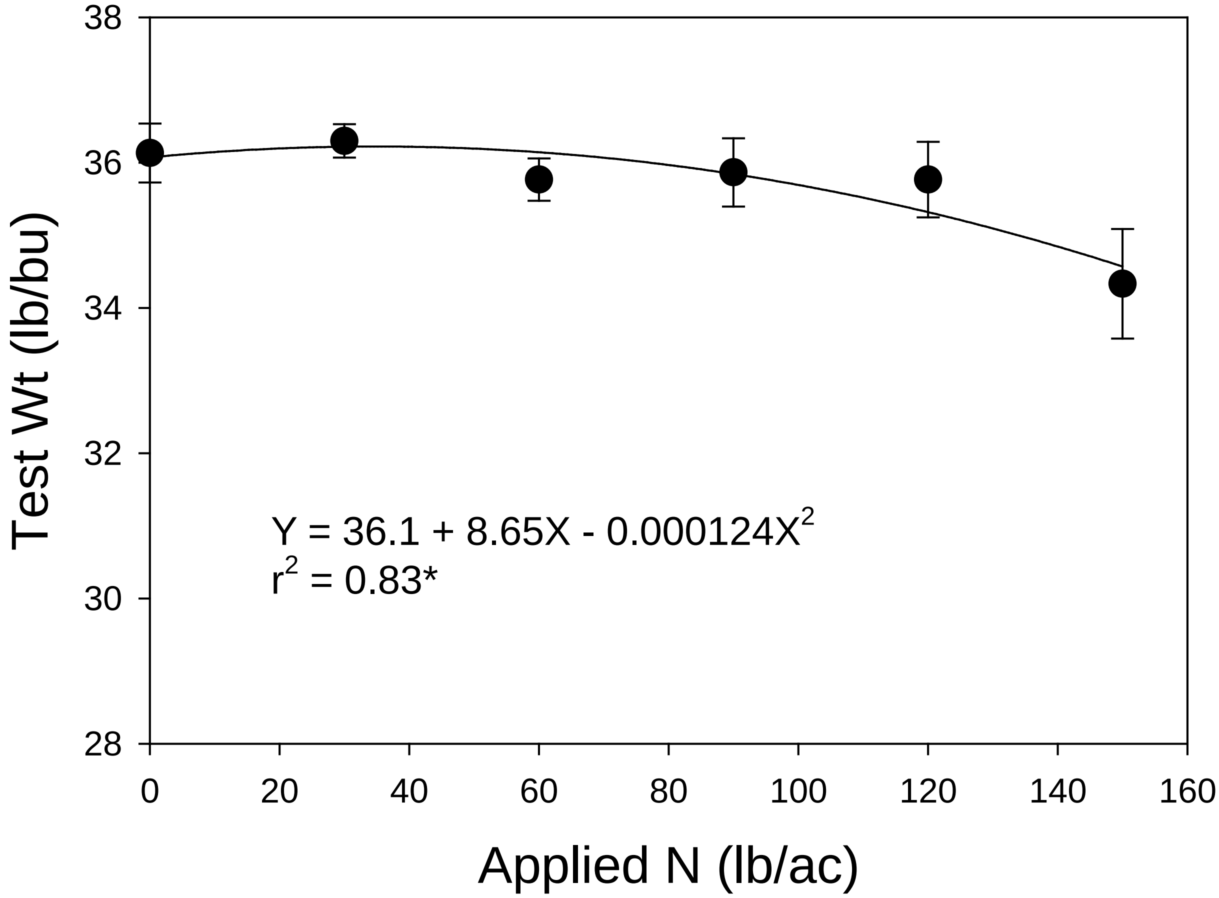

Fig 2. Relationship of oat grain test weight and applied nitrogen in 2019 growing season at the SDSU SE Research Farm.

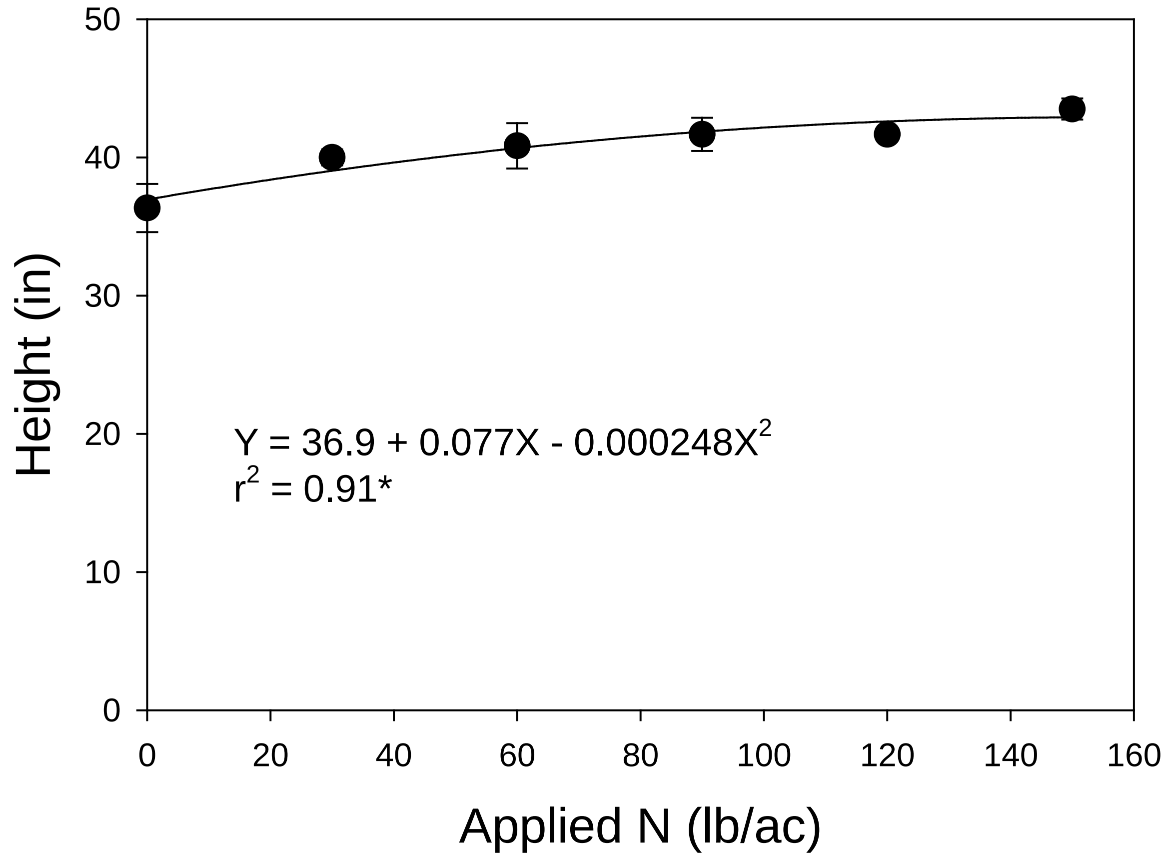

Fig 3. Relationship of oat plant height and applied nitrogen in 2019 growing season at the SDSU SE Research Farm.

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Sulfur and Nitrogen Applications on Soybeans Following a Rye Cover Crop

Ben Brockmueller, Peter Sexton*, Brad Rops, and Chelsea Sweeter

INTRODUCTION

There has been an increase in winter rye cover cropping in the upper Midwest due to its role in promoting soil health. One benefit of rye is its ability to take up and sequester mobile nutrients such as nitrogen and sulfur that could be lost from a system through leaching. Nitrogen and sulfur are converted into organic forms in the plant and released back into the soil as the tissues decompose. Previous experience has shown that rye has the potential to sequester sulfur leaving these nutrients deficient in the following crop. Continued research into the management considerations that may help alleviate the effects of nutrient sequestration include looking at incorporating supplemental fertilizers on soybeans.

MATERIALS AND METHODS

This study was done using on-farm trials and at the Southeast Research Farm. Winter rye (Rymin) was planted as a cover crop in three locations. In 2018, these were at the Southeast Research Farm, Tornberg Farm, and Christensen Farm. In 2019, trials were located in Arlington, Yankton, and the Southeast Research Farm. These trials were set up as a randomized complete block design with 7 fertilizer treatments replicated four times at each location. The fertilizer treatments were Ammonium Sulfate [$(NH_4)_2SO_4$], Magnesium Sulfate ($MgSO_4$), Urea (CH_4N_2O) and a control with no added fertilizer. In 2019, the Magnesium Sulfate was substituted with Sul-Po-Mag [$K_2Mg_2(SO_4)_3$]. Each fertilizer treatment was applied at a 10 lb/ac and 20 lb/ac rate of S. Urea was applied at an equivalent rate of nitrogen as was used in the Ammonium Sulfate treatments. In 2018, at the Southeast Research Farm location, a cover crop of Rye (Rymin) was no-till seeded using a drill on November 7, 2017. It was terminated using a burndown herbicide (glyphosate and metolachlor) on May 18, 2018. Soybeans were no-till seeded on May 31, 2018 and harvested on October 29, 2018 with Kincaid 8XP plot combine. In 2019, rye was no-till seeded on October 2, 2018. It was terminated on May 3, 2019 using 1 pt/ac of Dual and 32 oz/ac of Glyphosate. Soybeans (AG24X7) were no-till planted on June 4, 2019 and were harvested October 30, 2019 using a ZÜRN plot combine. Grain samples were collected at harvest and analyzed for nutrient composition.

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RESULTS AND DISCUSSION

We did not observe any statistical differences in soybean yield between our treatments in either 2018 or 2019. Nutrient analysis of grain samples in 2018 (Table 1) showed higher levels of sulfur in the treatments where sulfur fertilizers were applied. However, we did not see any difference between Mg-SO_4 and Ammonium Sulfate treatments. Numerically, 20 lb/ac of Sulfur applied at either treatment trended towards higher sulfur concentrations in the grain than 10 lb/ac of applied sulfur. Yet, this increase in grain sulfur did not translate to any increases in yield. Grain nutrient analysis work for 2019 is still in progress as we seek to provide a better snapshot of the nutrient content in soybeans and the ability of supplemental fertilizers to bridge gaps that may exist from rye's sequestration of nitrogen and sulfur.

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The authors would like to express their appreciation to the Nutrient Research Education Council (NREC) and the South Dakota Agricultural Experiment Station who supported this research.

Table 1:

Effects of soybean yield and seed nutrient composition with nitrogen and sulfur applications following a rye cover crop. 6 treatments and a control of no fertilizer were used at 3 locations in 2018

Location	Treatment	Yield	Test Weigt	N	P	K	S	Mg	Zn	Mn	N:S Ratio
		bu/ac	lb/bu	---------------------------------g/kg-------------------------------					---------mg/kg---------		
SERF	Control	56.0	50.0	62.7	5.86	19.3	3.05 c	2.66 c	37.8	32.5	20.6
	Mg SO4 10*	57.1	51.1	63.2	6.39	20.5	3.10 bc	2.78 a	36.3	34.8	20.0
	Mg SO4 20	56.6	50.9	63.9	6.37	20.0	3.22 a	2.69 bc	37.3	33.0	19.8
	AS 20	52.1	50.6	63.4	6.24	19.7	3.18 ab	2.69 bc	35.5	34.3	19.9
	AS 10	55.8	47.9	63.7	6.25	20.1	3.17 ab	2.75 ab	35.5	32.8	20.1
	Urea 10	60.9	50.3	63.7	6.04	19.5	3.05 c	2.73 abc	35.8	32.3	20.9
	Urea 20	61.0	49.8	63.1	6.27	20.0	3.10 bc	2.74 abc	35.5	31.3	20.4
	Mean	56.8	50.1	63.4	6.20	19.9	3.13	2.72	36.2	33.0	20.2
	LSD	NS	NS	NS	NS	NS	0.118	0.0801	NS	NS	NS
Christensen	Control	62.3	53.6	62.9	5.80	18.9	3.03 c	2.91 ab	37.5 c	34.5	20.0 a
	Mg SO4 10	67.3	53.5	63.1	5.74	18.8	3.33 ab	2.87 bc	40.25 ab	36.3	19.0 b
	Mg SO4 20	64.0	54.7	63.2	5.89	18.9	3.38 a	2.84 c	41.5 a	37.5	18.7 b
	AS 10	64.7	52.1	63.2	5.84	18.9	3.34 ab	2.87 bc	40.8 a	37.5	18.9 b
	AS 20	65.1	53.9	62.6	5.83	19.0	3.41 a	2.87 bc	41.5 a	38.3	18.3 b
	Urea 10	65.3	53.5	63.2	5.70	18.5	3.19 bc	2.84 c	38 bc	35.0	19.9 a
	Urea 20	66.3	53.3	62.9	5.83	19.1	3.17 bc	2.94 a	40 ab	37.5	19.9 a
	Mean	64.3	53.5	63.0	5.80	18.8	3.26	2.88	39.9	36.6	19.4
	LSD	NS	NS	NS	NS	NS	0.300	0.06	2.46	NS	1.3
Tornberg	Control	55.3	51.5	60.7	5.73	18.4	3.23	2.64	33.3	29.0	18.8
	Mg SO4 10	55.6	52.5	60.7	5.50	18.1	3.21	2.61	33.3	28.5	18.9
	Mg SO4 20	57.5	52.2	61.3	5.73	18.5	3.28	2.63	33.8	29.0	18.7
	AS 10	58.3	51.5	61.3	5.59	18.3	3.23	2.61	32.5	28.3	19.0
	AS 20	57.4	52.6	60.7	5.68	18.4	3.27	2.63	34.0	29.5	18.6
	Urea 10	57.8	52.3	61.0	5.80	18.7	3.29	2.71	33.3	28.5	18.6
	Urea 20	59.1	52.1	60.7	5.75	18.8	3.23	2.64	33.8	28.8	18.8
	Mean	57.3	52.1	60.9	5.68	18.4	3.25	2.64	33.4	28.8	18.8
	LSD	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
	F-Test Probability										
	Location	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
	Treatment	NS	0.0217	NS	NS	NS	<0.01	NS	<0.01	0.0488	<0.01
	Location x Trt	NS	NS	NS	NS	NS	0.0413	<0.01	0.0158	0.0873	0.0601

**Each treatment applied at 10 and 20 lb/ac of S. Urea rates were determined using an equivalent N rate for the N applied in the AS treatments.*

Table 2: Soybean yield results at 3 locations in 2019

Nitrogen and Sulfur application following a rye cover crop at locations in 2019

Treatments	Yankton	SERF	Arlington Rye*	Arlington No Rye*
	----------------------------(bu/ac)---------------------			
Control	59.9	73.3	57.6	61.0
$K_2Mg_2(SO_4)_3$ 10**	59.1	69.3	61.6	63.5
$K_2Mg_2(SO_4)_3$ 20	61.0	71.7	61.8	62.6
AS 10	60.7	70.7	60.3	64.7
AS 20	59.7	67.9	59.1	66.4
Urea 10	61.4	65.8	61.3	66.6
Urea 20	59.3	70.4	62.4	63.5
Mean	60.2	69.9	60.6	64.0
CV	5.04	6.88	4.87	6.56
LSD	NS	NS	NS	NS

**At the Arlington location, plots were set up with and without a rye cover crop.*
***Each treatment applied at 10 and 20 lb/ac of S. Urea rates were determined using an equivalent N rate for the N applied in the AS treatments.*

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Impact of Rye Seeding Rate on Nutrient Cycling and Soybean Production

Ben Brockmueller, Peter Sexton*, Shannon Osborne, Bee Chim, and Chelsea Sweeter

BACKGROUND

Agricultural producers have gained an interest in incorporating cover crops into their cropping systems in order to access the benefits that cover crops can provide to their operation. One of these benefits is the capture of residual nutrients to prevent losses between harvest and spring planting and cycling them back into the system. In Southeast South Dakota, winter rye excels as a cover crop in corn and soybean rotations. Winter rye is strongly winter hardy meaning that it can be expected to germinate late in the season following corn harvest as long as temperatures are above 34 degrees and will experience less winter kill than other winter cover crops. When fit into a corn and soybean rotation, one of the major advantages of rye is that it has the potential to improve the internal nutrient cycling systems in our soils. Rye will capture residual nitrates remaining from the corn growing season and hold them in stable, organic forms. The amount of nutrients that rye can capture from the soil is directly dependent on the rye biomass production. Upon termination of the cover crop, these residues will eventually break down and provide nutrients to the soil system. However, the rate at which these nutrients are returned to the system are dependent on how quickly the rye tissues decompose. While there are several factors affecting decomposition rates, in this study we are interested in looking at the effect of residue quality. Residue quality is determined by the C:N ratio of plant materials and the fibrous components that make up the residues. In this study, our objectives were to observe how rye seeding rates affect the overall rye biomass production, residue quality of rye tissues, soybean nutrient concentrations, and soybean yields.

MATERIALS AND METHODS

In this study, we implemented 5 seeding rate treatments of 0, 20, 40, 60, and 80 lb/ac of winter rye (Rymin) which was drilled into corn stubble on October 3, 2018. Rye biomass and corn residue measurements were recorded on May 2 and May 30, 2019. Rye tissue and corn residues were analyzed for nutrient content at each date. Rye was terminated and soybeans (AG21X7) were planted on June 5, 2019. At the R3 and R6 soybean growth stage, soybean plants and crop residues were measured for biomass and nutrient content in an effort to track where the nutrients were located and how these concentrations changed in each of these sinks throughout the growing season. Soil sampling was done at each of the previous sampling dates. On October 18, 2019 all soybean plots were harvested.

RESULTS

Rye biomass production (Table 1) was not significantly different for the 20, 40, and 60 lb/ac rye seeding rate treatments. At 80 lb/ac, we saw an increase in biomass production. This

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increase also resulted in significant differences in rye uptake of N, P, K, and S at the 80 lb/ac seeding rate but not among lower seeding rates. At the boot stage when rye was terminated, the rye residue quality showed increases in C:N ratios as the seeding rate of rye increased. Additionally, NDF values were significantly higher at the highest seeding rate, but not different at the 3 lowest seeding rates. At the final rye sampling date on May 30th, the highest seeding rate of rye showed a decrease in the amount of corn residues on the soil surface (Figure 1). However, by the end of the growing season, this decrease in crop residues was offset by higher amounts of rye biomass being returned to the soil resulting in the 80 lb/ac treatment of rye having the highest amount of residue left on the soil surface at the end of the growing season. Upon soybean harvest we did not observe any difference in soybean yield or test weight based on rye seeding rate treatments (Table 2).

DISCUSSION

As no difference in rye dry matter production or nutrient uptake was observed between 20, 40, and 60 lb/ac seeding rates of rye, it is possible that the same nutrient cycling benefits of rye can be achieved by using a lower seed rate. Since residue quality decreases (higher C:N and NDF values) at 80 lb/ac, it is expected that rye at this seeding rate will decompose and cycle nutrients slower than at lower seeding rates. Therefore, if nutrient sequestration is a concern, lower seeding rates may be beneficial although we did not observe any difference in yield or soybean nutrient content between treatments during the 2019 growing season. Due to higher rye dry matter production and longer residence time on the soil surface, the 80 lb/ac seeding rate may be beneficial if weed suppression is the goal. We are continuing work on soybean nutrient status during the growing season and more information on the fibrous components of rye by each treatment.

ACKNOWLEDGEMENTS

The authors would like to express their appreciation to the Nutrient Research Education Council (NREC) and the South Dakota Agricultural Experiment Station who supported this research.

Table 1: Rye dry matter, nutrient uptake, and quality on May 30, 2019. Rye was terminated and soybeans were planted on June 5, 2019.

Treatments	Dry Matter	Nitrogen	Phosphorus	Potassium	Sulfur	C:N Ratio	NDF
	----------lb/ac----------					----%----	
20	1084 b	22.1	4.33	29.8	1.77	20.4 c	52.2 b
40	1222 ab	22.5	4.60	32.8	1.83	22.5 bc	54.0 b
60	1197 b	20.6	4.28	31.4	1.72	24.1 b	54.1 b
80	1671 a	25.6	5.98	40.7	2.22	27.7 a	59.1 a
mean	1294	22.8	4.82	33.6	1.87	23.7	54.0
CV %	22.7	21.0	27.3	22.1	20.6	6.71	3.99
LSD (0.05)	470	NS	NS	NS	NS	2.54	3.5

Figure 1: Observed crop residues on May 30 (only corn residue) at rye boot stage and September 3 (corn and rye residue) at soybean R6 stage. 2 samples per plot were taken using a frame of 2.34 ft^2. Letters on graph represent significant differences between the treatments within each sampling date.

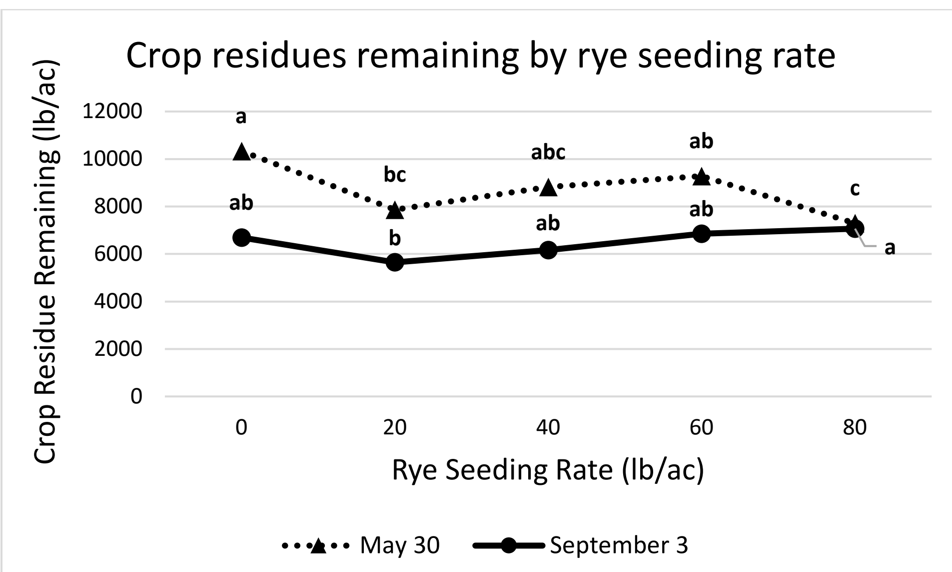

Table 2: Soybean grain moisture, test weight, plant stand, and yield for 5 different treatments of rye seeding rates.

Treatment (lb/ac)	Moisture (%)	Test Wt (lb/bu)	Stand (plants/ac)	Yield (bu/ac)
0	9.00	54.1	96,413	55.0 a
20	9.55	53.9	103,382	56.1 a
40	9.84	53.6	97,575	55.9 a
60	9.63	53.2	121,968	55.2 a
80	9.69	53.6	92,928	56.6 a
Mean	9.72	53.7	102,453	55.7
CV %	3.20	2.15	11.5	4.26
LSD (0.05)	NS	NS	18,216	NS

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Rye Burndown Timing Effects on Nutrient Cycling and Soybean Production

Ben Brockmueller, Peter Sexton*, Shannon Osborne, Bee Chim, and Chelsea Sweeter

BACKGROUND

As producers wrestle with different management options to alleviate some of the challenges of growing winter rye as a cover crop, the burndown timing of rye has become an important consideration in relation to the concern of rye nutrient sequestration. Terminating rye earlier in the growing season has the potential to limit nutrient sequestration by limiting the biomass produced and reducing nutrient uptake of rye. Nutrients are then cycled quicker due to lower C:N ratios from less mature plant materials. However, delaying the termination date of rye allows producers to take advantage of many of the ecosystem services provided by growing a cover crop. Later burndown dates increase the amount of residual nutrients that rye is able to scavenge and cycle back into the system, more biomass can result in better weed suppression, and increases in organic matter impacts water infiltration and soil aggregation among other soil health benefits. Therefore, it is essential to find a balance between taking advantage of these ecosystem services and maintaining high soybean yields. This study examined how different termination dates of rye can affect nutrient uptake in rye tissues and the speed of decomposition and nutrient release of crop residues. Additionally, we looked at the impacts of burndown dates on soybean yield and soybean nutrient status at two stages in the growing season.

MATERIALS AND METHODS

A randomized complete block design was implemented in which winter rye was planted at 45 lb/ac on October 2, 2018 in a field utilized for corn silage the previous season. In the spring, rye was burned down in approximately 10-day intervals as weather permitted. Burndown dates in 2019 were April 19, April 29, May 13, May 23, and May 31. Rye biomass, crop residue biomass, and soil samples were measured for each treatment at the time of rye termination. The final rye treatment was terminated using a mix of 1 pt/ac of Dual and 32 oz/ac of glyphosate on May 31. Soybeans (AG24X7) were planted on June 4 at 150,000 seeds/ac. All plots were sampled for crop residue biomass, soybean biomass, and soil samples. All residues, rye tissues, and soybean samples were tested for nutrient content at each sampling date. Rye and crop residue samples were also measured for Neutral Detergent Fiber (NDF), Acid Detergent Fiber (ADF), Acid Detergent Lignin (ADL), Crude Fiber (CF), and C:N ratios as measures of residue quality. All plots were harvested on October 18, 2019 using a ZÜRN plot combine.

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RESULTS AND DISCUSSION

Rye dry matter increased throughout the spring with the largest increases occurring between May 13 and May 31. Increases of 850 lb/ac were observed between May 13 and May 23 and another 850 lb/ac were added between May 23 and May 31 (Table 1). This emphasizes the need for timely management if residue buildup or nutrient sequestration are a concern. All nutrient uptake amounts increased as biomass production increased. C:N ratios and NDF values rose as the season progressed and rye plants matured resulting in more fibrous materials. The rate in which C:N and NDF values increased was much higher in the final two weeks of growth. Overall, corn residues were low due to silage harvest from the previous season. Corn residues at the last sampling date were the lowest; yet, less difference in residue amounts were observed in the earlier sampling dates (Figure 1). Residue amounts continued to decrease at very similar trends for the April 19, April 29, and May 13 dates even with the addition of rye residues signaling that these tissues decomposed rather quickly. The drastic increase in biomass between May 13 and May 31 resulted in higher amounts of residue being returned to the soil and larger differences in C:N ratio and NDF values slowing the decomposition time. Therefore, we saw a net increase in residues remaining by the R3 soybean stage. By the end of the growing season, we did not see statistical differences in residue remaining between the April 19 to the May 13 termination dates. In terms of soybean production, the latest burndown date showed numerically the highest yield although it was not statistically different from the earliest burndown date (Table 2). In addition, test weights trended towards increasing as burndown date was delayed. Soybean whole plant nutrient analysis at both the R3 and R6 dates is ongoing work.

ACKNOWLEDGEMENTS

The authors express appreciation to the Nutrient Research Education Council (NREC) and the South Dakota Agricultural Experiment Station who supported this research.

Table 1: Rye dry matter, nutrient uptake, and quality at each burndown date. Rye reached boot stage at the final termination date and soybeans were planted on June 4.

Treatments	Dry Matter	Nitrogen	Phosphorus	Potassium	Sulfur	C:N ratio	NDF
	----------lb/ac----------					----%----	
4/19/2019	189 d	9.49 c	1.12 d	6.01 d	0.72 d	8.14 d	32.2 d
4/29/2019	310 d	13.3 c	1.66 d	10.0 d	0.98 d	9.48 d	36.4 d
5/13/2019	829 c	24.0 b	3.80 c	25.1 c	1.90 c	14.0 c	42.6 c
5/23/2019	1682 b	33.7 a	6.48 b	47.5 b	2.79 b	20.4 b	50.1 b
5/31/2019	2529 a	36.0 a	8.39 a	56.0 a	3.25 a	29.1 a	57.4 a
Mean	1108	23.3	4.29	28.9	1.93	16.2	44.7
CV (%)	20.6	17.4	13.5	15.9	20.6	9.06	5.82
LSD (0.05)	353	6.25	0.90	7.12	0.50	2.03	3.67

Figure 1: Observed crop residues at 3 stages in the growing season. Initial April/May samples are the amount of residue remaining at the time of rye termination for each treatment. At these initial samples, only corn residues were present. The August 6 and August 30 sampling dates were at soybean growth stages of R3 and R6 respectively. 2 samples per plot were taken using a frame of 2.34 ft^2. Letters on graph represent significant differences between the treatments within each sampling date.

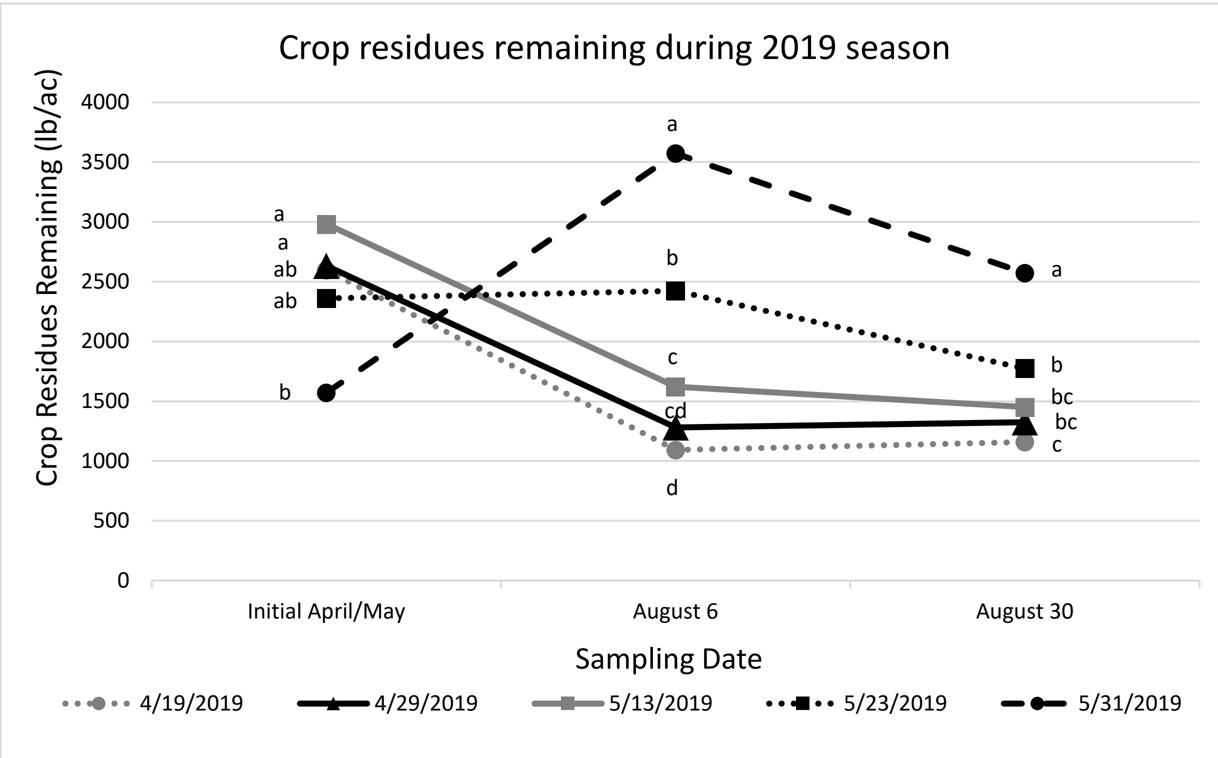

Table 2: Soybean grain moisture, test weight, plant stand, and yield for 5 different treatments of rye burndown dates.

Treatments	Moisture (%)	Test Weight (lb/bu)	Stand (plants/ac)	Yield (bu/ac)
4/19/2019	11.6	58.9 b	117,089	71.0 ab
4/29/2019	11.6	58.8 b	130,099	66.9 b
5/13/2019	11.8	59.3 a	131,958	67.4 b
5/23/2019	11.7	59.1 ab	105,938	67.4 b
5/31/2019	11.7	59.4 a	98,504	73.0 a
Mean	11.7	59.1	116,718	69.1
CV (%)	1.97	0.56	29.1	5.58
LSD (0.05)	NS	0.46	NS	5.32

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Inter-seeded Cover Crops Influence on Corn Nitrogen Fertilizer Needs and Corn and Soybean Yield

Jason D. Clark*, Shannon Osborne,
Peter Sexton, and Peter Kovacs

INTRODUCTION

Moving from conventional to no-till with the inclusion of cover crops can improve soil organic matter, soil structure, and water and nutrient holding capacity that may reduce environmental degradation from the loss of fertilizers and improve crop yield. Cover crops can be inter-seeded directly into standing corn and soybean with a high clearance planter. This innovative method of planting cover crops lowers seeding rate requirements and increases the time cover crops are growing and taking up excess nutrients and water and providing grazing for cattle. Inter-seeding cover crops may change the amount and timing of nitrogen (N) provided to the crop from decomposition (mineralization), which may increase or decrease needed N fertilizer to optimize corn grain yield.

The objectives of this project were to 1) compare the effect of N fertilizer on corn grain yield with no cover crop versus single- and multiple-species cover crops and 2) determine the effect of single- and multiple-species cover crops on soybean yield.

METHODS

Corn and soybean areas were planted in adjacent fields to establish a corn-soybean rotation with both crops present each year. Cover crop treatments were inter-seeded for corn at the V7 growth stage and for soybean at the V5 growth stage. Cover crop treatments were: 1) no cover crop, 2) single grass species (annual rye grass), and 3), grass/broadleaf mixture (annual rye grass, crimson clover, turnip, and radish). Six nitrogen rates from 0–250 lbs ac^{-1} in 50 lb increments were applied near planting to only the corn.

RESULTS

Soybean

Across the three cover crop treatments, soybean yield ranged from 52 to 76 bu ac^{-1} with a mean yield of 66 bu ac^{-1} (Fig. 1). The grass/broadleaf cover crop mixture compared to grass and no cover crop treatments resulted in a more variable effect on soybean yield. Although, when comparing the mean soybean yield of each cover crop treatment, there was only a 3 bu ac^{-1} difference (65 to 68 bu ac^{-1}). Therefore,

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there was no practical soybean yield differences among the no cover and cover crop mixtures. These results indicate that grass or grass/broadleaf cover crop mixtures can be inter-seeded into soybean without reducing soybean yield.

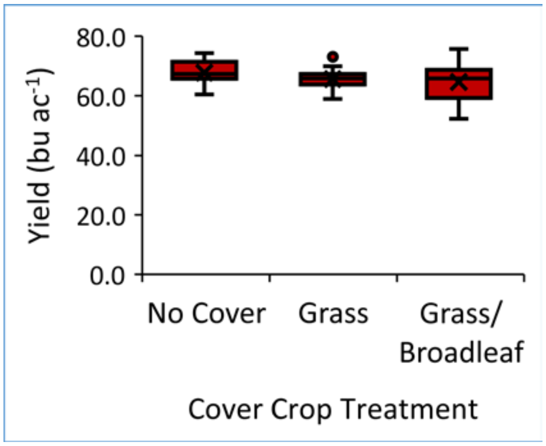

Figure 1. The influence of three cover crop mixtures on soybean yield at the Southeast Research Farm near Beresford, SD in 2019.

Corn

Across the three cover crop treatments and N rates, corn grain yield ranged from 142 to 235 bu ac^{-1} with a mean yield of 180 bu ac^{-1} (Figure 2). The zero-N plots grain yield averaged 168 bu ac^{-1} regardless of cover crop treatment. The addition of N fertilizer (50–250 lbs ac^{-1}) increased mean corn grain yield 7–30 bu ac^{-1} for no cover crop, 1–17 bu ac^{-1} for the grass cover crop, and 6–33 bu ac^{-1} for the grass/broadleaf cover crop. Overall, grain yield did not increase substantially with added N fertilizer as it would in most seasons. Therefore, we were not able to calculate an optimal N rate at this site. This lack of greater increases in yield with more N fertilizer applied may have been due to the high winds causing some stalk breakage during the growing season.

Within each N fertilizer rate there was also no significant difference in grain yield among the three cover crop treatments. This result indicates that grass or grass/broadleaf cover crop mixtures can be inter-seeded into corn without reducing yield.

Preliminary results here are based on one growing season. This project will continue for the next several years to improve our understanding on the influence of inter-seeded cover crops on corn N fertilizer needs and corn and soybean yield.

ACKNOWLEDGMENT

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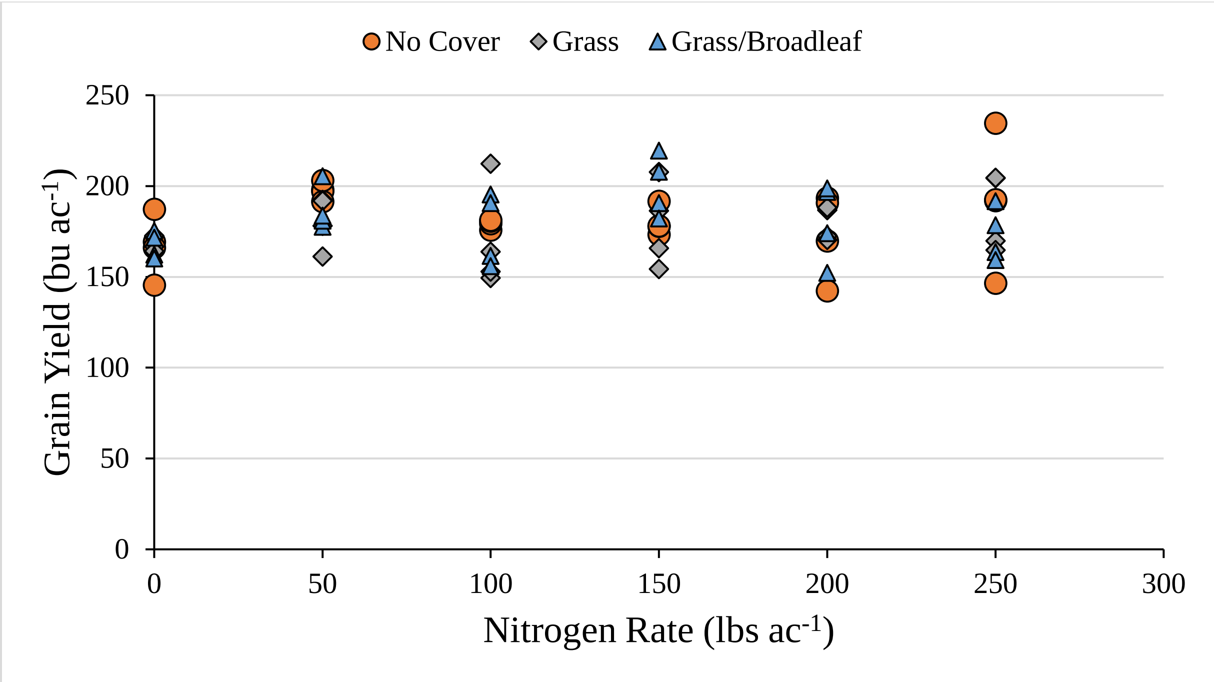

Figure 2. Corn grain yield response to N fertilizer within three cover crop treatments at the Southeast Research Farm near Beresford, SD in 2019. Cover crop treatments consisted of 1) no cover crop, 2) single grass species (annual rye grass), and 3), grass/broadleaf mixture (annual rye grass, crimson clover, turnip, and radish).

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Nitrogen Rate and Application Timing Influence on Corn Grain Yield in Eastern South Dakota in 2019

Anthony Bly*, Debankur Sanyal, John Wolthuizen, Peter Kovacs, Jason D. Clark, and Brad Rops

INTRODUCTION

Nitrogen applied for crop production is a large expense and has significant environmental implications if over applied. Therefore, it is important that research efforts focus on determining application practices that limit nitrogen use while maintaining highest economic yields. Several rate and application timing studies were conducted across Eastern South Dakota in 2019.

RESULTS AND DISCUSSION

Nitrogen rate increased grain yield at all sites. However, rate responses were divided into 2 groups (high and low yielding) and graphed (Figure 1). Grain yield was maximized at the high yield sites at about 140 lbs. N/a (fertilizer + soil test 0-2ft) and 200 lbs. N/a at the low yield sites. It is speculated that stress caused reduction in N use efficiency at the low yield sites.

Nitrogen application timing did not significantly influence corn grain yield at any site (Figure 2). Nitrogen applied at plant was sufficient to provide enough N for highest grain yields despite the record setting precipitation in Eastern South Dakota in 2019.

ACKNOWLEDGMENTS

This project partially funded by SDNREC (South Dakota Nutrient Research and Education Council), the South Dakota Ag. Experiment Station, SDSU Extension and the Southeast Research Farm. Mention of proprietary products does not imply endorsement. This research conducted with un-biased and scientifically sound methods.

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Materials and Methods

Item	Description
Locations	Ipswich, Mansfield, Volga, Bushnell (2x) and Garretson (2X)
Nitrogen rates (Fertilizer source)	0,40,80,120,160,200 (SuperU=urea+DCD+NBPT)
Application timings	Pl=planting, V6 and V10 growth stages
Corn hybrids	Farmers choice
Plot size	15 x 30 ft
Replications	4
No-till sites	Ipswich, Mansfield and Garretson
Conventional till sites	Bushnell and Volga
Previous crop	Wheat + cover crop = Ipswich and Mansfield
	Soybeans = Volga, Garretson and Bushnell
Row width	Ipswich, Mansfield, Volga and Garretson= 30 inch, Bushnell=20
Soil samples	Pre plant 0-6 and 6-24 inch composite by replication.
Harvest procedure	Plot combine
Statistical analysis	SAS

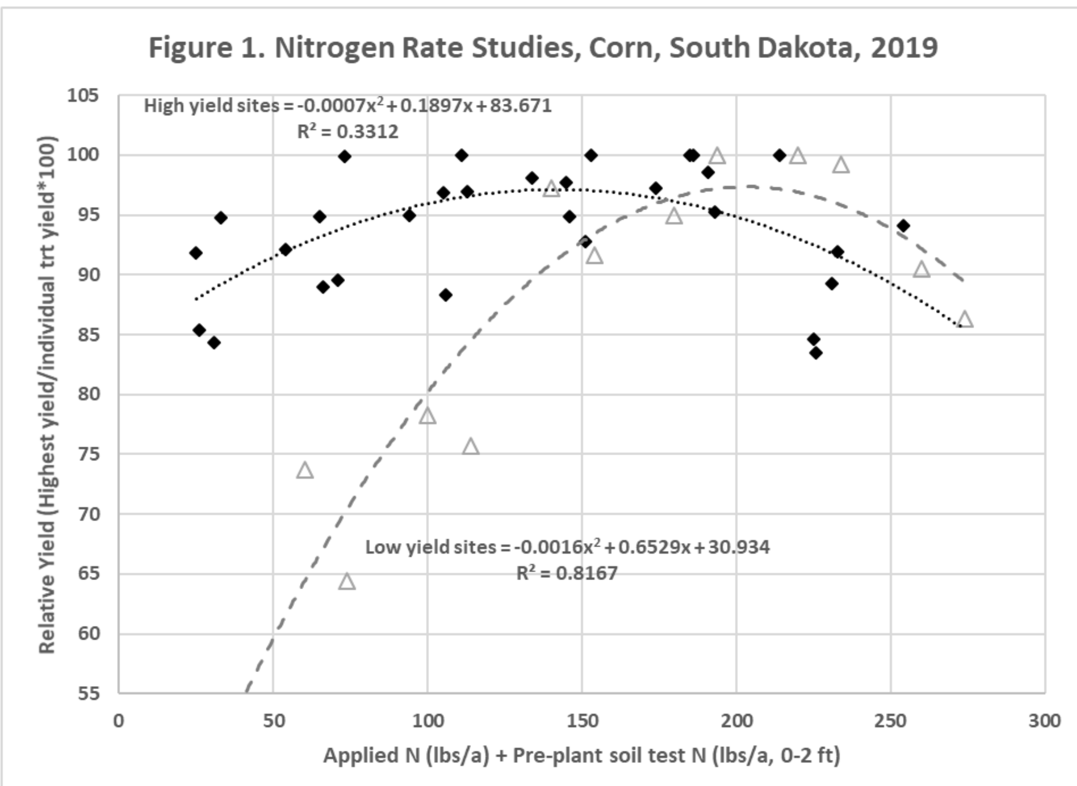
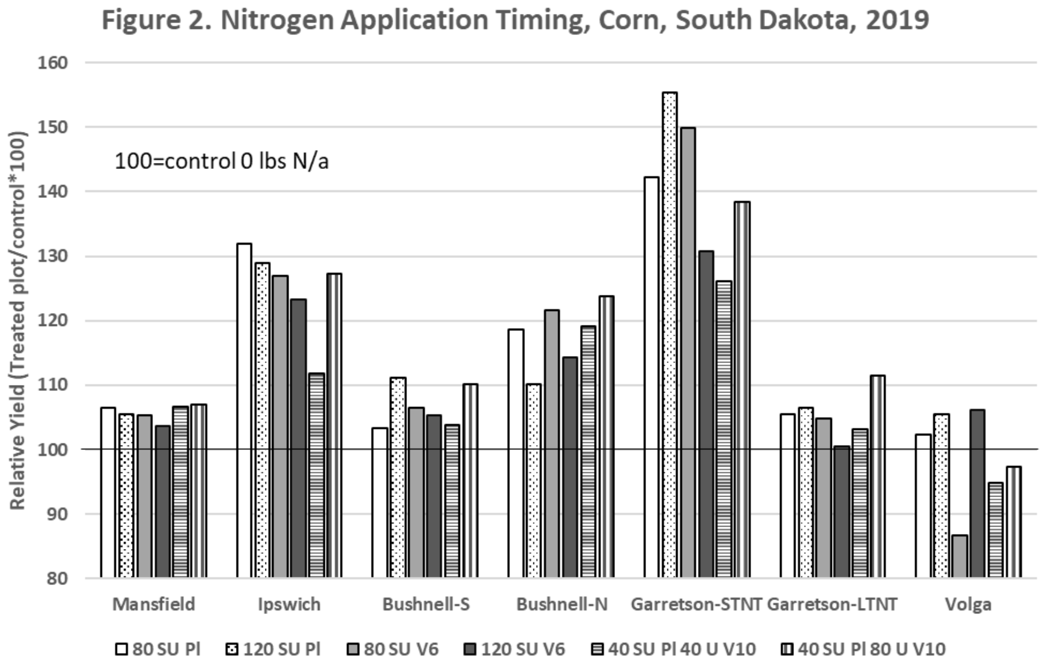


Figure 1. Nitrogen Rate Studies, Corn, South Dakota, 2019



N Timing treatments compared with the control 0N plot=100, treatment number indicates N rate, SU=superU (urea+DCD+NBPT), U=urea, Pl=planting, V6 and V10 = 6th and 10th leaf growth stages

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Influence of West Central Products on Soybean and Corn Grain Yield at Southeast Research Farm in 2019

Anthony Bly*, Brad Rops
and Peter Sexton

INTRODUCTION

Soybean and corn producers are looking for production methods that increase nutrient use efficiency. Several agro-chemical products are available to enhance nutrient availability and uptake. A research study was conducted on the Southeast Research Farm near Beresford, SD to evaluate several West Central nutrient enhancing products influence on soybean and corn grain yield in 2019.

RESULTS SUMMARY

Soybean grain yield parameters were not significant at the 0.05 level of probability (Table 1). However, grain yields were significantly different at 0.10 probability level. The check plot and Soyshot at 1.5 gallons/a were the lowest yielding. All other treatments increased grain yield.

Corn grain yield parameters were not significantly different at the 0.05 level of probability (Table 2). However, similar to soybeans, corn grain yields were significantly different at the 0.10 probability level. SAS Proc GLM procedure was used because one plot had to be discarded due to poor stand in the yield rows. The LSMEANS option showed that treatments 3, 5, 7 and 9 had significantly higher yields when compared with the control.

CONCLUSIONS

While positive grain yield increases were measured in these soybean and corn research trials, multi-year research projects should be conducted to evaluate yield response trends to better develop recommendations.

ACKNOWLEDGEMENTS

These projects partially funded by West Central, SDSU Extension, SD Agriculture Experiment Station and the Southeast Research Farm. Mention of proprietary product does not imply endorsement. This research conducted with un-biased and scientifically sound methods.

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Methods:

Item	**Description**
Corn hybrid	Pioneer P0589AMXT
Soybean variety	Pioneer P18A98X (Extend)
Corn planting date and seeding rate	May 15, 2019 (32,000)
Soybean planting date and seeding rate	June 3, 2019 (160,000)
Project treatments	See Tables 1 and 2 for complete list.
Tillage	No-till
Soil samples	Pre-plant 0-6 inch, N,P,K,Zn,pH,OM
Row width	30 inches
Corn N Nitrogen rate	150 lbs N/a, 50/50 split, pre-plant and side-dress
Plot size	10 x 30 ft
Replications	4
Statistics	SAS, corn (GLM, missing data), soybeans (ANOVA)

Table 1. Influence of several West Central in-furrow products on soybean grain parameters at Southeast Research Farm near Beresford SD in 2019.

	Grain (averages)		
Treatment	Moisture	Test weight	Yield
	%	lbs/bu	bu/a
1 – Control (5 gpa water in furrow)	12.4	60.2	50.0
2 – Soyshot 1.5 gpa	12.1	60.5	50.4
3 – Soyshot 2.0 gpa	12.0	60.7	57.1
4 – Soyshot 1.5 gpa + Cygin 2.0 oz/a	12.2	60.2	56.3
5 – Soyshot 1.5 gpa + WC477 (exp.) 2 oz/a	12.2	60.3	55.6
6 – Paralign 2.0 gpa	12.2	60.8	55.6
CV %	3.53	0.66	8.73
Pr>F (.05)	0.82	0.20	0.08
LSD(.05)	NS	NS	NS

Plot size = 10 x 30 ft (4 replications)
Planted June 3, 2019 (160,000 seeds/a)
Soil Test Results: Olsen P=6 ppm, Ext. K=172 ppm, Zn=.41 ppm, OM=3.7%, pH=6.8

Table 2. Influence of several West Central in-furrow products on corn grain parameters at Southeast Research Farm near Beresford SD in 2019.

Treatment (all in-furrow placement)	Grain (averages) Moisture	Test weight	Yield
	%	lbs/bu	bu/a
1 – Control	14.9	57.5	172.7
2 – Starter (10-34-0, 5 gpa)	15.3	58.0	185.6
3 – Starter + 1 qt/a 9% EDTA Zn	15.2	57.9	190.3**
4 – Starter + 1 qt/a Levesol Zn	15.4*	57.7	184.5
5 – Starter + 2 qt/a Levesol Zn	15.5**	57.7	195.6**
6 – Starter + 1 qt/a Levesol Zn + 2oz/a Cygin	15.3	57.4	183.9
7 – Starter + 1 qt/a Levesol Zn + 4 oz/a WC 477 (Exp.)	15.4*	57.5	198.8**
8 – Paralign 3 gpa	15.5**	57.6	181.5
9 – Paralign 3 gpa + 2 oz/a Cygin	15.5**	57.7	199.1**
10 – Paralign 3 gpa + 4 oz/a WC 477 (Exp.)	15.5**	57.6	183.3
11 – Starter + 1 qt/a 9% Zn + 2 oz/a Cygin	15.3	57.6	183.7
12 – Starter + 1 qt/a 9% Zn + 4 oz/a WC 477 (Exp.)	15.1	57.6	182.8
CV %	2.6	0.95	6.3
Pr>F (.05)	0.51	0.96	0.10
LSD(.05)	NS	NS	NS

(*indicates significance at Pr<.10, ** significance at Pr<0.05 compared to the control treatment)
Plot size = 10 x 30 ft (4 replications), SAS Proc GLM for missing data analysis.
Planted May 15, 2019, Pioneer P0589AMXT (32,000 seeds/a seeding rate)
Soil Test Results: Olsen P=13.0 ppm, Ext.K=269ppm, Zn=0.53ppm, OM=4.2%, pH=5.5

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Cover Crop Blend and Nitrogen Rate Influences on Corn Grain Yield at Salem SD in 2019

Anthony Bly*, Debankur Sanyal, John Wolthuizen and Brad Rops

INTRODUCTION

Cover crops have become a popular practice for soil health improvement and alternative livestock forage in South Dakota. Not much is known about the impact of cover crops on subsequent nitrogen recommendations for corn. A large research study was initiated in 2017 to help answer this question and provide recommendations and guidance to producers that use cover crops.

Materials and Methods

Item	Description
Cover crop blends	Control=no cover, grass, broadleaf and blend.
Cover crop species	Oats, Barley, Foxtail Millet, Sorghum Sudan, Radish, Turnip, Pea, Lentil
Grass blend	Oats, Barley, F.Millet, S.Sudan = 22.5% each species Radish, Turnip, Pea and Lentil = 2.5% each species
Broadleaf blend	Radish, Turnip, Pea and Lentil = 22.5% each species Oats, Barley, F.Millet, S.Sudan = 2.5% each species
Blend	12.5% of each species previously listed
Cover crop planting date	August 16 after oat harvest
Tillage	No-till
Previous crop	Oats
Row Spacing	22.5 inches
Corn Hybrid	Producer's choice
Corn planting date	June 4, 2019
Plot size	15 x 30 ft
Replications	4
Harvest method	Plot combine
Nitrogen rates (fertilizer)	0,40,80,120,160,200 (Super U = urea + DCD + NBPT)
N application timing	planting
Soil samples	Pre-plant 0-6 and 6-24 inch composition by cover crop and replication.

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RESULTS AND DISCUSSION

Nitrogen rate significantly increased corn grain yield for all cover crop blends (Figure 1). The broadleaf and blend cover crop treatment yield curves were significantly lower when compared with the control and grass. This separation in the N rate yield response curves has been observed in similar plots during 2018 and is currently un-explained. Soil samples are currently under analysis and hopefully the soil health parameters could help explain these differences.

ACKNOWLEDGMENTS

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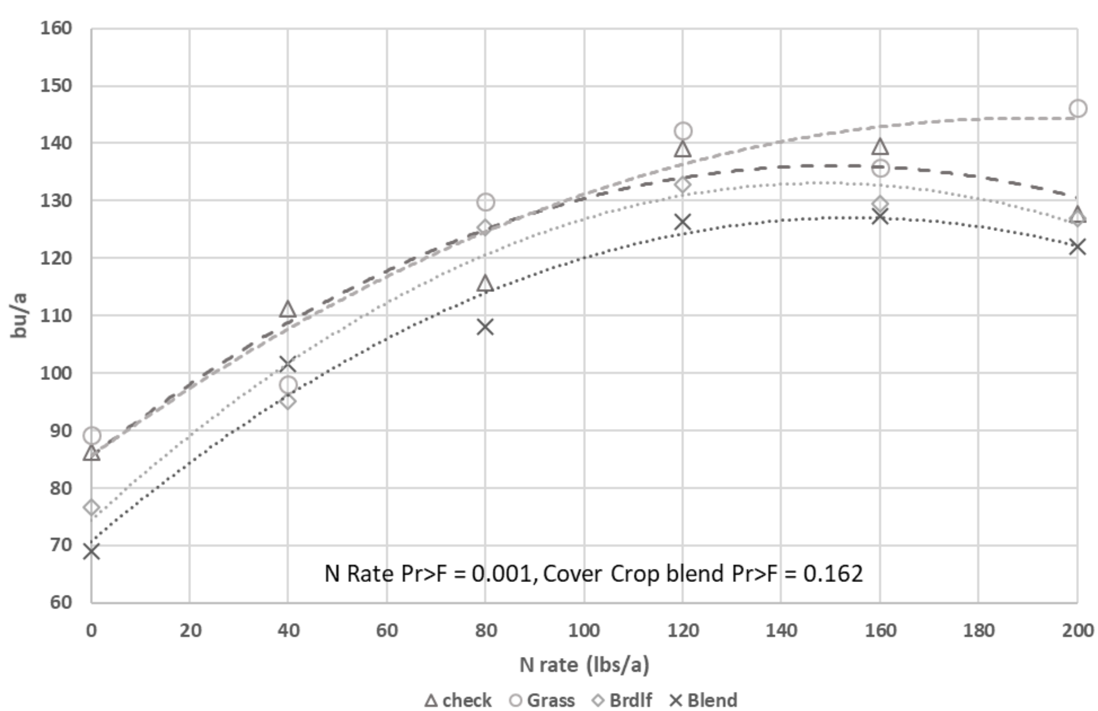

Figure 1. Cover Crop blend influence on corn grain yield response to N rate at Salem SD during 2019.

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Evaluating Winter Alfalfa Survival

Southeast Research Farm, Beresford, SD

Sara Bauder*, Brad Rops
Co PIs: Craig Sheaffer, Valentin Picasso Risso, Jared Goplen, Jacob Jungers

INTRODUCTION

Winter injury of alfalfa in the northern U.S. continues to affect plant stand persistence and consequently limits the productivity and profitability of alfalfa production. Winter injury ranges from partial killing of crown buds and yield reduction to the complete killing of alfalfa plants with total yield loss. Improvement in alfalfa cultivar winter survival is very important, but some alfalfa cultivars are marketed without winter survival data. In order to further investigate these questions, researchers from Minnesota, Wisconsin, and South Dakota are working together to evaluate alfalfa winter survival in a multi-year project.

The objectives are to: 1) Evaluate alternative field approaches to measure winter survival of alfalfa cultivars; 2) Evaluate artificial freezing to predict winter survival under controlled conditions; and 3) Evaluate digital image processing technology to quantify winter injury. This project will consist of conducting field trials and controlled freezing tests, and will develop a digital imaging method to improve the efficiency of winter survival testing and ultimately increase the availability of winter survival characterization of alfalfa varieties. We will conduct education programs to transfer new standard tests to potential users and to educate growers about reducing risks of winter injury.

METHODS

The responsibilities of this project have been split up between the states involved. At this time, Objective 1 is under way in South Dakota at the Southeast Research Farm. This objective consists of 3 sub-objectives: 1) row rating treatment, 2) whole plot rating evaluation, and 3) plot yield rating. In order to complete these three sub-objectives, 2 sets of plots were established, called ‘experiment 1’ and ‘experiment 2’. The same twelve alfalfa lines were used as test treatments in both experiments. Experiment 1 consisted of whole plots planted with a small Brillion-style seeder (4’x15’), and experiment 2 consisted of 20’ long, single row plots thinned down to 1 plant per 8-12” with 3’ of barren soil between each plot (row). Experiment 1 (whole plot treatments) will be used to complete sub-objective 2 and 3. Experiment 2 (single row treatments) will be used to complete sub-objective 1.

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Table 1. Explanation of Methods in Winter Kill Evaluation Treatment at the Southeast Research Farm near Beresford, SD, 2019.

Item	*Experiment 1*	*Experiment 2*
Previous Crop	Soybean	Soybean
Plot Size	4'x15'	Single row 3'x20'
Begin Soil Test (11/15/18)	NO3N (0-6"): 4.8lbs/a, Olsen P: 13ppm, K: 180ppm, pH: 5.5, OM: 4.7	
Seeding Date	06 June, 2019	06 June, 2019
Treatments	See Table 2	See Table 2
Pest Control	Hand weeding throughout season, Kondo insecticide @ 3.2oz/ac with 32oz/a Select Max applied on 27 July, 2019.	
Mowing Dates (2019)	30 Aug, 09 Oct, 06 Nov	30 Aug, 09 Oct, 06 Nov
Replications	6	6

Table 2. Description of Alfalfa Treatment Varieties in Winter Kill Evaluation Treatment at the Southeast Research Farm, 2019.

Treatment Label	*Alfalfa Line*
1	1642
2	1909
3	1910
4	1912
5	1913
6	1915
7	1916
8	1919
9	1921
10	1922
11	1923
12	1924

SUMMARY

This research work was established at the Southeast Research Farm in 2019 and will continue through 2020. All plots in experiment 1 and 2 will be rated for winter kill; yield will be measured on experiment 1 (large plots), and digital imaging will be used as a part of Objective 3 as well. Results of this project will be reported in the 2020 Southeast Research Farm Report. Pending results, extension publication materials and programming may also be created as a result of this multi-state work.

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Investigation of Braco White Mustard on Soybean Cyst Nematode Suppression in Southeastern South Dakota

Sara Bauder*, Connie Strunk, and Brad Rops

Soybean cyst nematode (SCN) is the number one soybean production constraint in South Dakota. One of the challenges in managing SCN is apparent lack of visual above ground symptoms. By the time symptoms are visual, up to 30% yield loss is already occurring in the field. It is therefore important to scout soybeans for SCN even when no symptoms are being displayed. SCN symptoms, if present, include stunted plant growth, yellowing plants, and soybean rows with uncovered and uneven canopy. Typical control or prevention methods include management of crop rotation and cultivar selection. This project was conducted in order to examine further integrated pest management control methods for SCN in South Dakota. Braco mustard is known for nematode specie suppression in other crops, this preliminary trial was designed to investigate Braco mustard's ability to control SCN in South Dakota.

METHODS

Plots were planted per treatment, this includes hand broadcasting into standing oats (treatments 7, 8, and 9) at 25lbs per acre on July 24, 2018, and direct seeding (treatments 4, 5, and 6) with a 15' drill at 20lbs per acre on August 3, 2018. Growth was monitored and pests were managed throughout the growing season on an as-needed basis. On August 29, 2018 Clethodim was used to control weeds across the plot area and glyphosate was hand sprayed around plot edges and in check plots (where the harvest of standing oats moved broadcast mustard seed) to keep rouge mustard and weed pressure down. At early flower stage (October 26, 2018), all treatments requiring tillage were chopped finely with a rotary mower and immediately tilled in with the proper implement per trial protocol (below). Control plots and no-till plots were left undisturbed. Plots were soil sampled (per South Dakota suggested SCN sampling methods) multiple times throughout the study at the 0-6" depth: prior to planting (July 24 and August 8, 2018), prior to incorporation (October 23, 2018), and after termination early the following spring due to early fall ground freeze (April 8, 2019).

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Table 1. Materials and Methods

Item	Description
Previous crop/tillage	Conventional Tilled Oat (Hayden)
Plot size	30’ X 20’
Begin soil test	OM: 4.0, NO_3N (0-12”): 20lbs/a, Olsen P: 10ppm, K: 288, pH: 6.7, EC: 0.2, Texture: Med.
Fertilizer Added	8/3/18; 58 lbs/acre applied as 28% UAN
Braco Seeding Date	Broadcast in standing oat trt 7/24/18; Drilled trt 8/3/18
Braco Seeding Rate	25 lbs/a broadcast; 20 lbs/a drilled
Treatments	Refer to Table 2
Soil Samples	0-6”; 10 cores/plot: 7/24/18 (trt 7,8,9), 8/8/18, 8/23/18, 4/8/19
Pest Management	Clethodim Applied 8/29/18, Glyphosate Applied 8/29/18 by hand as clean up
Mowing/Tillage	Treatments 4, 5, 7, and 8 mowed and tilled on 10/26/18
Replications	4
Experimental Design	Randomized Complete Block Design

Table 2. Effects of Braco Mustard on Soybean Cyst Nematode in 2018 at the SDSU Southeast Research Farm near Beresford, SD.

---Treatment---						-------Soybean Cyst Nematode-------			
label	---Tillage---			---Mustard---		Number of SCN eggs+J-2/100 cm^3 soil			
#	Disk[1]	Roto-Till[2]	No Tillage[3]	Broadcast[4] (lbs/a)	Drilled [5] (lbs/a)	8/8/18a	10/23/18b	4/8/19b	11/8/19[6]
1	x				0	475	88	138	600
2		x			0	150	300	138	300
3			x		0	288	88	88	200
4	x				20	150	300	88	850
5		x			20	275	63	88	400
6			x		20	350	138	100	200
7	x			25		338	75	100	750
8		x		25		413	0	38	700
9			x	25		125	213	50	500
mean						284.7	131.9	91.7	500
CV						--------------2.101----------------			

[1]Disked following mowing to incorporate mustard at full bloom on 10/26/18.
[2]Roto-tilled following mowing to incorporate mustard at full bloom on 10/26/18.
[3]No-tillage was used throughout the growing season.
[4]Broadcast into standing mature oats by hand 7/24/18.
[5]Drilled using 15’ 750 no till drill on 8/3/18.
[6]Final soil samples taken just following soybean harvest. Samples taken across treatments (as a composite sample per treatment), not replications- therefore no statistics were run on the 11/8/19 values; they are for reference only.

Table 3. Significance of mean squares in the analysis of variance as affected by the main factors and their interaction in a Braco Mustard Study near Beresford, SD in 2018.

Source Of Variation	df	SCN
Block	3	NS
Tillage Method	2	NS
error (a)	6	
Seeding Method	2	NS
Tillage:Seeding	4	NS
error (b)	18	
SCN Sampling Date	2	0.0347
Date:Tillage	4	NS
Date:Seeding	4	NS
Date:Tillage:Seeding	8	NS
error (c)	54	

[1]Soybean Cyst Nematode count as 'Number of SCN eggs+J-2/100 cm^3 soil'.

Table 4. Average visual Plant Stand and Plant Vigor ratings per treatment at full bloom on Braco Mustard at the SDSU Southeast Research Farm near Beresford, SD. October 26, 2018

	Plant Rating from 1-10	
Trt.	Stand[1]	Vigor[2]
1	0	0
2	0	0
3	0	0
4	8	9
5	8	9
6	9	10
7	8	8
8	8	7
9	8	8

[1]Plant stand ratings as of 10/26/18 at full bloom prior to termination via mowing and tillage. Rating determined visually on a scale of 1-10. 1= 10% expected stand, 10=100% expected stand.

[2]Plant vigor ratings as of 10/26/18 at full bloom prior to termination via mowing and tillage. Rating determined visually on a scale of 1-10. 1= poor, 10= excellent plant health.

SUMMARY

The 2018 growing season brought in high precipitation in April followed by abnormally warm temperatures in May and June with July-August having below average maximum temperatures. The Southeast Research Farm received record high rainfall for the season, at a total of 35.75" of precipitation for the year of 2018 (10.09" above average). However, by the time this mustard trial was established, an oat crop had grown to maturity in the plot, and ample, but manageable moisture was available at planting and throughout the growing period.

Of the parameters measured, date was statistically significant at the 0.05 level. Replication, tillage method, and seeding method did not show consistent or statistically significant results. However, date of sampling for SCN does show a significant decrease in the sampled SCN population from the August to the September sampling date. This may indicate that the mustard decreased the SCN population of the soil. However, due to spatial variability of SCN populations and the limitations of realistic sampling protocols, we cannot exclusively claim the Braco mustard caused populations to decrease. When plots were soil sampled after the following soybean crop in November of 2019, SCN numbers clearly rose again or sample special variability greatly affected results.

Soybean Cyst Nematode populations can be highly detrimental to South Dakota soybean growers, and management options for SCN are minimal. If an alternative crop such as Braco mustard could suppress this pest, it would allow growers another useful management option. Before conclusive findings can be stated, further research may be required.

ACKNOWLEDGMENTS

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SOUTHEAST RESEARCH FARM ANNUAL REPORT
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Southeast Research Farm, Beresford, SD 57004

Round Bale Storage Demonstration
Southeast Research Farm, Beresford, SD

Sara Bauder*, Tracey Erickson,
Dr. Kevin Shinners, Scott Bird

Producing high quality forages requires much attention to crop growth stage, timing of harvest, and conditioning; however, proper storage of a high quality product is vital to maintaining value and often overlooked. To demonstrate the value of proper hay bale storage, South Dakota State University Extension Field Specialists Sara Bauder and Tracey Erickson teamed up with University of Wisconsin professor, Dr. Kevin Shinners by creating a hay storage demonstration.

METHODS

On February 1, 2019, 44 net wrapped round bales weighing an average of 1,479 lb. were delivered to the Southeast Research Farm near Beresford, SD. All bales came from the same lot; each were weighed and stacked outdoors on slightly sloped, well-drained area. Seven bale stacks were formed and are detailed in Figure 1. Each stack was core sampled at the time of initial stacking on February 1 for compositional analysis. Bales were left untouched for the remainder of the winter and most of the summer until stacks were core sampled, moisture probed with a Delmhorst moisture sensor, and weighed again on July 25, 2019. The 2019 cropping season was unseasonably wet, with about 20 in. of rain falling at the Southeast Research Farm from Feb. 1-July 31 (climate.sdstate.edu).

RESULTS

The ‘control’ bales (stored indoor on a dirt floor) picked up some moisture via wicking, but were otherwise dry and similar in weight to their original weight into storage (Figure 2). However, bales stacked in other formations did not fare as well. For example, bales in Pile G were observed to have moisture damage and mold growth, especially to the bottom bales which took on excess moisture (Figure 1). Bales in the bottom of the ‘pyramid stack’ were also observed to have moisture damage (Pile F); in fact, two of these bales weighed more in August than they did in February due to moisture accumulation.

CONCLUSIONS/BEST MANAGEMENT PRACTICES

This demonstration reinforces that when storing round bales outdoors, stacking of any kind may result in poor shedding of precipitation and slow drying that will most likely lead to dry matter losses and reduction in nutrient value (Figures 1, 2, 3). Leaving adequate space between bales (simulated by Pile B) allowed water to shed off bales and resulted in less moisture accumulation as compared to bale stacking. In addition, the demonstration showed extensive quality losses on bottom bales in Piles F and G, likely due to water shed from top bales. It is also clear that

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where bales touched in rows or piles, moisture accumulated.

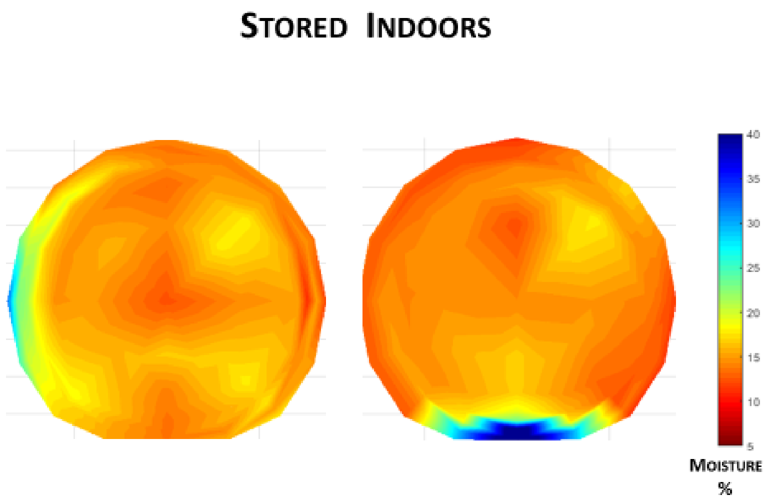
The best bale conservation always comes from protecting bales from the elements – storing under a tarp or inside a building. Wrapping bales in plastic or breathable film (B-wrap) will also help conserve value; however, bales stored outdoors and uncovered can still be well-conserved if these simple practices are followed:

- Take care not to place bales where they will be shaded.
- Place bales in rows that run north to south with about 3 feet between the rows.
    - These practices help sunlight dry bales after precipitation. There are pros and cons to how the rows are made. Butting bales tightly together helps keep rain and snow away from the bale face and takes less storage space. On the other hand, rowing the bales with a gap of 12 to 18 in. allows the bale face to dry if they get wet.
- Bales should be on a slight slope to help water drain away. Placing bales on a well-drained surface like a rock pad is an ideal way to do this. This practice also uses the sun to help bales dry after they have been exposed to rain or snow.

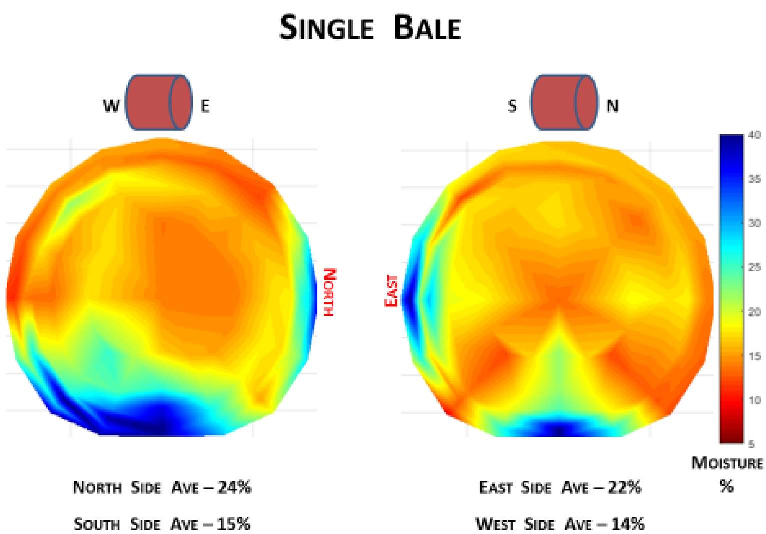
Dry matter loss of hay is generally a function of moisture, temperature, and time. Figure 4 depicts commonly accepted storage losses based upon various research trials. As one can see, there is great variability in losses depending upon storage methods. In turn, storage losses are a function value with consideration to several factors of your operation. To further evaluate the storage cost of round bales on your operation see the University of Wisconsin's "Comparing Round Bale Storage Costs" spreadsheet at https://fyi.extension.wisc.edu/forage/files/2014/01/BaleStorage5-7-04.xls.

Figure 1.

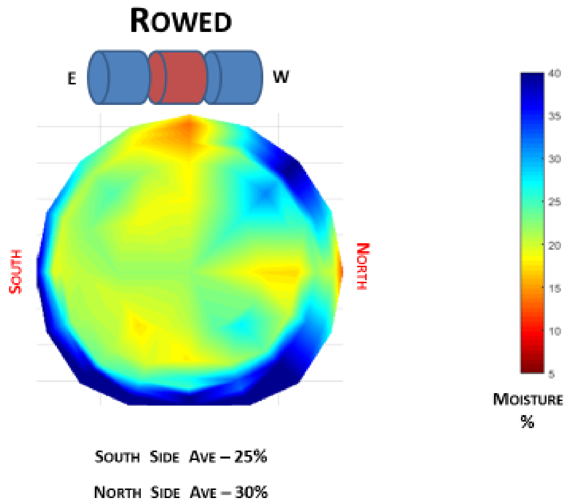
**Figure 1 footnote* [1]Moisture maps created by Dr. Kevin Shinners, University of Wisconsin.



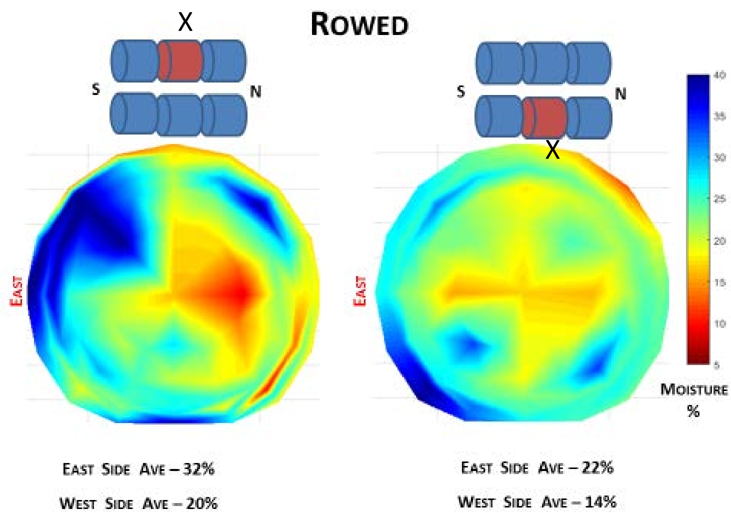
Pile A. Two bales stored in a building with a dirt floor.



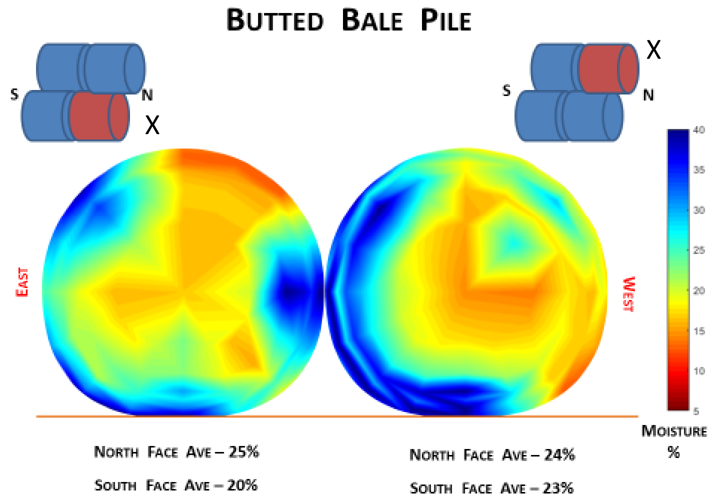
Pile B. Two bales set alone outdoors; one facing east/west, the other facing north/south.



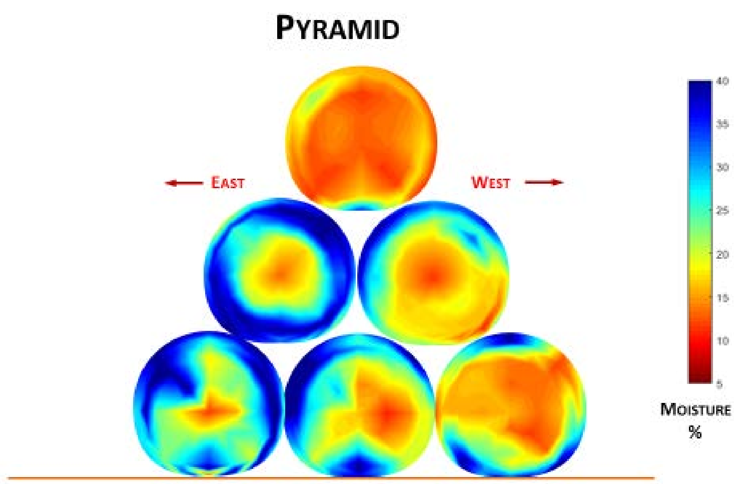
Pile C. Three bales rowed from east to west outdoors with faces nearly touching. Moisture samples taken from bale indicated in red (middle bale).



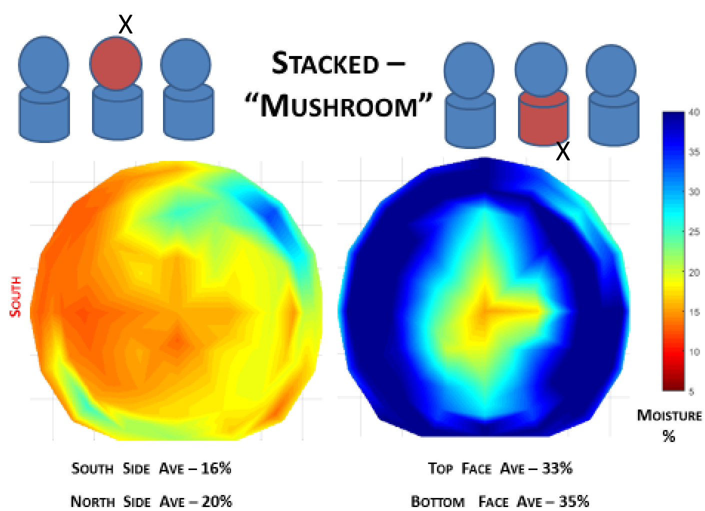
Pile D. 6 bales rowed from north to south outdoors. Approximately 3' between rows and faces nearly touching. Bales probed indicated in red (X).



Pile E. 4 bales placed in a 'pod' facing north and south outdoors. All bales butted together tight. Bales probed indicated in red (X).



Pile F. 11 bales placed in a pyramid (6 on bottom, 4 on second layer, 1 on top) facing north and south outdoors. All bales butted together tight.



Pile G. 6 bales placed in 'mushroom' stacks with top bales facing east and west outdoors. ~3' left between stacks. Bales probed indicated in red (X).

Figure 2. 2019 Bale Stacking Demonstration-Bale Weight. Beresford, SD

Pile[1]	Initial Weight (Avg.) 1-Feb	Final Weight (Avg.) 25-Jul	Weight Loss (Avg.)
	lbs.	lbs.	lbs.
A	1474	1368	106
B	1438	1332	106
C	1540	1378	162
D	1492	1364	128
E	1480	1315	165
F	1437	1356	82
G	1476	1327	148

[1]See pile description in Figure 1.

Figure 3. 2019 Bale Stacking Demonstration Hay Quality Results. Beresford, SD.

Pile[1]	DM[2]		CP[3]		RFV[4]		RFQ[5]	
	1-Feb	25-Jul	1-Feb	25-Jul	1-Feb	25-Jul	1-Feb	25-Jul
	%	%	%	%				
A	81.72	84.04	17.31	17.8	126	119	130	116
B	79.77	84.15	17.21	17.23	118	105	119	101
C	78.88	82.03	17.48	18.06	113	97	121	96
D	79.99	82.95	17.89	18.65	122	111	136	110
E	78.03	82.02	16.88	18.98	100	105	103	108
F	84.99	82.33	16.51	17.79	94	97	116	102
G	81.33	83.36	17.57	17.96	104	107	105	99

[1] See pile description in Figure 1.
[2] Dry matter
[3] Crude Protein
[4] Relative Feed Value
[5] Relative Feed Quality

Figure 4. Effect of Storage Method on Storage Losses

Storage	Range of Dry Matter Loss
Under Roof	2 - 10
Plastic wrap, on ground	4 - 7
Bale Sleeve, on ground	4 – 8
Covered, rock pad or elevated	2 -17
Uncovered, rock pad or elevated	3-46
Uncovered, on ground, net wrap	6 - 25
Covered, on ground	4 - 46
Uncovered, on ground	5 - 61

https://fyi.extension.wisc.edu/forage/big-bale-storage-losses-how-different-options-stack-up/

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Plant Growth Regulator-based Herbicide Performance for Soybean Planted at Three Planting Dates at the Southeast Research Farm, Beresford, SD

Clay, Sharon*, Graig Reicks, Joy Amajioyi

Plant growth regulator (PGR, i.e. auxin-type herbicides) tolerant soybean varieties have revised post-emergent broadleaf weed management. This study examined 1) the performance of PGR-based herbicide (dicamba and 2,4-D) treatments compared with the nonPGR (e.g. conventional) herbicide programs; 2) the efficacy of a PGR-based program based on soybean planting date; 3) if an over the top application of rhizobia applied with the herbicide would improve rhizobia numbers, number of active nodules, plant greenness, or seed protein.

MATERIALS AND METHODS

Roundup Ready 2 Xtend® variety (dicamba and glyphosate tolerant) with a 2.0 maturity rating and an Enlist E3™ variety (2,4-D, glufosinate, and glyphosate tolerant) with a 2.1 maturity rating were planted at 160,000 seeds ac^{-1} in 30" wide rows. Planting dates were May 5 (planting date 1; PD1), June 5 (PD2), or June 19, 2019 (PD3) at the Southeast Research Farm (Beresford). Preemergence herbicide tank mixes (Table 1) were applied at each planting date for burn down of emerged weeds (PD2 and PD3), and to provide residual weed control (all planting dates), especially for grass weeds. Individual plots were 4 rows wide and 30 ft long with treatments replicated four times.

The May 7 preemergence treatment (PD1) did not contain glyphosate (e.g. Roundup) because tillage just prior to planting left few emerged weeds. The June 4 and 19 preemergence applications were burndown applications and, because weeds had established, glyphosate plus surfactants were added to this treatment. Post-emergence treatments for all planting dates of the Enlist E3™ soybean plots were applied July 16; the treatment included 2,4-D choline, clethodim (for grass control) and glufosinate (Liberty; for broadspectrum weed control). Roundup Ready 2 Xtend® plots were treated with a mixture of glyphosate (for broadspectrum weed control) and dicamba (Xtendimax; for broadleaf weed control) on June 13, June 25, only, as the dicamba application cutoff date in SD is June 30. Additionally a herbicide treatment tank-mix of acifluorfen + clethodim, applied July 16, was used as a conventional herbicide treatment to compare with the PRG herbicide treatments.

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Table 1. Preemergence herbicide applications at SE Farm in 2018.

Planting Date(s)	Preemerge treatment date(s)	Herbicide Treatments	Rates ac^{-1}	Cost ac^{-1}
May 7	May 7	Valor® SX (51% Flumioxazin)	2.5 oz	$11.33
		Glory® (75% Metribuzin)	4 oz	6.80
		Me-Too-Lachlor™ (84.4% Metolachlor)	20.8 oz	11.15
		Spray	16.5 gal	
				$29.28
June 5 & June 19	June 4 & June 19	Panther® SC (41.4% Flumioxazin)	3 oz	$11.33
		Dimetric® EXT (75% Metribuzin)	5.28 oz	7.15
		Roundup PowerMax® (48.8% glyphosate)	32 oz	4.94
		Medal II® EC (82.4% S-metolachlor)	20.8 oz	11.15
		AMS	1.5 lbs	0.50
		Duce® Methylated Veg. Oil and Surfactant Blend	22.9 oz	6.55
		Strike Zone® LC drift agent	2.84 oz	1.78
		Spray	17.8 gal	
		Total		$43.40

A spray containing only rhizobia was applied to select treatments on July 1. The pre-only plots were divided, and half the plot received rhizobia spray. Recommended surfactants, adjuvants, and drift retardant, for each herbicide type were incorporated into the spray mix as well (Table 2).

Soil samples were collected at R3-R4 growth stage to determine root nodule activity in late July. Weed biomass in a 1 m^2 area in-between rows was collected on September 27, just prior to soybean harvest, dried at 60 ^{0}C to constant weight, and biomass quantified. Weed flora observed in this sampling included common waterhemp, redroot pigweed, barnyard grass, yellow and green foxtail, common lambsquarters, prostrate pigweed, and eastern black nightshade. The middle two rows of the plots were harvested on Oct. 29, using a small plot combine. Grain dried, weighed and yield reported at 13% moisture.

RESULTS

The cost of the herbicide treatments (based on SD 2019 average cost) ranged from $29 to $43 for the preemergence herbicides and with an additional $26 to 36 for the postemergence spray mix combination. Planting date and herbicide treatment impacted soybean yield, weed biomass, and in some cases, number of root nodules and root nodule activity (Table 3 and 4).

For the Enlist E3TM variety, the highest soybean yield were observed for the June 5 (PD2) and June 19 (PD3) planting dates. Herbicide treatment comprising of a mixture of 2,4-D + Cleth + Glufosinate resulted in 56.9 bu/ac yield (PD2) and 57.7 bu/ac yield (PD3). The lowest soybean yield was measured in the PD1 planting. The low yield in this planting date was most likely due to poor emergence from the use of non-treated seeds for planting. Weed biomass was lowest for PD 2 for all herbicide treatments. Highest nodule activity was observed in PD 3 (67.7%), whereas PD1 treated with 2,4-D + Cleth had the lowest percent nodule activity (33.3%). Applying rhizobia had mixed influence on rhizobia numbers and activity, and had little influence on overall plant greenness.

In Roundup Ready 2 Xtend® variety, grain yields were similar among all planting dates but generally greater than the EnList variety yields planted at the same date. Highest yields were measured for Dicamba two application treatment for PD1 (62.50 bu/ac), and the Acifluorfen + Rhizobia treatment for PD2 (66.1 bu/ac). Weed biomass was greatly reduced by the dicamba treatments across the three planting dates. PDs 1, 2 and 3 were similar in the percent nodule activity when treated with the various herbicide treatments. However, the lowest nodule activity (49.2%) was recorded in the pre-only plot of PD 3. As with the Enlist treatment, plant greenness was not influenced by herbicide or rhizobia treatment.

It is known that glyphosate-resistant common waterhemp is present on the Southeast Farm. The EnList and Xtendimax did improve the waterhemp control, although glyphosate alone was not tested. Acifluorfen applied in mid-July also provided excellent control of waterhemp and maintained soybean yield.

This study will be repeated in 2020.

ACKNOWLEDGEMENT

This research was funded by SDSU Experiment Station and the South Dakota Soybean Research and Promotion Council.

Table 2. Postemergence herbicide applications at SE Farm in 2018.

Treatment	Herbicide Treatments	Rates ac^{-1}	Dates Applied	Cost ac^{-1}
Dicamba	XtendiMax® (dicamba)	22 oz	6/25/19	$12.25
	Roundup PowerMAX® (48.7 glyphosate)	32 oz		7.85
	Class Act® Ridion®	21.4 oz		4.17
	Strike Zone® LC drift agent	3.58 oz		2.24
	Spray	22.4 gal		
	Total			**$26.51**
Acifluorfen	Acifin™ 2L (20.1% acifluorfen)	24 oz	7/16/19	13.60
	Select Max® (12.6% clethodim)	16 oz		11.94
	Class Act® Ridion®	18.5 oz		3.60
	AMS	2.5 lbs		0.75
	Spray	19.3 gal		
	Total			**$29.89**
2,4-D and 2,4-D + Glufosinate	Enlist One™ (55.4% 2,4-D choline)	32 oz	7/16/19	$10.00
	Select Max® (12.6% clethodim)	16 oz		11.94
	AMS	2.5 lbs		0.75
	Class Act® Ridion®	16.3 oz		3.18
	Liberty® 280 SL (24.5% glufosinate)	29 oz		11.10
	Spray	17.0 gal		
	Total without Liberty			**$25.87**
	Total with Liberty			**$36.97**

Table 3. Effect of planting date and herbicide on Enlist E3™ soybean yields, weed biomass, greenness index, nodule number and root nodule activity in 2019

Herbicide Treatment	**Grain Yield (bu/ac)**			**Weed Biomass (lbs/ac)**			**Grain Oil Content**			**Grain Protein Content**		
	PD1 (May 5)	PD2 (Jun 5)	PD3 (Jun 19)	PD1 (May 5)	PD2 (Jun 5)	PD3 (Jun 19)	PD1 (May 5)	PD2 (Jun 5)	PD3 (Jun 19)	PD1 (May 5)	PD2 (Jun 5)	PD3 (Jun 19)
2,4-D	37.7	50.0	54.3	66.9	1.4	0.0	19.7	20.0	19.8	34.8	34.6	34.6
2,4-D + Rhizobia	50.1	51.8	45.3	120.2	0.0	2.7	19.4	20.0	19.9	35.3	34.1	34.7
2,4-D + Glufosinate.	33.8	56.9	57.7	476.1	0.0	0.0	19.9	19.9	19.7	34.5	34.6	34.9
2,4-D + Glufo. + Rhizobia	33.1	48.9	54.5	308.8	0.0	813.4	19.9	19.9	19.9	34.5	34.6	34.3
Pre only	39.6	51.9	50.9	156.4	0.0	0.0	19.3	19.9	19.9	35.0	34.7	34.1
Average among treatments	38.9	51.9	52.5	225.7	0.3	163.2	19.6	19.9	19.8	34.8	34.5	34.5
p-value	0.40	0.56	0.53	0.81	0.45	0.26	0.14	0.97	0.28	0.32	0.29	0.07

Herbicide Treatment	**SPAD Value**			**Nodule Number (plants/10.8cm diameter golf hole cutter)**			**Percent Active Nodule (plants/10.8cm diameter golf hole cutter)**		
	PD 1	PD 2	PD 3	PD 1	PD 2	PD 3	PD 1	PD 2	PD 3
2,4-D	40.5	41.8 a	42.5	18.3	28.5	42.0	33.3	52.2	67.7
2,4-D + Rhizobia	41.5	40.9 a	41.0	31.0	27.0	42.3	52.0	56.0	62.0
2,4-D + Glufosinate.	42.3	41.4 a	41.8	25.3	38.0	37.8	36.1	50.6	43.4
2,4-D + Glufo. + Rhizobia	40.2	41.8 a	41.8	16.7	43.5	34.7	40.0	48.6	62.5
Pre only	40.0	38.6 b	40.4	54.0	43.3	38.3	44.7	61.0	51.8
Pre + Rhizobia	42.1	42.2 a	41.8	45.0	42.3	38.0	67.7	61.9	56.4
Average among treatments	41.1	41.1	41.6	31.7	37.1	38.9	45.6	55.1	57.3
p-value	0.15	**0.05**	0.24	0.07	0.76	0.99	0.78	0.66	0.75

*Values followed by different letters are significant at $p < 0.05$

Table 4. Effect of planting date and herbicide on Enlist E3^{TM} soybean yields, weed biomass, greenness index, nodule number and root nodule activity in 2019

Herbicide	**Grain Yield (bu/ac)**			**Weed Biomass (lbs/ac)**			**Grain Oil Content**			**Grain Protein Content**		
	PD1 (May 5)	PD2 (Jun 5)	PD3 (Jun 19)	PD1 (May 5)	PD2 (Jun 5)	PD3 (Jun 19)	PD1 (May 5)	PD2 (Jun 5)	PD3 (Jun 19)	PD1 (May 5)	PD2 (Jun 5)	PD3 (Jun 19)
Dicamba 1app.	57.4 a	65.6	53.5	15.6 b	0.0	0.0	19.3	19.6	19.7	35.0	34.7	34.9
Dicamba 1app + Rhizobia		63.0	46.8		0.1	0.6		19.5	19.7		34.7	34.7
Dicamba 2app.	62.5 a			2.9 b			19.5			34.5		
Dicamba 2app. + Rhizobia	54.2 a			8.0 b			19.6			34.5		
Acifl. + Cleth	59.8 a	63.4	53.5	25.2 ab	22.1	0.0	19.4	19.6	19.7	35.2	34.8	34.6
Acifl. + Cleth + Rhizobia	50.4 ab	66.1	53.1	14.9 b	10.5	0.0	19.4	19.6	19.6	34.9	34.7	34.8
Water + Rhizobia		59.5	50.1		1.5	11.8		19.5	23.6		34.8	29.2
Pre only	38.8 b	57.6	48.5	43.9 a	26.9	67.9	19.6	19.4	19.7	34.2	34.9	34.8
Average among treatments	**53.9**	**62.5**	**50.9**	**18.4**	**10.2**	**13.4**	**19.5**	**19.5**	**20.33**	**34.7**	**34.8**	**33.8**
p-value	**0.02**	0.11	0.71	**0.05**	0.14	0.38	0.51	0.39	0.43	0.07	0.95	0.47

	SPAD Value			**Nodule Number (plants/10.8cm diameter golf hole cutter)**			**Percent Active Nodule (plants/10.8cm diameter golf hole cutter)**		
	PD 1	PD 2	PD 3	PD 1	PD 2	PD 3	PD 1	PD 2	PD 3
Dicamba 1app.	40.4 b	40.4	41.5	47.3	54.3	56.3	61.2	72.2	57.2
Dicamba 1app + Rhizobia		40.3	41.8		51.3	54.0		69.5	81.7
Dicamba 2app.	40.6 ab			29.0			60.9		
Dicamba 2app. + Rhizobia	41.4 a			36.0			73.6		
Acifl. + Cleth	41.3 a	41.7	41.5	60.3	59.8	54.3	68.1	74.1	64.1
Acifl. + Cleth + Rhizobia	41.4 a	41.0	40.9	56.8	50.5	34.3	68.3	62.1	68.3
Water + Rhizobia		41.0	41.3		52.3	55.5		58.6	83.7
Pre only	40.3 b	40.1	39.8	53.5	43.0	44.8	59.7	69.3	49.2
Pre + Rhizobia	41.4 a	40.3	41.3	55.0	47.3	53.5	79.3	83.6	60.5
Average among treatments	**41.0**	**40.7**	**41.2**	**48.3**	**51.2**	**50.4**	**67.3**	**69.9**	**66.4**
p-value	0.04	0.20	0.27	0.50	0.99	0.81	0.58	0.63	0.34

*Values followed by different letters are significant at $p < 0.05$

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In-Season Foliar Protection Management Effect on Soybean Yield and Seed Composition in Eastern South Dakota - 2019

Kelsey Bergman, Péter Kovács*

INTRODUCTION

Over the last century soybean [*Glycine max (L.) Merr.*] yields have been on the rise, and with this rise has come a slow decrease in grain protein concentration. This lower quality protein means that those who use soybeans for its meal will have to buy more grain to meet the same protein demands as they once did. Research over the years has shown that there are many factors that influence protein levels. Foliar diseases and insect damage can reduce leaf area and photosynthesis, therefore reducing grain yield (Bassanezi et al., 2001) and influencing grain composition. Foliar protection applications can aid in maintaining healthy crop canopies during grain fill, which relieves crop stress and extends photosynthetic production.

The objective of this research was to compare foliar applications of fungicide and insecticide effects on grain yield and protein levels in soybean seeds in different maturity group varieties.

METHODS

Oat (*Avena sativa* L.) and corn (*Zea mays* L.) were the preceding crops in 2018 and 2019, respectively. Soybean was planted at 140,000 seeds per acre on May 17, 2018 and June 8, 2019 (re-planted due to very low stand establishment). The two varieties used were: GH1024X, GH2041X (maturity group (MG) 1.0 and 2.0, respectively). The foliar treatments were untreated control, fungicide (Miravis, and Trivapo; 13.7 fl. oz/A rate), insecticide (Endigo ZC; 4.5 fl. oz/A rate), combination of fungicide and insecticide, and in 2019 an addition of foliar fertilizer (Generate; 32 fl. oz/A rate) and a combination of foliar fertilizer, fungicide, and insecticide applications. Applications were carried out at beginning pod (R3) growth stage.

Soybeans were harvested on October 18 in both 2018 and 2019 and yield data was recorded through a Kincaid 8XP plot combine; yields were adjusted to 13% moisture content. Seed protein and oil concentrations were determined by InfraTec Nova (FOSS Analytics, Hillerød, Denmark). Statistical analyses were carried out through R Studios software package.

RESULTS

Data on grain yield, grain protein, and oil concentrations are shown in Table 1. Yield ranged from 82-88 Bu/A in 2018 and 54-63

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Bu/A in 2019. In both years there were variety differences; MG 2 variety out yielded MG 1 variety by 3 Bu/A and by 7 Bu/A across the foliar treatments in 2018 and 2019, respectively. Grain protein and oil concentrations were also higher in MG2 compared to MG1 variety in both years. In 2018, averaged across MGs, fungicide treatment alone and the fungicide and insecticide treatments increased grain yield by 4 Bu/A relative to the untreated control. Within the MG2 variety, fungicide and insecticide treatment increased the protein concentration by approximately 0.5% relative to the control treatment in 2018 (Table 1). Oil concentration was also higher with fungicide treatment compared to the other foliar treatments averaged across the maturity groups. Grain protein concentration was not influenced by the foliar protection treatments in 2019, except the foliar fertilizer application in MG2 variety which resulted lower protein concentration than the control treatment.

ACKNOWLEDGEMENTS

Research was funded by United Soybean Board. Authors appreciate the support of the SD Agricultural Experiment Station and USDA-NIFA.

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Table 1. Maturity group (MG) and foliar protection treatment effects on grain yield, protein and oil concentrations near Beresford, SD in 2018 and 2019.

		2018			2019		
		Yield (Bu/A)	**Protein (%)**	**Oil (%)**	**Yield (Bu/A)**	**Protein (%)**	**Oil (%)**
MG1	**Control**	82.4c †	35.1bc	18.5bc	54.5e	34.4abcd	18.1b
	Fungicide and Insecticide	83.8bc	34.9c	18.5bc	54.2de	34.3abcd	18.0b
	Fungicide	83.6c	34.7c	18.7a	57.3abcde	35.1a	17.9b
	Insecticide	81.9c	34.9c	18.4c	54.5de	34.3bcd	18.1b
	FFI††				56.0bcde	34.6abcd	18.0b
	Foliar Fertilizer				54.9cde	34.1d	18.0b
MG2	**Control**	82.8c	35.0bc	18.7a	58.3abcde	34.9ab	18.1a
	Fungicide and Insecticide	88.2a	35.5a	18.7ab	63.7a	34.8abc	18.3a
	Fungicide	87.9ab	35.2ab	18.9a	63.1ab	34.8ab	18.1a
	Insecticide	84.9abc	35.0bc	18.8a	63.7a	34.8abc	18.2a
	FFI				61.7abcd	34.8abc	18.2a
	Foliar Fertilizer				62.2abc	34.9ab	18.2a

† Different letters indicate statistically significant differences within a column for maturity group x foliar protection treatment interaction (*p*=0.05)

†† Combination of foliar fertilizer, fungicides and insecticide application

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In-Season N and S Application Effect on Soybean Yield and Grain Composition in Eastern South Dakota

Kelsey Bergman, Péter Kovács*

INTRODUCTION

Over the last century soybean [*Glycine max (L.) Merr.*] yields have been on the rise, and with this rise grain protein has slowly decreased. Research over the years has shown that there are many factors that influence protein levels. Environment and in some cases crop management practices influenced grain protein levels. A management practice that may affect protein levels is in-season fertilizer application, which can contribute to protein synthesis.

The objective of this research was to compare N and S application timing and their affects on grain yield and protein concentrations in soybean seeds.

METHODS

Soybeans were planted into oat (*Avena sativa* L.) residue in 2018 and corn (*Zea Mays* L.) residue that was conventionally tilled in 2019 at 140,000 seeds per acre on May 17, 2018, and June 8, 2019. The two varieties used were: AG11X8, AG24X7 (MG1.1 and MG2.4, respectively). Nitrogen and S were applied at either pre-plant, four trifoliate leaves (V4), beginning pod (R3), and at both V4 and R3 growth stages. At each application timings 10 lbs/A S as ammonium-sulfate (AMS), and total of 40 lbs/A N from AMS and urea was applied.

Soybeans were harvested from the center two rows of each plot on October 18 in both 2018 and 2019, using a Kincaid 8XP plot combine; yields were adjusted to 13% moisture content. Seed protein and oil concentrations were determined by InfraTec Nova protein analyzer (FOSS Analytics, Hillerød, Denmark). Statistical analyses were carried out through R Studios software package.

RESULTS

Data on grain yield, grain protein, and oil concentrations are given in Table 1. In 2018 across fertilizer application timings the MG1 variety out yielded the MG2 variety (76.5 Bu/A vs. 71 Bu/A) and also had higher grain oil concentration, but the MG2 variety resulted in higher grain protein concentration. Fertilizer application timings did not influence grain yield. Across the maturity groups, pre-plant N and S fertilizer application in 2018 increased grain protein concentration compared to the untreated control.

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The planted variety only effected grain oil concentration in 2019; opposite of 2018 when the MG2 variety had higher grain oil concentration averaged across the fertilizer application treatments. Grain yield did not differ among fertilizer application timings.

Overall, results did not indicate that N or S fertilizer application improved grain yield or grain protein levels during these two wet growing seasons near Beresford.

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Research was funded by United Soybean Board. Authors appreciate the support of the SD Agricultural Experiment Station and USDA-NIFA.

Table 1. Maturity group (MG) and fertilizer application timing effects on grain yield, protein and oil concentrations near Beresford, SD in 2018 and 2019.

		2018			2019		
Variety	**Fertilizer application timing**	**Yield Bu/A**	**Protein %**	**Oil %**	**Yield Bu/A**	**Protein %**	**Oil %**
MG1	**Control**	77.72a	34.5c	18.6a	57.4a	34.1a	17.8b
	Pre	75.96abcd	34.6c	18.6a	56.3a	34.1cde	17.8b
	V4	74.63abcde	34.5c	18.7a	58.3a	33.9e	17.9b
	R3	76.42abc	34.5c	18.7a	56.7a	34.3bcde	17.8b
	V4+R3	77.61ab	34.4c	18.7a	55.2a	34.2bcde	17.9b
MG2	**Control**	71.47cde	35.3ab	18.4b	52.3a	34.6abcd	18.4a
	Pre	70.14e	35.5a	18.3b	53.0a	34.7abc	18.4a
	V4	70.42e	35.5a	18.3b	54.3a	34.6abcd	18.3a
	R3	71.00de	35.1b	18.4b	55.2a	34.9a	18.4a
	V4+R3	72.60bcde	35.3ab	18.4b	53.1a	34.8ab	18.5a

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Additional Inoculation Effect on Soybean Yield and Seed Composition in Eastern South Dakota

Kelsey Bergman, and Péter Kovács*

INTRODUCTION

Over the last century soybean yields have been on the rise, and with this rise has come a slow decrease in the quality of the seeds. Research over the years has shown that there are many factors that influence protein levels.

Inoculation has been shown to be beneficial in fields in which soybeans have not been grown in over five years. Though inoculation with *Bradyrhizobium japonicum* has been successful in increasing soybean nodulation, with increases in plant fresh weight, seed protein, and seed yield in soils with a low or absent native population according to Abel and Erdman (1964) and Caldwell and Vest (1970).

The objective of this research is to compare if additional inoculations increase grain yield and protein concentrations.

MATERIAL AND METHODS

In this study the soybeans were re-planted at 140,000 seeds per acre on June 8, 2019. The previous crop was corn (*Zea mays* L.) which was conventionally tilled. The variety used was AG24X7 (maturity group 2). Four combinations of inoculation treatments with and without sulfur supply. 20 lbs S/A was broadcast applied at planting as ammonium sulfate (AMS). The inoculation treatments were as follow:

- untreated
- additional inoculation with Bradyrhizobium Japonicum,
- additional inoculation with Azospirillum brasilense, and
- additional inoculation with Bradyrhizobium japonicum and Azospirillum brasilense).

Three additional intensive management treatments were also established with the control, and with the two bradyrhizobium inoculation treatments. These plots received 20 lbs S/A MES10 (12-40-0-10S) at planting, and an additional 10 lbs S/A of AMS and 32 fl. oz/A of Brandt Smart Quattro through foliar application at V4 (four trifoliate) growth stage. At R3 growth stage (beginning of pod setting) 4.5 fl. oz/A of Endigo ZC, 13.7 fl. oz/A of Miravis and Trivapro, and 64 fl. oz/A of Brandt Smart Quattro was applied.

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Soybeans were harvested on October 18, 2019 and yield data was recorded through a Kincaid 8XP plot combine; yields were adjusted to 13% moisture content. Seed protein and oil concentrations were determined by InfraTec Nova (FOSS Analytics, Hillerød, Denmark). Statistical analyses were carried out through R Studios software package.

RESULTS

Grain yield with Bradyrhizobium inoculation did not differ from the control treatment averaged across the two S fertilizer treatments (Table 1). However, seed inoculation with Azospirillum only resulted in 6 Bu/A lower yield compared to additional inoculation with both inoculants. Inoculation did not influence the grain protein (Table 1).

When we utilized the intensive management strategy, grain yield increased by 4 Bu/A averaged across the three inoculation methods (control, Bradyrhizobium only, and Bradyrhizobium and Azospirillium together; Table 2) but the different inoculation did not influence grain yield. The intensive crop management also increased grain protein averaged across the three inoculations (Table 2).

Overall, in the first year of this study additional inoculation did not improve grain yield substantially. However, the intense crop management has increased grain yield and protein regardless of inoculant.

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Table 1. Inoculum application, with or without additional sulfur application effect on grain yield, protein and oil concentrations near Beresford, SD in 2019.

Inoculant	S fertilizer application	Yield (Bu/A)	Protein (%)	Oil (%)
Control		53.08 ab†	34.7	18.6 a
Bradyrhizobium japonicum		52.37 ab	34.8	18.5 ab
Azospirillum brasilense		49.58 b	34.6	18.6 a
Both		55.74 a	34.8	18.4 b
Control	**No**	52.81	34.7	18.7
	Yes	53.35	34.7	18.6
Bradyrhizobium japonicum	**No**	52.48	34.9	18.4
	Yes	52.25	34.6	18.7
Azospirillum brasilense	**No**	50.65	34.7	18.7
	Yes	48.50	34.6	18.6
Both	**No**	55.89	34.7	18.4
	Yes	55.59	34.8	18.4

† different lower-case letters indicate statistically different results within a column at p=0.05 confidence level

Table 2. Inoculum application, with Sulfur, Fungicide, and Insecticide applications, effects on grain yield, protein and oil concentrations near Beresford, SD in 2019.

Inoculant	S Fertilizer application	Yield (Bu/A)	Protein (%)	Oil (%)
Control		54.91	34.7 b	18.5 a
Bradyrhizobium japonicum		54.13	34.9 ab	18.4 ab
Both		55.75	34.9 a	18.3 b
	No	53.73 b†	34.8 b	18.5 a
	Yes	53.63 b	34.7 b	18.5 a
	Intensive mgmt.	57.44 a	35.0 a	18.1 b

† different lower-case letters indicate statistically different results within a column at p=0.05 confidence level

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Early Season Split N Applications in Corn

Rebecca Saucerman, Jason D. Clark,
and Péter Kovács*

INTRODUCTION

Nitrogen usage is commonly recognized as one of the single greatest controllable aspects of corn (*Zea mays* L.) production. However, N has several problems limiting its effectiveness. As nitrogen changes form in the soil, it can be lost to the atmosphere through volatilization, or leach out of reach of plants roots into groundwater, leading to potential environmental and human health problems. The lost N also impacts the profitability of corn production. The majority of N is taken up and utilized by the plant after the V5-6 growth stages. Due to the prevalence of spring rains and delayed N availability, split N application can improve N availability to plants and increase grain yield. Objective of this research is the comparison of early season split nitrogen fertilizer applications compared to a single preplant application.

MATERIALS AND METHODS

The second year of this research was completed in 2019. Each year our field has followed soybeans (*Glycine max* (L.)) in rotation. Each plot was 45 feet long with six rows 30 inches apart. The field was planted at a rate of 33,500 plants/acre P9621AM in 2019. The field was conventionally tilled. All fertilizer treatment was urea (46-0-0) with broadcast application. Total N rates ranged from 0 to 240 lbs N/acre with 40 lbs N/acre increments. Preplant treatments received all of their fertilizer before planting. The V3 and V5 split treatments received 40 lbs N acre^{-1} at planting with the remainder N applied when the plants were either at the V3 or V5 growth stage. The treatments are listed below by the total amount of nitrogen applied per acre. Center two rows were harvested by a Kincaid 8XP combine to determine grain yield and yield was adjusted to 15.5% moisture content.

RESULTS

Grain yields ranged from 118.9 bu/acre (Pre 0) to 230.4 bu/acre (V3 240) (Table 1). Figure 1 also displays that yield plateaued with 191 lbs N/ac with preplant application, and with 153 and 166 lbs N/ac with V3 and V5 split application strategy, respectively.

Another analysis that gives more insight is the Economic Optimum Nitrogen Rate (EONR) which considers the cost of fertilizer and the increased income from yield gain. The EONR N rates and their associated yields for each application timings are shown in Table 2. While the yield with optimum N rates for all

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application timings are similar, the split applications required about 40 lbs less N than the preplant only application to reach that level of yield (Figure 1, Table 2).

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Table 1. Nitrogen application timing and rate effect on grain yield in 2019 and averaged across 2018 and 2019.

Treatments application timing and N rates (lbs N/ac)	**2019 (bu/ac)**		**2018-2019 (bu/ac)**	
Preplant 0	118.92	c	130.27	g
Preplant 40	141.02	b	155.71	f
Preplant 80	194.24	ab	197.60	e
Preplant 120	202.01	ab	205.93	bcde
Preplant 160	217.67	a	210.63	abcde
Preplant 200	219.58	a	222.57	abcde
Preplant 240	224.26	a	224.84	abc
V3 80	202.02	ab	200.55	cde
V3 120	218.70	a	208.02	abcde
V3 160	221.07	a	215.75	abcde
V3 200	227.72	a	225.98	abcd
V3 240	230.41	a	222.31	a
V5 80	192.33	ab	199.34	cde
V5 120	210.78	a	208.43	abcde
V5 160	221.22	a	218.93	ab
V5 200	219.30	a	221.40	ab
V5 240	212.21	a	214.01	ab

†Treatments with the different letters within a column indicates statistically different yields at P=0.05 confidence levels

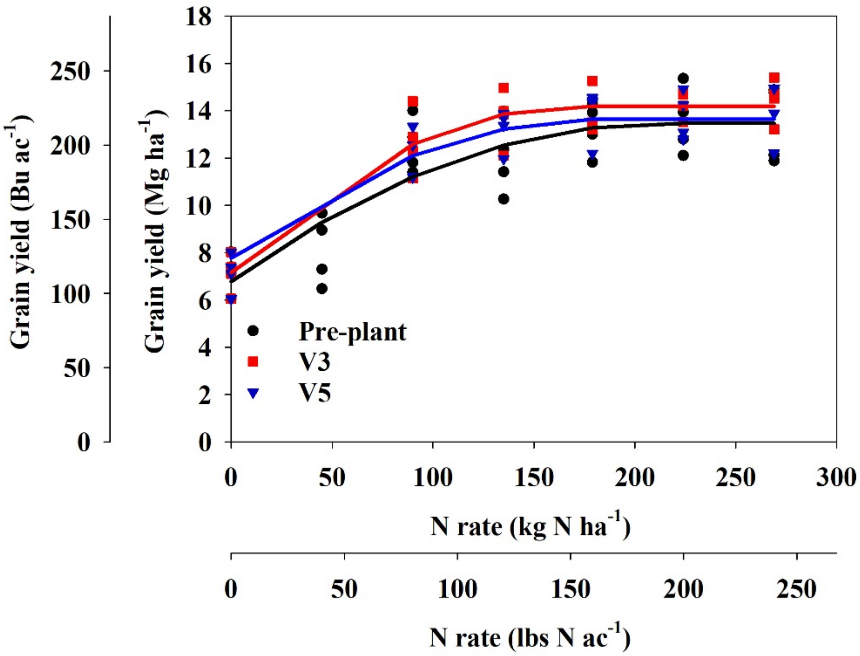

Figure 1. Grain yield reponse to nitrogen application timing and ratein 2019.

Table 2. Economic Optimum Nitrogen Rates and their associated yield

	2019	
Application timing	**Yield**	**N**
Preplant	221.99	195.48
V3	226.12	152.74
V5	217.47	157.99

†Grain price of $3.58 were used along with the fertilizer costs of $400/ton urea in 2019; a second application cost of $5.50 was factored into the split applications profitability.

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Exploring Late-Season Nitrogen Treatments in Corn in Eastern South Dakota

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and Peter Kovacs*

INTRODUCTION

Corn (*Zea mays* L) yield has steadily increased over the last few decades. Yield increase has been attributed to improved hybrids and production practices. Newer hybrids utilize more N later in the growing season (Ciampitti and Vyn, 2012). Due to increased rainfall over the past decades in eastern South Dakota split N application may increase efficiency of fertilizer.

The objective of the research is to determine if mid to late-season N application can be utilized in South Dakota to improve grain yield, and to establish the efficacy of the nitrogen fertilizer based on the timing and rate.

METHODS

One pre-plant application followed by either a V10 or V14 in-season N application were utilized to understand what ratio and timing of the fertilizer were optimum. Pre-plant applications were 60, 80 and 120 pounds of N per acre. Pre-plant applications were applied with broadcast urea (46-0-0). The in-season V10 or V14 applications were 40, 60, 80, 100, 120, and 140 pounds of N per acre. The in-season N was applied with a y-drop unit and liquid 28-0-0 fertilizer. The total N per acre equaled either 120, 160, or 200 pounds N per acre. Table 1 displays the individual preplant and in-season N rate combinations and their in-season application timing. The experiment was conducted with six rows in 30-inch row spacing and approximately 45 feet long. The center two rows were harvested with the Kincaid 8XP plot combine. The harvested yield was then adjusted to 15.5% moisture.

RESULTS

Grain yields from 2018 ranged from 141.6 bu/acre (0 N) to 210.5 bu/acre (Pre 80 and V10 80). 2019 yields ranged from 118.9 bu/acre (0 N) to 221.4 bu/acre (Pre 80 N and V10 120 N). Figure 1 shows the yield from the 2018 harvest data. The 2018 harvest data did not show differences between treatments. The 2019 harvest data is shown in Figure 2. Yields were similar among treatments in 2019 and when 2018 and 2019 treatment results were combined (Figure 3).

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Table 1: The timing and rate of nitrogen applied for 2018 and 2019 treatments.

Treatment	Pre-N Rate	In-Season Timing and N Rate	Total N
1	60	V10 60	120
2	60	V10 100	160
3	60	V10 140	200
4	80	V10 40	120
5	80	V10 80	160
6	80	V10 120	200
7	120	V10 40	160
8	120	V10 80	200
9	60	V14 60	120
10	60	V14 100	160
11	60	V14 140	200
12	80	V14 40	120
13	80	V14 80	160
14	80	V14 120	200
15	120	V14 40	160
16	120	V14 80	200

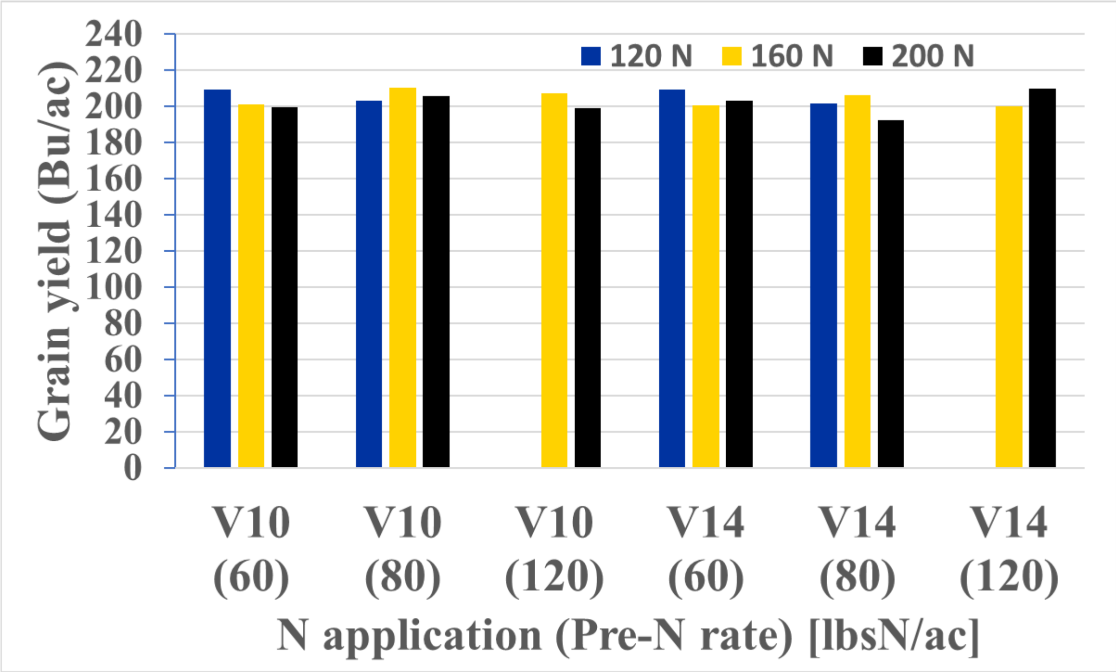

Figure 1: Late N application timing and N rate, and pre and in-season N application ratio effect on grain yield in 2018. Different colors of the bars indicate the total N applied. Late N application timing and pre plant N rate indicate on the horizontal axis.

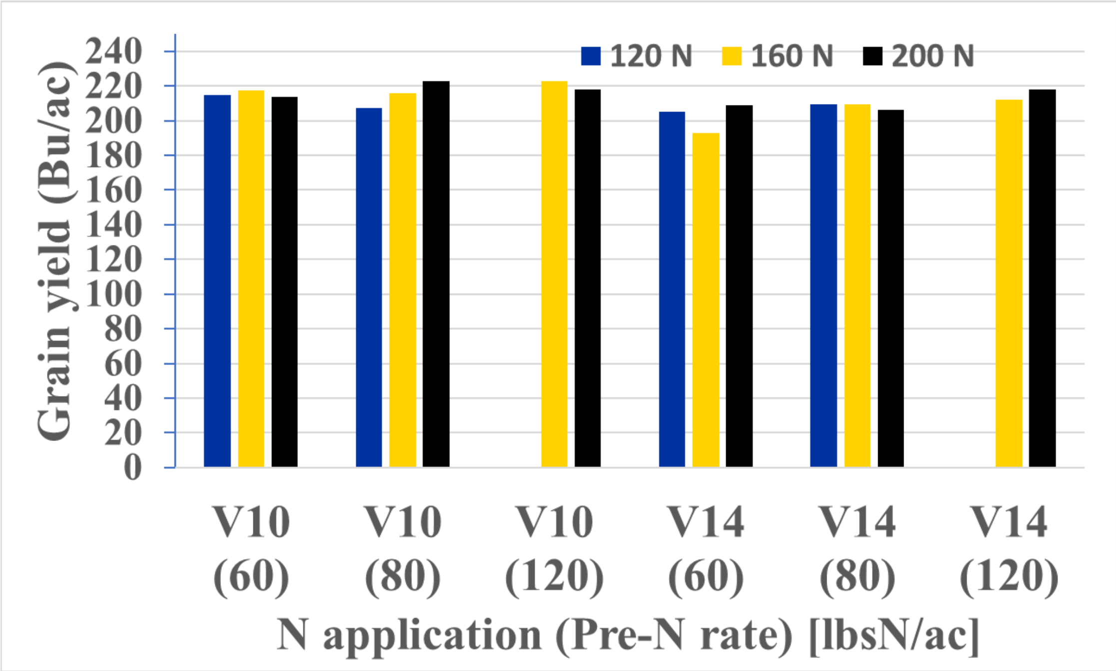

Figure 2: Late N application timing and N rate, and pre and in-season N application ratio effect on grain yield in 2019. Different colors of the bars indicate the total N applied. Late N application timing and pre plant N rate indicate on the horizontal axis.

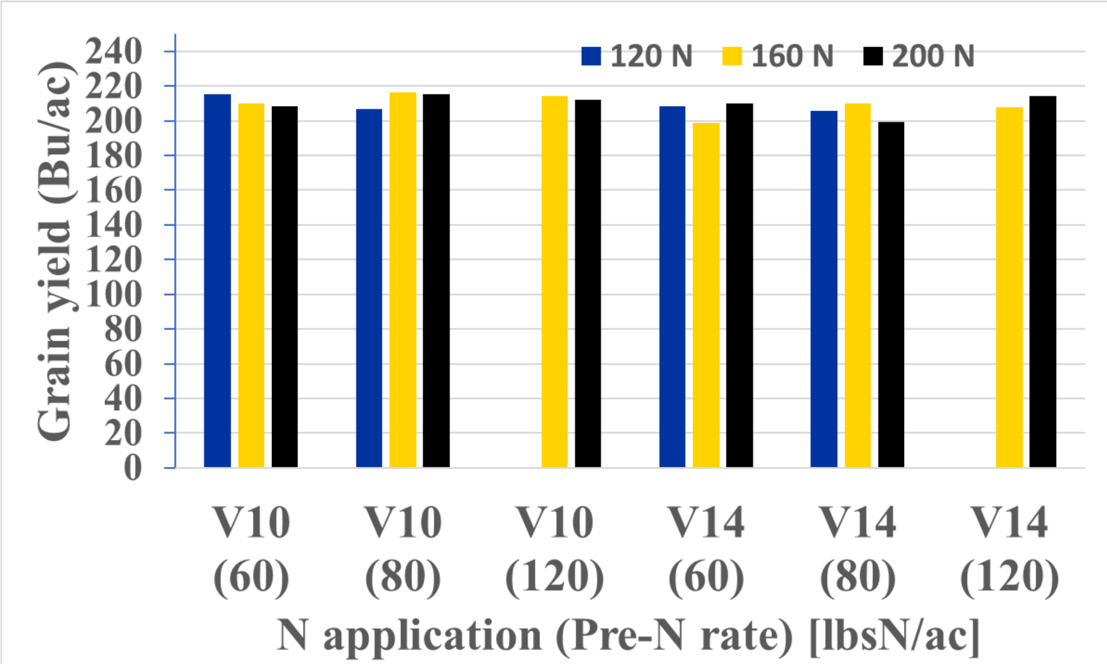

Figure 3: Late N application timing and N rate, and pre and in-season N application ratio effect on grain yield averaged across in 2018 and 2019. Different colors of the bars indicate the total N applied. Late N application timing and pre plant N rate indicate on the horizontal axis..

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In-furrow Starter Fertilizer

Kelsey Bergman and Péter Kovács*

INTRODUCTION

Conservation tillage and no-till has increased substantially in the past decade in South Dakota (NRCS, 2017)

Soils that are no-till are often cooler and wetter in early spring (Kaspar et al.,1990; Wolkowski, 2001) and when the readily available nutrients are applied close to the roots this allows the corn plants to grow quicker early in season.

There have been numerous publications investigating in-furrow or starter (2x2) fertilizer applications with conflicting results. One of the main findings is that no-till fields tended to do better with in-furrow fertilizer than conventional tilled fields. Researchers in many publications observed yield increase in no till fields (Scharf, 1999; Riedell et al., 2000; Vetsch and Randall, 2000) while others have not seen yield increases in no-till environment (Bundy and Andraski, 1999; Bermudez and Mallarino, 2002; Bermudez and Mallarino, 2004: Vyn and Jovick, 2001). A study in Nebraska (Wortmann et al. 2006) also shows no yield increase with starter fertilizer application in a field that has been tilled, except for early season growth.

The objectives of this project in Eastern South Dakota were: 1) assessing the importance of starter fertilizer placement and whether it will increase early season plant growth and improve grain yield in South Dakota environment, 2) assessing the need to apply starter fertilizer with in-season N application, and 3) comparing the effectiveness of the two starter fertilizer application methods efficiency with in-season N application approach.

MATERIALS AND METHODS

Plots were planted at 33,500 seeds per acre into a no-till field on May 16, 2018, and 32,500 seeds per acre on June 10, 2019. P0157AMX and DKC 49-72RIB hybrids were planted in 2018 and 2019, respectively. The 2019 plantings were delayed due to wet field conditions. The corn followed soybean crop [*Glycine max (L.) Merr*.]. Starter fertilizer was applied with in-furrow placement at the rate of 3.5, 6, or 11.5 lbs ac^{-1} and by 2x2" placement with the rate of 6, and 11.5, 20, and 30 lbs ac^{-1} rate, and an untreated control (Figure 1). The starter fertilizer was a 1:1:1 volumetric mix of 28-0-0, 10-34-0 and water in 2018, and a mix of 28-0-0, 6-24-6, and water in 2019. Urea fertilizer (46-0-0) was surface broadcast at planting or top-dressed at V5-V6 growth stages, at the rate that total N application (starter and urea) was 140 lbs N ac^{-1} for each plot.

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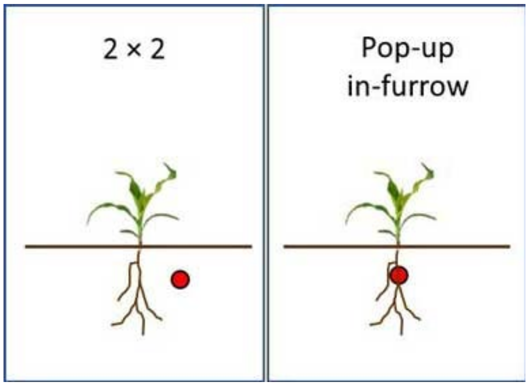

Figure 1. Example of the different fertilizer placements. On the left is starter 2x2 and on the right is the in-furrow fertilizer placement (images from Ruiz Diaz, 2019).

Plant heights were measured from the ground to the highest fully developed leaf collar on 10 consecutive plants at V5. Plant biomass was then taken at V5 growth stage in 2018 from a 6' long section of one of the central rows from each plot, and samples were taken at V7 in 2019 from 7 plants. Samples were dried, weighed, and biomass production was calculated per acre. Samples were then ground through a 1mm sieve and sent to AgSource Laboratories in Lincoln, Nebraska for analysis.

The center two rows for yield determination were harvested on October 29, 2018; and on October 30, 2019, respectively.

Biomass, and nutrient uptake results were statistically analyzed for differences in nutrient accumulations and for nutrient concentrations in the plant between the treatments. While yield was analyzed for statistical differences between the treatments and by year.

RESULTS

Table 1 shows grain yield for each treatment in 2018 and 2019. Lower grain yields in 2019 were likely due in part to the later planting of the trial. Only the (main) N fertilizer application and starter fertilizer rate interaction influenced grain yield in 2018 (Table 2). With pre-plant N application, the medium starter fertilizer rate resulted in lower yield than the other treatments with the same fertilizer application timings. With topdress N application, grain yields did not differ when starter fertilizer was applied, and only the medium starter application rate resulted in higher grain yield compared to the treatment without starter fertilizer application. In 2019, grain yield decreased when starter fertilizer applied was averaged across starter fertilizer placement and N application timing but the amount of starter fertilizer application rate did not impact yield (Table 3). The N application timing and starter fertilizer placement interactions revealed that the preplant N application and in-furrow starter fertilizer application timing lowered grain yield compared to the other treatments in 2019 (Table 4).

The V5 biomass sampling in 2018 showed the presence of N either applied as starter fertilizer or the N fertilizer; the topdress N application without starter fertilizer produced the lowest biomass compared to the rest of the treatments (Table 2). Plants were also taller with starter fertilizer (Table 3). When preplant N was applied, starter fertilizer rate and placement did not impact V5 N uptake (Table 2). However, with topdress N application, starter fertilizer application increased N uptake compared to no starter fertilizer treatment, similarly to the biomass accumulation. On the other hand for N uptake, only the high starter fertilizer rate with topdress N application resulted similar N accumulation to that of preplant N application treatments. With increasing starter fertilizer rate P uptake also increased numerically (Tables 2 and 5), however statistically lower P uptake was observed only with the topdress N timings, likely due to the lower biomass accumulation for those treatments.

Yield response to the starter fertilizer and its placement showed mixed results in 2018 and 2019. Some of the contributing factors to this are the different available starter fertilizers, hybrid differences as crop response, the different early season weather conditions, and planting time differences.

ACKNOWLEDGEMENTS

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Table 1: Starter fertilizer placement and rate effect on grain yield in 2018 and 2019 at the South East Research Farm.

N Application Timing	Starter N Placement	Starter N rate (lbs N/ac)	2018	2019
Preplant	**In-furrow**	**0**	226.81	167.10
		3.5 (low)	222.27	139.40
		6 (medium)	203.66	146.44
		11.5 (high)	235.53	137.49
	2 x 2	**6 (low)**	217.84	161.41
		11.5 (medium)	206.30	152.18
		20 (high)	233.98	162.04
Topdress	**In-furrow**	**0**	208.68	167.11
		3.5 (low)	214.47	166.35
		6 (medium)	225.94	166.11
		11.5 (high)	215.42	156.48
	2 x 2	**6 (low)**	219.14	160.84
		11.5 (medium)	218.00	167.21
		20 (high)	221.60	167.04

Table 2: Fertilizer application timing and starter fertilizer rate interaction effects on grain yield, biomass accumulation, N, P, and K uptake at V5 growth stage in 2018 at the South East Research Farm.

N Application Timing	Starter N rate (lbs N/ac)	Yield (bu/ac)	Biomass (lbs/ac)	N uptake (lbs N/ac)	P uptake (lbs P/ac)
Preplant	**0**	226.81 ab	696.4 a	33.4 a	2.8 bc
	Low	220.06 bc	685.3 a	32.0 ab	2.6 cd
	Medium	204.98 d	731.0 a	33.5 a	2.7 bc
	High	234.76 a	684.9 a	32.0 ab	2.8 abc
Topdress	**0**	208.68 cd	605.5 b	24.5 d	2.4 d
	Low	216.81 bcd	680.4 a	28.8 c	2.8 bc
	Medium	221.97 b	677.5 a	29.9 bc	3.0 ab
	High	218.51 bc	737.9 a	31.5 abc	3.1 a

Table 3: Starter fertilizer rate effects on plant height at V5 in 2018, and on grain yield in 2019 at the South East Research Farm.

Starter N rate (lbs N/ac)	Plant height at V5 (")	Grain yield (2019) (bu/ac)
0	**5.96 b**	**167.11 a**
Low	**6.42 a**	**157.00 b**
Medium	**6.48 a**	**157.98 b**
High	**6.50 a**	**155.76 b**

Table 4: Fertilizer application timing and starter fertilizer placement interaction effects on grain yield in 2019 at the South East Research Farm.

N Application Timing	Starter N Placement	Grain yield (2019) (bu/ac)
Preplant	**In-furrow**	**147.48 b**
	2 x 2"	**160.55 a**
Topdress	**In-furrow**	**164.14 a**
	2 x 2"	**165.68 a**

Table 5: Starter fertilizer placement and rate interaction effects on P uptake at V5 growth stage in 2018 at the South East Research Farm.

Starter N Placement	Starter N rate (lbs N/ac)	P uptake (lbs P/ac)
In-furrow	**0**	**2.6 c**
	Low	**2.7 bc**
	Medium	**3.0 ab**
	High	**2.8 bc**
2 x 2”	**0**	**2.6 c**
	Low	**2.7 bc**
	Medium	**2.7 bc**
	High	**3.2 a**

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SOUTHEAST RESEARCH FARM ANNUAL REPORT
South Dakota State University
2019 Progress Report
Agricultural Experiment Station
Plant Science Department
South Dakota State University, Brookings, SD 57007
Southeast Research Farm, Beresford, SD 57004

Sulfur Source and Application Timing Effect on Soybean Yield

Péter Kovács*

Stricter environmental/emission regulations for industrial companies and lower emission levels from vehicles during the past few decades have decreased the S pollutant emission levels. In addition, sulfur removal through grain has also increased in newer soybean varieties due to their greater yield. There are also numerous reports of visual sulfur deficiency in corn and/or soybean throughout the Midwest along with research studies that reported crops having a yield response to S application.

GOALS AND OBJECTIVES

The goal of the project is to investigate if there is yield response to S fertilizer in soybean. Specific objectives are 1) determine if S source and rate affect soybean yield response and nutrient uptake, and 2) determine if S application timing affects yield response to fertilizer application.

S sources studies

Pre-plant soil test indicated 30.6 lbs ac^{-1} SO_4-S levels in the top 2' soil (Table 1). Using the SD Fertilizer recommendation guide this would categorize soil S levels as high. Three different sulfur sources were used in these trials, ammonium-sulfate (21-0-0-24S), Microessential (MES10; 12-40-0-10S), and Tiger XP (0-0-0-80S) fertilizers. The latter two sources contained combination of elemental sulfur and sulfate sulfur in the fertilizers. 5, 10, 20, and 30 lbs S ac^{-1} rate was applied, and supplemental N and P fertilizers were applied to provide equal amounts nutrients within the same S rates. Fertilizers were broadcast applied immediately following planting. At Beresford, AG20X7 was planted on May 16, 2019, and the same variety was replanted on June 8, 2019.

Grain yields presented in Figure 1. Neither S source nor applied S rates influenced grain yield (Figure 1).

Harvest stand did not differ at either location among treatments (Table 2). Similarly to the grain yield, grain protein and grain oil did not differ due to the different S sources or S rates (Table 2).

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Table 1. Pre-plant soil chemical properties for the S Sources study near Beresford, SD (SERF) in 2019.

Soil Parameters	SERF 0-6"	6-24"cm
Soil pH	6.2	7.9
Organic matter (%)	3.1	2.3
NO_3-N (ppm)	8.0	7.0
Bray-1 P (ppm)	18.7	6.6
SO_4-S (ppm)	3.3	4.0

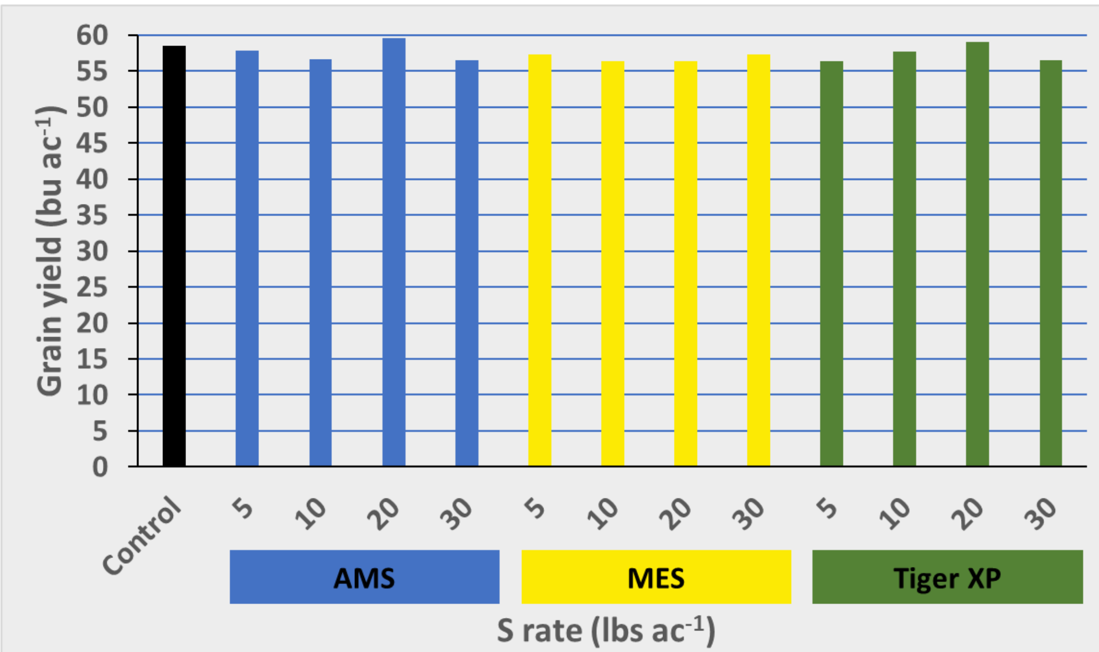

Figure 1. S sources and S rate effect on grain yield in 2019 near Beresford, SD

Table 2. S sources and S rate effect on grain protein and oil concentration and harvest stand in 2019 near Beresford, SD

S Sources and Rate (lbs ac^{-1})	Protein (%)	Oil (%)	Harvest stand (plants ac^{-1})
Control	33.6	18.8	115,800
AMS 5	33.5	19.0	116,200
AMS 10	33.4	19.0	111,500
AMS 20	33.8	18.8	114,200
AMS 30	33.5	18.8	115,200
MES 5	33.5	18.9	111,200
MES 10	33.2	19.0	113,500
MES 20	33.5	18.8	118,800
MES 30	33.8	18.8	118,800
Tiger XP 5	33.4	19.0	118,500
Tiger XP 10	33.9	18.8	116,800
Tiger XP 20	33.6	18.9	115,200
Tiger XP 30	33.5	18.9	113,200
p<F			
S Source	0.88	0.75	0.85
S Rate	0.88	0.18	0.96
S Source x S Rate	0.43	0.76	0.80

<u>*S Season studies*</u>

Pre-plant soil test indicated 90 lbs ac^{-1} SO_4-S levels in the top 2’ soil (Table 3). Using the SD Fertilizer Recommendation Guide this would categorize soil S levels as very high, respectively at the two sites. Five different sulfur application timings and their combinations were applied using ammonium-sulfate (21-0-0-24S) fertilizer. 5 lbs S ac^{-1} one time application rate was applied at pre-plant V4 (four fully expanded trifolate), R2 (full bloom), R3 (beginning pod), R4(full pod) growth stages, and combination of two 5 lbs ac-1 at a time application combinations (V4+R2, V4 + R3, and R2 + R3 compared to pre-plant 10 lbs S ac^{-1} rate). In addition, an unfertilized treatment, and V4 S application with micronutrient package (32 fl. oz ac^{-1} Brandt Quattro) was also included in the study. Pre-plant treatments were broadcast applied immediately following planting while in-season treatments were foliar sprayed at 15 GPA rate. AG20X7 variety was planted on May 16, 2019, and the same variety was replanted on June 8, 2019.

Grain yield, grain protein, and oil concentration were not different due to treatments in 2019 (Table 4). Even though statistical differences were not detected, grain yield ranged from 52 to 58 bu ac^{-1} near Beresford.

No response to added fertilizer was likely explained by the initial high soil S test levels at this field in 2019.

Further data analysis for biomass accumulation, and nutrient uptake will be continued for both studies.

Table 3. Pre-plant soil chemical properties for the S application timing study near Beresford, SD (SERF) in 2019.

Soil parameters	SERF 0-6”	6-24”cm
Soil pH	6.9	7.6
Organic matter (%)	3.1	2.9
NO_3-N (ppm)	5.5	6.8
Bray-1 P (ppm)	22.0	14.5
SO_4-S (ppm)	6.0	13.0

Table 4. S application timing and rate effect on grain yield, grain protein and oil concentration, and harvest stand near Beresford, SD in 2019.

S timing	Grain yield (bu ac^{-1})	Protein (%)	Oil (%)	Harvest stand (plants ac^{-1})
Control	58.18	33.4	19.0	117,500
Pre-plant (5 lbs ac^{-1})	55.47	33.5	18.9	107,500
V4	56.97	33.6	18.8	106,200
R2	58.11	33.7	18.9	118,200
R4	56.99	33.6	18.8	106,900
R5	52.78	33.1	18.9	105,600
V4 + micronutrients	57.82	33.9	18.8	114,800
Pre-plant 10 (lbs S ac^{-1})	55.98	33.8	18.8	109,500
V4 + R2	58.41	33.6	18.8	113,200
V4 + R4	55.29	33.7	18.8	118,200
R2 + R4	55.29	33.3	19.0	114,500
***p*<F**				
Application timing	0.35	0.51	0.79	0.08

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SOUTHEAST RESEARCH FARM ANNUAL REPORT
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Southeast Research Farm, Beresford, SD 57004

SDSU Biophysics and Hydrology Lab: Project Report from Research Plots located at the SDSU Southeast Research Farm

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Project 1. USDA-CAP Site

An experiment was initiated in 2016 to study the impacts of cover crops and grazing under integrated crop livestock (ICL) system on soil properties and greenhouse gas fluxes at South-east Research Farm of South Dakota State University. The treatments were imposed in the year 2016 as three phases viz. maize, soybean and oat phase. The maize phase included two levels i.e. maize only (M) and maize followed by grazing (ICL_M); soybean phase included two levels i.e. soybean only (S) and soybean followed by grazing (ICL_S); oat phase included three levels i.e. oats only (O), oats followed by cover crops (O+CC) and oats followed by cover crops and grazing (ICL_{O+CC}) in a randomized complete block design with four replications. The results showed that soil pH, electrical conductivity, soil organic carbon and total nitrogen did not differ between ungrazed and grazed treatments under all the phases. The bulk density (BD) of 0-5 cm of the soil profile for the ungrazed and grazed treatments under maize, soybean and oat phase ranged between 1.18 to 1.33 g cm^{-3}. In maize phase, M (1.18 g cm^{-3}) and ICL_M (1.20 g cm^{-3}) treatments had similar BD; however, in soybean phase, S had significantly lower BD (1.24 g cm^{-3}) than the ICL_S (1.33 g cm^{-3}). There were no significant differences observed in BD between O, O+CC and ICL_{O+CC} in oat phase. Similarly, soil penetration resistance was significantly lower in S (0.68 MPa) as compared to ICL_S (0.92 MPa) in soybean phase, however no significant differences were recorded in maize and oat phase. In maize phase, ICL_M had similar cumulative CO_2 and N_2O fluxes as that of M in 2016, 2017 and 2018. In soybean phase, cumulative CO_2 fluxes were not affected by soybean grazing (ICL_S) in 2016 and 2017; however, in 2018, ICL_S had significantly lower cumulative CO_2 fluxes (2584 kg C ha^{-1}) as compared to S (3176 kg C ha^{-1}). The cumulative N_2O fluxes were not affected by soybean grazing (ICL_S) in all the three years. In oat phase, similar cumulative CO_2 fluxes were observed among ICL_{O+CC}, O+CC and O in 2016, 2017 and 2018. The cumulative N_2O fluxes were observed among ICL_{O+CC}, O+CC and O in 2016 and 2017, however, in 2018, ICL_{O+CC} had significantly lower cumulative N_2O fluxes (2048 g N ha^{-1}) as compared to O+CC (2767 g N ha^{-1}). This study showed that in general, integrated crop livestock system does not negatively impact soil physical properties and greenhouse gas fluxes.

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Deliverables

Publication(s)

- **Dhaliwal, J.K.**, Abagandura, G.O. and Kumar, S. (2019). Short-term impact of integrated crop-livestock system on soil surface greenhouse gas fluxes in maize-soybean-oat rotation. (In preparation)

Oral presentation(s)

- **Dhaliwal, J.K.**, Singh, N., Abagandura, G.O., Sekaran, U. and Kumar, S. 2019. Short-Term Cover Crops and Grazing Under Integrated Crop-Livestock System Do Not Negatively Impact Soil Surface Greenhouse Gas Fluxes. Oral Presentation at the ASA-CSSA-SSSA. International Annual Meeting at San Antonio, TX, November 10-13, 2019.

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Project 2: Long-term Rotation and Tillage Plots / Field 302

In this project, we are exploring potential of small grains (e.g. wheat and oat) and winter cover crops (CC) as a management alternative to diversify cropping systems in the region. Rotations, tillage and cover cropping were respectively assigned as main-plot, sub-plot and sub-sub plot factors. The final plot size is 10 m wide by 30 m long. The three crop rotations [corn-soybean (2-yr), corn-soybean-oat (3-yr), and corn-soybean-oat-winter wheat (4-yr)] and two tillage systems [no-till (NT) and conventional-till (CT)] at the site were initially established beginning in 1991, and cover cropping [cover crop (CC) and no-cover crop, (NC)] was initiated following the main crops harvest in the fall of 2013.

Physical & Hydrological Properties: Before the fall tillage operation, intact soil core samples were collected in the fall of 2015 after maize and soybean harvest for 0–7.5 and 7.5–15 cm soil depths and analyzed for soil water retention (SWR), pore size distribution, bulk density (BD). Our results showed that NT with 4-year rotation had the lowest BD under maize and soybean phases (1.21 and 1.19 g cm^{-3} respectively) compared with the CT system. Similarly, soils managed under NT with 4-year rotation in the soybean phase retained 27, 28, 28, 32, 33, 31 and 26% more water compared with CT and 4-year system at 0–7.5 cm depth at 0, –0.4, –1.0, –2.5, –5.0, –10 and –30 kPa matric potentials respectively. In situ-demonstrations, such as water infiltration (qs) and soil penetration resistance (SPR) were also conducted. Our results indicate that NT had 31% greater qs than CT system under4-year rotation. Similarly, NT with 4-year rotation decreased SPR by 20% compared to CT with 4-year rotation in the soybean phase. In conclusion, data from these demonstrations showed that diversified crop rotation under NT enhanced soil physical and hydrological properties compared with CT with less diverse systems (e.g. maize–soybean).

Soil Biochemical Properties: Soil samples were collected in the maize and soybean phases at planting and harvest in 2016 at surface depth (0–7.5 cm). A significant tillage x rotation interaction was observed for all the parameters. At planting, under the maize phase, NT with the 4-yr rotation increased microbial biomass carbon by 86% and nitrogen by 20% compared with the same cropping system (4-yr) under CT. The hot-water-extractable carbon fraction under NT was, respectively, 19, 27, and 71% higher at maize harvest, soybean planting, and soybean harvest than under CT. Urease activity under the 4-yr rotation with NT was 55% higher than that under the 2-yr rotation with NT and almost doubled that under the 4-yr rotation with CT. Beta-glucosidase enzyme activity was higher under the 2-yr cropping system with NT than in the other treatments at planting and harvest in the maize phase. In conclusion, diverse cropping system (maize–soybean–wheat–oat, the 4-yr rotation) managed with NT could benefit soil health by improving MBC, MBN, hot-water-extractable C, and urease and b-glucosidase enzyme activity.

On-going experiments

Green House Gas Emissions: Since summer of 2017, the greenhouse gas flux measurements were conducted on vegetation season of corn and soybean from 2-yr and 4-yr rotation managed with NT system. The CC treatments were also included in this study. The objective was to understand greenhouse gas potential when CC residues were incorporated into soil. We are planning to continue these flux measurements for coming years.

Moisture and Temperature dynamics: Similarly from 2017, our research group is also measuring the soil water and temperature dynamics. The plots selected are managed with NT and CC treatments. We installed the sensors at different depths up to 60 cm. Soil moisture, water retention rods and temperature sensors were installed in PVC pipes protected with watchdogs. The objective of the study was to understand soil water improvements with use of cover crops in NT and corn/soybean and corn/soybean/oats/winter wheat rotation.

Economic analysis: The objective of this 6-yr study (2014 to 2019) is to determine profitability of cropping systems featuring three crop rotations: (corn-soybean), (corn-soybean-oats), and (corn-soybean-oats-winter wheat); two tillage systems: NT and CT, with and without cover crop treatments. Annual enterprise budgets were assembled based on field data (seeds, fertilizer, pesticides, machinery operations, and crop yield) collected over the 6-yr period of the study. Machinery operations costs, charges of fertilizer application, as well as pre and post harvesting charges, were determined for each rotation within each tillage system, using average North Dakota custom rates for the 6-yr period [Haugen, 2016].

Deliverables

Publications

- Alhameid A., **J. Singh**, U. Sekaran, S. Kumar, E. Ozlu, and S. Singh (2019) Crop rotational diversity impacts soil physical and hydrological properties under long-term no- and conventional-till soils. *Soil Research*, https://doi.org/10.1071/SR18192
- Alhameid A., **J. Singh**, U. Sekaran, S. Kumar, and S. Singh (2019) Soil Biological Health: Influence of Crop Rotational Diversity and Tillage on Soil Microbial Properties. *Soil Science Society of America Journal*, 83(5), pp. 1431-1442.
- Maiga, A., A. Alhameid, S. Singh, A. Polat, **J. Singh**, S. Kumar, and S. Osborne (2019) Responses of soil organic carbon, aggregate stability, carbon and nitrogen fractions to 15 and 24 years of no-till diversified crop rotations. *Soil research*, 57(2), pp. 149-157.

Oral presentations at ASA-CSA-SSSA annual conference at San Antonio

- **Singh J.**, N. Singh, S. Kumar, and P. Sexton (2019) Computed tomography-measured soil pores, and selected hydrological and physical properties as influenced by different rotations, tillage, and cover crop management. "Embracing the Digital Environment" ASA-CSSA-SSSA annual meeting, San Antonio, TX.

- **Singh J.**, N. Singh, U. Sekaran, G.O. Abagandura, J.K. Dhaliwal, S. Kumar, and P. Sexton (2019) Responses of soil microbial community structure and greenhouse gas fluxes to crop rotations that include winter cover crops. "Embracing the Digital Environment" ASA-CSSA-SSSA annual meeting, San Antonio, TX.

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Project 3. Compost experiment-Impacts of Organic Soil Amendments on Greenhouse Gas Fluxes and Plant Yield in South Dakota

The atmospheric concentration of greenhouse gases (GHG) carbon dioxide (CO_2), nitrous oxide (N_2O) and methane (CH_4)) is increasing. Organic soil amendments can affect soil organic carbon and nitrogen and microbial activity which can affect the emission of these GHG. The magnitude of GHG emissions will be influenced by the rate and type of these organic amendments. This study was conducted in Beresford, SD to investigate the impacts of different rates of compost and manure on GHG fluxes and plant yield from soils managed under continuous corn (*Zea mays* L.) in 2018 and 2019. The experimental site has 24 plots with 4.6 to 20 m dimensions into complete randomized block design. The treatments included three compost application rates [5600 kg ha^{-1}, 11200 kg ha^{-1}, and 16800 kg ha^{-1}], two manure rates [2240 kg ha^{-1} and 4480 kg ha^{-1}], along with control replicated four times. The manure and compost were applied in the spring of 2018 and 2019 in a manual application and incorporated at the soil surface one to three days after planting. The GHG fluxes were observed once a week during the 2018 growing season. Soil water content and temperature are measured at each time of GHG sampling. Cumulative fluxes will be calculated using linear interpolation. At harvest, soil samples were taken in 2018 and 2019 to measure total carbon and total nitrogen. Grain and biomass samples were also collected in these two years. Data will be analyzed using Mixed Model analysis in PROC MIXED. In this study, we hypothesized that organic amendments would increase the amount of carbon and nitrogen stored in the soils and increase yield thus they may reduce GHG emissions. However, the response of GHG emission to these amendments may vary depending on the type and rate of these organic amendments. Few studies addressed the effects of manure application on GHG emissions with a comparison to compost.

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Project 4: Manure experiment-Carbon and Nitrogen Pools as Affected by Long-term Manure Application in Corn-Soybean Rotation

With an objective to understand the long-term effects of different rates of manure and synthetic fertilizer on soil carbon (C) and nitrogen (N) pools in corn-soybean cropping system, a study was conducted at Beresford, South Dakota. Treatments included three manure application rates: low (LM), medium (MM), and high manure rate (HM)), two synthetic fertilizer application rates: medium (MF) and high fertilizer rate (HF), and a control (CK; neither manure nor synthetic fertilizer was applied) replicated four times. Soil samples were collected from 0-10 and 10-20 cm soil depths in 2018 to measure permanganate oxidizable C, microbial biomass C and N, dissolved organic C and N, particulate organic C and N, and C and N mineralization. Further, carbon management index (CMI) was calculated from this data. On average, manure treatment had higher soil C and N pools as compared to synthetic fertilizer and control. At 10-20 cm depth, HM had 113% and 98% higher DOC than MM and LM, respectively, and 215% higher DON compared to LM. The principal component analysis showed that manure rate has a significant influence on the majority of C and N pools. No significant differences on C and N pools were observed between the synthetic fertilizer and CK treatments. Therefore, this study suggests that manure application can be beneficial to enhance C and N pools compared to synthetic fertilizer and zero fertilizer application.

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South Dakota State University
2019 Progress Report
Agricultural Experiment Station
Plant Science Department
South Dakota State University, Brookings, SD 57007
Southeast Research Farm, Beresford, SD 57004

Exploring a New Microbial Pathway for Nitrate Control using Cover Crops and Bioreactors at the Southeast Research Station

Shin-Yi Marzano* and Michael Lehman

SUMMARY High N fertilizer application to support corn production can result in nitrate leaching into waters which causes eutrophication. Some commercial corn/soybean producers use cover crops to increase nutrient retention, although there is some concern that nutrient leaching, especially phosphorus, may occur during cover crop decomposition. An unexplored biological pathway for nitrate retention in agricultural soils is dissimilatory nitrate reduction to ammonium (DNRA), a process recently found to be present in agricultural soils with varying degrees. DNRA can also be coupled with anaerobic ammonium oxidation (anammox) to remove nitrogen from tile drainage water. Managing agricultural soils to optimize cover crop benefit and the DNRA- anammox process that competes with nitrification are promising approaches for the control of nutrient leaching. By retaining soil N, available nitrogen to crops will be increased while mitigating the environmental impacts from leached N. The field plots are in a corn and soybean rotation with or without rye cover crops. Soil and plant samples were collected for analysis before and after decomposition of rye in the field, and by varying the timing of suppression in the greenhouse. We hypothesize that microbes capable of biological nitrification inhibition (BNI) are enriched in corn rhizospheric soil.Soil samples associated with corn roots are being characterized for the abundance for N cycling genes. Soil health indicators including soil protein, permanganate oxidizable carbon, enzyme activities, and carbon mineralization activity are being measured. In the two years since the rye cover crop treatments were applied, soil health measures have progressively improved in response to cover crop treatments. Multivariate statistical analyses will determine drivers of nutrient leaching and BNI effect. The ***goal*** of the project is to improve understanding about the importance of cover crop decomposition and microbial processes in nutrient leaching and retention in SD agricultural soil. Data collected in this reporting period are summarized below:

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Objective 1. Determine the BNI effect of rye on soil health.

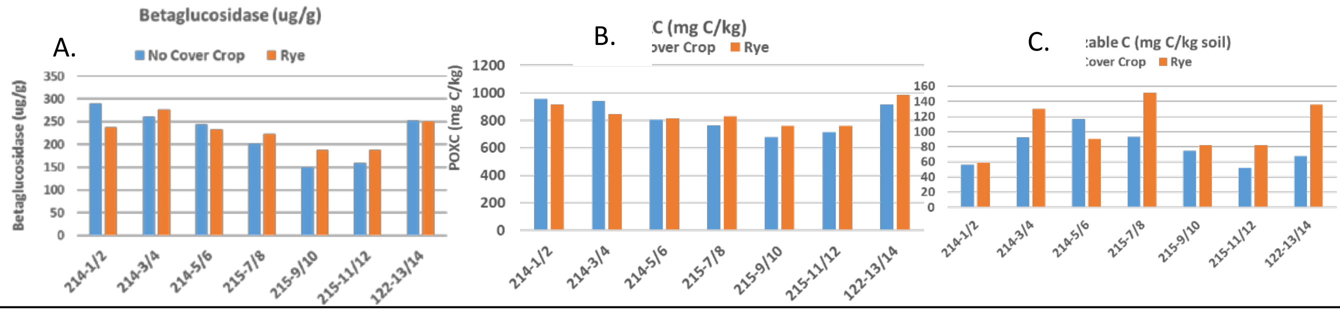

Figure 1. Soil heath indicator measurement. (A) Soil β-glucosidase enzyme activity (P=0.8) (B) Soil oxidizable carbon (P=0.72) (C) Soil mineralizable carbon (P=0.13) were measured from May 2018 samples.

In 2018, even though there were increases in rye-treated plots for the levels of soil protein, soil oxidizable carbon, and mineralizable carbon compared to the control without the cover crop treatment, the differences were not significant statistically (P>0.10) (Figure 1). However, in 2019, after two years of rye cover crop, the protein level accumulatively increased significantly, which measures the bioavailable N (P=0.005) (Figure 2).

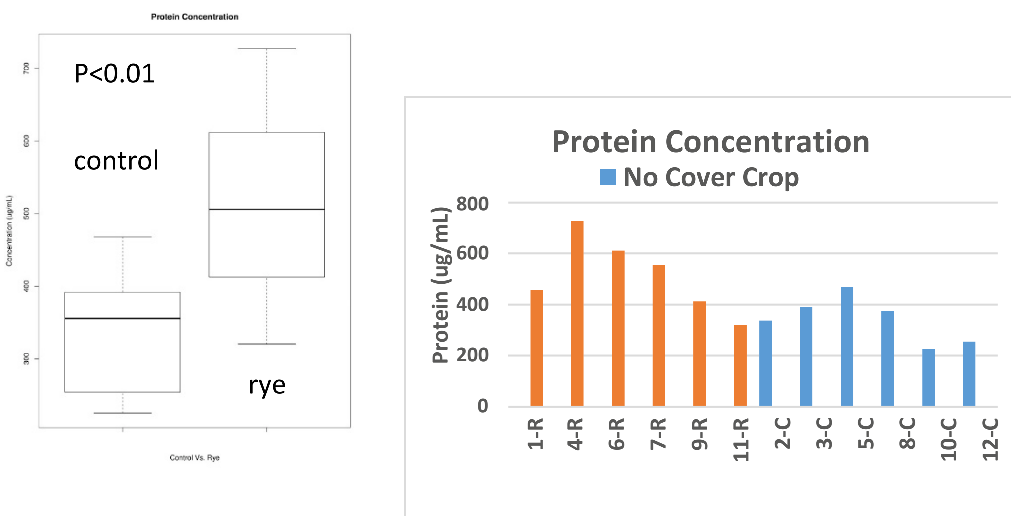

Figure 2. Available N increased significantly after two years of rye treatment in Beresford, SD site.

Objective 2. Determine the BNI effect of rye on N-cycling genes

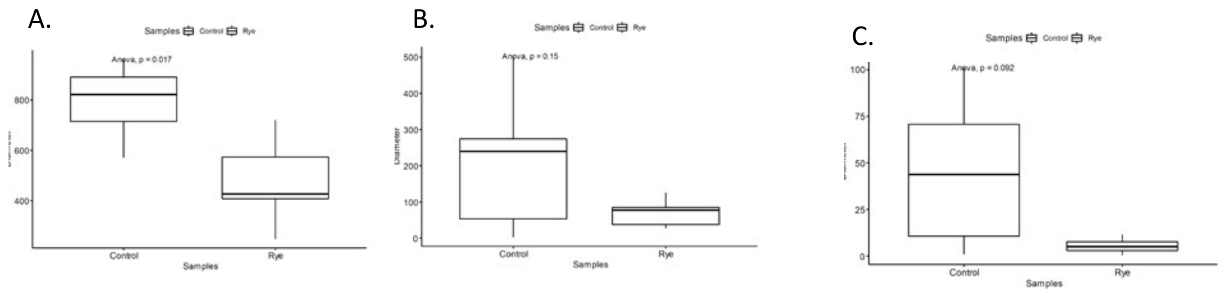

Figure 3. Rye reduces (A) hao enzyme produced by proteobacterial AOB-ammonia oxidizing bacteria responsible for nitrification; (B) *Nitrospira* population (NxrBF) responsible for nitrite oxidation in the second step of nitrification; (C) archaeal amoA (ammonia monooxygenase).

We quantified the amount of N-cycling genes from May 2019 samples, among which 3 genes showed a significant increase in the rye treated plots (Figure 3).

<u>Work yet to be accomplished</u>

Soil samples were taken recently in October 2019 for soil health which requires time to do the analyses. We also plan on taking another soil sample in May 2020 to compare the soil health and N-cycling genes. Rye treated plots showed a reduction in nitrification corresponding to archaeal population. We would like to confirm this finding with the 2020 sampling. This was a three-year project but now the third year is not renewed, so we request more time to finish the work that ties to the timing of the field sampling in 2020. The impact of this work is to demonstrate that rye cover crop plays a role of biological nitrification inhibition (BNI) in our Beresford, SD experimental site as we speculated. Including cover crop such as rye with BNI effects will help shift the existing production system towards a low-nitrifying production system to reduce unintended and unknown consequences on the environment of massive injections of N-fertilizer into agricultural systems.

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2019 CORN FOLIAR FUNGICIDE TRIALS

Dalitso Yabwalo*, Connie Tande and E. Byamukama

INTRODUCTION

Common leaf diseases of corn in South Dakota include gray leaf spot (*Cercospora zeae maydis*), common rust (*Puccinia sorghi*), southern rust (*Puccinia polysora*), anthracnose (*Colletotrichum graminicola*), eyespot (*Aureobasidium zeae*), and northern corn leaf blight (*Exserohilum turcicum*). These diseases rarely reach critical economic injury levels in South Dakota, even though the 2018 season did have moderately severe levels that occurred quite late in the season.

Prevalence of foliar diseases may raise the risk for stalk rots, ear rot, and lodging leading to potential losses. The extent of disease severity is a direct result of management style, presence of inoculum, and optimum weather conditions for the pathogens to thrive. Different pathogens prefer different conditions; nonetheless, wet and humid conditions are preferred by most pathogens.

There are several strategies for disease prevention and management such as crop rotation, and cultivar selection. However, when disease pressure threatens yield and quality, fungicides may be used to manage corn foliar diseases effectively. Fortunately, the availability of resistant cultivars and better management has helped reduce disease epidemics in South Dakota. Corn fungal diseases occur less frequently and when they do occur, the intensity is often too low to justify fungicide use.

Disease monitoring and evaluation of different disease management strategies is important. Continuous testing of efficacies of various fungicides is critical, as knowledge generated from such tests is useful in times of extensive disease occurrences. This study was aimed at evaluating the efficacy of several experimental and commercially available fungicides applied at tasseling to control fungal pathogens in corn.

MATERIALS AND METHODS

An early maturing hybrid, DKC31-10 RIB, was planted at a population of 35,000 plants/acre. The trial was set up as a randomized complete block design with four blocks. All assessments were carried out on plants from the middle two rows. Fungicides were applied at tasseling, each with a 0.125% v/v nonionic surfactant. Foliar disease monitoring and data collection were conducted at 7-day intervals, stating on the 14th day after fungicide application until R5 or just before black layer formation. A generalized model was used to analyze the

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collected data with plant population per acre as a covariate for yield.

RESULTS AND DISCUSSION

Foliar Fungicide Study

There was a high stalk incidence due to environmental conditions, particularly moisture, otherwise plots were free of foliar diseases during the critical crop growth stages. As such, there were no significant statistical differences among treatments (Table 1). Nonetheless, the observed differences might have significant economic implication on large-scale production. A significant association between yield and stalk rot, *r* = -0.38, *p*=0.011, and between yield and population, *r* = -0.33, 0.027.

SUMMARY

Application of fungicides had no effect of observed results, as treatments effects were non-significant for all traits. The efficacies of various products are identifiable with high disease pressure.

ACKNOWLEDGEMENT

Thanks go to all entities that provided support for these field trials including SDSU Agricultural Experiment Station, other public and private collaborators, and staff from Southeast Research Farm.

Table 1. Corn Foliar Fungicide I: The efficacy of different products for corn foliar disease management at Southeast Research Farm.

Product[†]	Rate	Unit	Eyespot (%)		Stalk rot (%)		Population (plants/ac)		Yield (bu/ac)	
Untreated Check			0.350	*a*[‡]	12.25	*a*	21135	*a*	166.91	*a*
Exp-A	8	fl oz/ac	0.231	*a*	13.75	*a*	20006	*a*	191.44	*a*
Delaro	8	fl oz/ac	0.456	*a*	13.00	*a*	21135	*a*	184.08	*a*
Delaro Exp-B	8 2.08	fl oz/ac fl oz/ac	0.256	*a*	12.00	*a*	23877	*a*	166.69	*a*
Delaro Exp-B	12 3.08	fl oz/ac fl oz/ac	0.125	*a*	10.25	*a*	21619	*a*	187.36	*a*
Exp-C	8	fl oz/ac	0.131	*a*	8.25	*a*	24039	*a*	198.48	*a*
Exp-C	12	fl oz/ac	0.013	*a*	12.00	*a*	21457	*a*	150.02	*a*
Headline AMP	10	fl oz/ac	0.175	*a*	8.75	*a*	22748	*a*	168.31	*a*
Miravis Neo	13.7	fl oz/ac	0.363	*a*	13.50	*a*	17908	*a*	158.83	*a*
Trivapro Fungicide	13.7	fl oz/ac	0.056	*a*	11.50	*a*	24846	*a*	176.48	*a*
Propulse	13.7	fl oz/ac	0.150	*a*	10.50	*a*	24845	*a*	191.18	*a*

[†]Exp = Experimental products; A, B, C.

[‡]Means followed by the same letter are not significantly different, $p \leq 0.05$

Table 2.2 Corn Foliar Fungicide I (FF I): The efficacy of different products for corn foliar disease management at Volga Research Farm, SD

Treatment name/Rate/Time	Yield (bu/ac)		Stalk rot (%)		Rust (%)		Eyespot (%)		Stand count (plants/ac)	
Untreated	162.66	a	0.00	a	4.80	a	3.10	a	30492	a
Delaro, 8fl oz/A @VT-R2	176.11	a	0.00	a	1.58	ab	1.05	a	30336	a
Delaro, 4fl oz/A @V5-V7	178.63	a	0.00	a	1.53	ab	2.73	a	33137	a
Trivapro (A4.1 oz/A+B10.5 oz/A), 13.7fl oz/A @V5	186.70	a	0.00	a	1.85	ab	2.18	a	30337	a
Priaxor, 4fl oz/A @V5	173.89	a	0.00	a	1.20	b	1.13	a	32514	a
Fortix, 4fl oz/A @V5	165.83	a	0.05	a	1.00	b	1.95	a	29403	a
Stratego YLD, 2.5fl oz/A @V5	189.09	a	0.00	a	3.58	ab	2.30	a	32981	a
Zolera FX 3.34SC, 5fl oz/A @V5	172.12	a	0.00	a	2.45	ab	2.70	a	29870	a
Priaxor, 4fl oz/A @VT	182.37	a	0.00	a	0.93	b	0.38	a	30803	a
Fortix, 4fl oz/A @VT	164.26	a	0.00	a	1.90	ab	0.98	a	30025	a
Trivapro (A4.1 oz/A+B10.5 oz/A), 13.7fl oz/A @VT	168.76	a	0.00	a	0.58	b	0.43	a	32826	a
Zolera FX 3.34SC, 5fl oz/A @VT	203.20	a	0.00	a	0.60	b	0.78	a	30648	a

Means followed by the same letter are not significantly different, p≤0.05

Table 3.1. Corn Foliar Fungicide I (FF II): The efficacy of experimental and commercial products for corn foliar disease management applied at tasseling at Southeast Research Farm, SD

Treatment name/Rate	Yield (bu/ac)		Stand count (plants/ac)		Eyespot (%)	
Untreated Check	122.02	b	24788	a	2.84	a
Aproach prima, 6.8fl oz/ac	125.11	b	26447	a	1.56	abc
Delaro 325 SC, 8fl oz/ac	131.21	ab	24788	a	1.95	ab
Trivapro (A+B), 13.7fl oz/ac	143.04	ab	23854	a	0.92	bc
Headline AMP, 10fl oz/ac	151.51	a	26655	a	1.27	bc
A1	150.09	a	26136	a	1.04	bc
A2	142.56	ab	26240	a	0.59	bc

Means followed by the same letter are not significantly different, p≤0.05

Table 3.2. Corn Foliar Fungicide I (FF II): The efficacy of experimental and commercial products for corn foliar disease management applied at tasseling at Volga Research Farm, SD

	Treatment name/Rate	**Yield (bu/ac)**		**Stand count (plants/ac)**		**Stalk rot (%)**		**Rust (%)**		**Eyespot (%)t**	
1	Untreated Check	168.98	c	30492	ab	0.73	a	3.77	a	3.82	a
2	Aproach prima, 6.8fl oz/ac	192.63	ab	31114	ab	2.03	a	0.90	b	1.80	ab
3	Delaro 325 SC, 8fl oz/ac	188.43	ab	32774	a	0.73	a	0.90	b	2.18	ab
4	Trivapro (A+B), 13.7fl oz/ac	193.90	ab	31011	ab	0.00	a	0.78	b	1.02	b
5	Headline AMP, 10fl oz/ac	191.53	ab	29040	b	0.00	a	1.03	b	1.97	ab
6	A1	179.43	bc	29870	ab	2.76	a	1.02	b	1.35	ab
7	A2	198.15	a	31115	ab	0.70	a	0.57	b	0.67	b

Means followed by the same letter are not significantly different, $p \leq 0.05$

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2019 SOYBEAN FOLIAR FUNGICIDE TRIALS

Dalitso Yabwalo*, Connie Tande
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INTRODUCTION

Septoria leaf spot or brown spot (*Septoria glycines*), Cercospora blight and purple seed stain (*Cercospora kikuchii*), frogeye leaf spot (*Cercospora sojina*), and downy mildew (*Peronospora manshurica*) are some of the common diseases that affect soybean in South Dakota. Most of these fungal diseases rarely cause major economic injury to soybean in the state except under mono-cropping systems and favorable weather conditions. Recently, there have been reports of increasing white mold, a fungal disease caused by *Sclerotinia sclerotiorum*, which can be devastating, especially to susceptible cultivars.

Soybean foliar diseases flourish in wet and humid conditions, especially under closed or dense canopies. Pathogens overwinter in infected crop straw or soil, in one form or another, from where spores are disseminated by splashing raindrops and wind onto the leaves of healthy growing soybean plants. White mold on the other hand, thrives in wet and cool conditions with temperature ranges of 68 to 78° F. Under optimal conditions, white mold can cause devastating yield losses of up to 50% and cause reduced seed quality. These diseases can be managed by planting resistant cultivars and adopting good cultural practices. However, when disease severity reaches economic injury levels, fungicide application should be considered.

Field experiment results presented in this document were generated from research plots carried out to evaluate the efficacies of experimental products compared with existing fungicides for foliar disease management at Southeast Research Farm (SERF).

MATERIALS AND METHODS

A susceptible soybean cultivar, AG14X7, was used for the foliar fungicide evaluation study planted at Southeast Research Farm. A randomized complete block design (RCBD) with four blocks was used.

This study was seeded at 140,000 seeds/acre. Foliar disease assessments were done on 10 leaves from R4 to R6 growth stages on a scale of 0 - 100%. Disease evaluations focused on the upper third of the canopy where zero represented disease free plots and 100 meant complete plant necrosis. Whole plot ratings evaluated the relative disease symptoms for each plot on a 0-100% scale, where completely green plants in a plot were rated zero, while fully necrotic plots were rated 100.

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Collected data was analyzed using a generalized linear mixed model (Proc GLIMMIX, SAS 9.4) where treatments were regarded fixed and blocks random. Multiple comparisons of treatment means were generated with a resampling approach.

RESULTS AND DISCUSSION

1.0 Foliar Fungicide Trial

SERF & Volga

The efficacies of several commercially available fungicides for foliar fungal disease management were evaluated. There were no statistically significant differences among plots treated with various fungicides for test weight, yield and brown spot. However, whole plot frogeye assessment showed higher disease pressure on untreated check (Table 1). Disease pressure was low throughout the season; therefore, mean differences were not detected among products. However, some observed differences might have significant practical implications.

Table 1. Foliar Fungicide Study: Means for yield, test weight, brown spot and cercospora leaf spot following application of fungicides at R3 at Southeast Research Farm.

Product[†]	**Rate**	**Unit**	**Test weight (lb/bu)**	**Yield (bu/ac)**	**Brown spot (%)**	**Whole plot Brown spot (%)**	**Frogeye (%)**	**Whole plot Brown spot (%)**
Untreated			57.01 *a*[‡]	62.58 *a*	2.65 *a*	6.00 *a*	7.5 *a*	11.25 *a*
Exp-A	8	fl oz/ac	56.55 *a*	62.59 *a*	1.65 *a*	3.75 *a*	1.75 *b*	2.75 *b*
Stratego YLD	4	fl oz/ac	56.94 *a*	67.85 *a*	1.50 *a*	3.00 *a*	1.45 *b*	2.50 *b*
Priaxor	8	fl oz/ac	57.10 *a*	68.46 *a*	0.95 *a*	2.00 *a*	1.35 *b*	3.00 *b*
Fortix	4	fl oz/ac	57.31 *a*	66.53 *a*	0.95 *a*	2.50 *a*	1.65 *b*	3.75 *b*
Sonata	1	qt/ac	56.97 *a*	61.85 *a*	2.00 *a*	4.50 *a*	2.3 *b*	3.50 *b*
Cuproxat	3.9	pt/ac	57.73 *a*	66.46 *a*	1.90 *a*	5.00 *a*	1.8 *b*	4.50 *b*
Domark 230ME	4	fl oz/ac	57.37 *a*	62.29 *a*	1.25 *a*	4.00 *a*	2.3 *b*	3.50 *b*
Trivapro	13.7	fl oz/ac	57.35 *a*	65.46 *a*	0.90 *a*	3.00 *a*	0.9 *b*	3.00 *b*
Zolera FX 3.34SC	5	fl oz/ac	57.48 *a*	66.48 *a*	0.95 *a*	2.75 *a*	0.8 *b*	2.00 *b*
Delaro	8	fl oz/ac	56.57 *a*	66.09 *a*	0.95 *a*	2.50 *a*	0.95 *b*	2.25 *b*

[†]Exp-A=Experimental product A

[‡]Means followed by the same letter are not significantly different, *p*=0.05

ACKNOWLEDGEMENT

Financial and material support for these studies came from the SD Soybean Research and Promotion Council, SDSU Agricultural Experiment Station and various corporations in the ag-chemical industry. Furthermore, we appreciate the collaborative efforts from staff at Southeast Research Farm.

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SDSU Oat Breeding

Melanie Caffe-Treml*, Nick Hall, and Paul Okello

It is important that farmers have access to improved oat varieties so that their operation can benefit from a more diversified crop rotation while maintaining farm profitability. The goal of the SDSU oat breeding program is to develop new oat varieties with improved agronomic characteristics and enhanced end-use quality for both grain and forage production.

SDSU oat breeding program uses the Southeast Research Farm (SERF) as one of its multiple testing locations to ensure that new varieties developed by the breeding program are adapted to the broad range of environmental conditions encountered in the state. In 2019, more than 1500 test plots were seeded at SERF. We evaluated materials at various stages, from early generations to advanced breeding lines, as well as several regional nurseries (Uniform Early Oat Performance Nursery (UEOPN), the Uniform Mid-Season Oat Performance Nursery (UMOPN), and the Mid-Western Cooperative Nursery).

Data collected on each test plot included heading date, crown rust severity, plant height, lodging severity, grain yield, and test weight. Milling and nutritional quality evaluations were also collected on harvested samples. The data collected is used to select lines with improved agronomic performance and improved milling and nutritional quality.

The South Dakota Crop Performance Testing (SD CPT) Oat Variety trials was also evaluated at SERF. A comparison among released varieties for grain production and milling quality performance can be found at https://extension.sdstate.edu/sites/default/files/2019-10/S-0002-2019-02-Oat-Regional_Summary.pdf.

For the second year at SERF, we conducted a forage trial to evaluate the forage potential of promising breeding lines. Plots were seeded on April 26, 2019. The growing season was characterized by severe crown rust infections. Plots were harvested with a forage harvester on July 3, 2019. Results are summarized in Table 1. Average dry matter yield at SERF in 2019 ranged from 6.4 t/a (breeding line SD170935) to 3.2 t/a (Rockford). Dry matter yield was significantly negatively correlated with crown rust severity (r = -0.5). Crown rust severity (area of the leaves covered with pustules) ranged from 17.5% for cultivar Rushmore to 95% for Rockford. In environments such as SERF where crown rust infections are frequent, the use of crown rust resistant cultivars for forage production is recommended.

The development of crown rust pustules on the leaves can be very rapid (Figure 1). The window for a fungicide application on susceptible cultivar is short. Crown rust infections significantly reduce grain yield and test weight

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on susceptible cultivars. Severe crown rust infection also results in plant lodging.

Table 1. Average performance of SDSU breeding lines and cultivars in the oat forage variety trials at SERF in 2019.

Entry	Dry matter yield (t/a)	Relative heading date (days)	Plant height (inches)	Crown rust severity (%)	Relative Feed Value
SD170935	6.4	6	50.7	40	94
SD150015	6.3	3	40.0	52.5	100
SD171570	5.9	7	47.7	37.5	93
Rushmore	5.7	1	38.3	17.5	103
SD170479	5.5	4	43.7	30	103
SD171139	5.4	6	43.7	55	94
MN Pearl	5.4	5	45.0	60	106
SD120665	5.2	2	41.7	40	113
SD170174	5.2	5	45.3	52.5	98
Deon	5.1	5	46.7	45	111
SD171340	5.0	4	43.7	52.5	96
SD160455	5.0	6	48.7	75	92
Warrior	5.0	2	41.0	22.5	112
SD150012	4.9	0	43.7	30	120
SD170528	4.8	6	43.0	52.5	98
SD170295	4.8	5	44.7	45	116
SD171498	4.7	7	40.7	35	96
SD140741	4.7	3	44.7	32.5	113
SD160778	4.7	5	42.7	50	106
SD160567	4.7	6	43.0	35	107
SD150081	4.6	2	39.0	75	99
Goliath	4.6	5	48.3	77.5	99
SD170963	4.6	5	44.3	32.5	100
SD150270	4.5	4	42.7	52.5	91
SD170970	4.5	5	44.0	30	112
SD160201	4.5	4	46.7	35	108
SD150020	4.4	1	39.3	52.5	110
Jerry	4.2	3	42.3	80	106
Hayden	4.0	3	41.3	82.5	99
Stallion	4.0	5	45.3	45	100
SD150112	4.0	0	41.7	32.5	91
Newburg	3.7	4	44.3	90	91
SD171438	3.7	4	40.7	62.5	101
Natty	3.7	1	43.0	75	117
Rockford	3.2	5	40.0	95	95
Mean	4.8	4	43.5	50.8	102.6

Figure 1. Rapid development of crown rust pustules on the leaves of susceptible cultivar Horsepower.

A new oat cultivar 'Rushmore' was released by the South Dakota Agricultural Experimental Station in fall 2019. Rushmore was derived from the cross SD080015//SD070110/SD060130. Rushmore was evaluated as experimental line SD140515 in the UEOPN and in the SD CPT Oat Variety Trials. Over 25 environments in the SD CPT Oat Variety Trials, Rushmore ranked third for grain yield and second for test weight. Average grain yield for Rushmore was 99 bu/ac in comparison to 92 bu/ac for Hayden. Average test weight was 34.7 lb/bu for Rushmore in comparison to 33.9 lb/bu for Hayden. Rushmore reaches heading approximately 1 day earlier than Hayden. Plant height is similar to Hayden with improved lodging resistance over Hayden. Disease resistance for Rushmore is better than Hayden. Rushmore is resistant to moderately resistant to crown rust, and moderately resistant to BYDV and smut. Rushmore exhibits good milling characteristics. Hull color for Rushmore is white.

Through support from General Mills Foundation, an oat variety trial under organic management was conducted at SERF. The trial was underseeded with medium red clover. Grain yield and test weight are reported in Table 2. Grain yield ranged from 25.5 bu/ac (Souris) to 101.7 bu/ac (SD160067). Test weight ranged from 26.6 lb/bu (Excel) to 39 lb/bu (Antigo). Cultivar Sumo was among the high yielding group and produced grain with high test weight. Sumo is resistant to crown rust.

Table 2. Grain yield and test weight of entries evaluated in the organic oat variety trial.

Entry	Yield (bu/ac)	Test weight (lb/bu)
SD160067	**101.7**	35.6
SD140741	**100.5**	36.6
MN Pearl	**88.7**	35.5
Sumo	**85.7**	37.8
SD150012	**83.2**	37.5
SD150081	81	36.1
SD160778	78.9	34.2
SD160240	75.7	35.8
Saddle	72.8	36.7
SD150515	71.9	34.9
Deon	71.6	35.1
Warrior	71.4	36.1
Reins	70.6	34.6
Leggett	70.3	35.2
Betagene	70	32.8
Antigo	69.4	39
SD150112	64.3	36.9
Goliath	63.9	32.8
SD120665	63.9	38.2
Badger	63.5	35.3
SD150270	57.7	36.7
Natty	57.2	35.9
Hayden	47.5	30.1
Shelby 427	46.8	33.4
Excel	44.8	26.6
Newburg	39.9	30.3
Saber	35.6	36.9
Jerry	31.1	29.3
Rockford	26.4	26.4
Souris	25.5	31.3
Trial Average	64.4	34.5
LSD (0.05)	18.1	3.8
CV%	17.2	6.8

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SOUTHEAST RESEARCH FARM ANNUAL REPORT
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Plant Science Department
South Dakota State University, Brookings, SD 57007
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Herbicide Residual Effects on Cover Crops after Wheat and Corn Silage at Southeast Research Farm

Gared Shaffer*, Anthony Bly, David Karki, Ruth Beck, Sara Bauder, and Paul Johnson

Interest in cover crops among South Dakota crop growers has increased in recent years. Producers have realized the need for scientific information on residual effects of commonly used herbicides on cover crops for proper incorporation of these species into their cropping systems. Therefore, it is imperative that information about herbicide residuals effects on cover crops is investigated in South Dakota. Surrounding states that include Minnesota, Iowa, Nebraska and Wisconsin have researched this topic to give their producers educational opportunities in learning how to integrate cover crops into their operations (Bosak 2014; Hartzler, B. and others 2015; Stahl 2016; Jhala and others 2016).

At the SDSU Southeast Research Farm this research observed commonly sprayed residual wheat herbicides and corn herbicides that where applied on wheat and corn from label recommendations. After wheat harvest cover crops were drilled and four weeks later stand counts where taken. There were no additional herbicides applied to the plots except glyphosate.

In 2018 wheat treatments, it was found at the Southeast Farm that there were significant differences between treatments in the Pearl Millet cover crop (Table C). It was found in the 2019 wheat treatments that radish cover crop had significant differences (Table F). Neither year in corn silage treatments, 2018 or 2019, showed any significant differences between treatments; P value set at .05, (Table J thru Table R). Across both research trials and both years, there were numerical differences within the treatments showing effects of certain active ingredients on certain cover crops. This also may be due to weather differences across both years. Germination was affected for some cover crop species by adverse field conditions in our silage treatment area in 2018. No post emergent herbicides were applied on corn silage treatments in 2018 due to weather, as you can see in the data.

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Table A		
Herbicides Applied 2018/2019 SE Farm Wheat		
Trade Name	Active Ingrediant(s)	Rate (acre)
Prowl H2O	Pendimemethalin	3 pt
Huskie	pyrasulfotole+bromoxynil	15 fl oz
Huskie Complete	pyrasulfotole+bromoxynil+thiencarbazone	13.7 fl oz
Olympus	Propoxycarbazone-sodium	0.9 oz
Rimfire Max	propoxycarbazone+mesosulfuron	3 oz
Varro	thiencarbazone	6.85 fl oz
GoldSky	Florasulam+fluroxypr+pyroxsulam	1 pt
PerfectMatch	clopyralid+fluroxypr+pyroxsulam	1 pt
Harmony SG	thifensulfuron	0.9 oz
Express	tribenuron	0.5 oz
Glean XP	Chlorsulfuron	0.33 oz
Teamate	Pyroxsulam	1 oz
Aim EC	carfentrazone	1 fl oz
Ally XP	Metsulfuron	0.1 fl oz
Talinor	bicyclopyrone+bromoxynil	18.2 fl oz
Amber	triasulfuron	0.47 oz
Peak	Prosulfuron	0.5 oz
Sierra	Flucarbazone	1 fl oz
Discover NG	Clodinafop	16 oz
Axial XL	pinoxaden	16.4 fl oz
Outrider	Sulfosulfuron	0.67 oz
Tacoma	fenoxaprop	0.66 pt

Table B				
Oat Stand Counts After Wheat				
Herbicides 2018	Average Plants/19 in. row		Herbicides 2019	Average Plants/19 in. row
Sierra	13.5		Harmony SG	14
Express	13		Discover NG	12.5
TeamMate	12		Tacoma	12
Peak	12		Huskie C.	12
Tacoma	11.5		Goldsky	11.5
Harmony SG	11.5		TeamMate	11.5
Check	11.5		Aim EC	11
Ally XP	11.25		Rimfire Max	11
Talinor	11.25		Prowl H2O	10.5
Discover NG	11.25		Glean XP	10.5
Amber	11.25		Express	10
Glean XP	11		Axial XL	10
Aim EC	11		Huskie	10
Rimfire Max	11		Varro	10
Olympus	11		Check	10
Huskie	11		Talinor	10
Axial	10.75		Outrider	9.5
Prowl H2O	10.75		Peak	9
PerfectMatch	10.5		Amber	9
Outrider	10		PerfectMatch	9
GoldSky	9.75		Olympus	8.5
Huskie C.	9.75		AllyXP	8
Varro	9			

Table C				
Pearl Millet Stand Counts After Wheat				
Herbicides 2018	Average Plants/19 in. row		Herbicides 2019	Average Plants/19 in. row
Rimfire Max	14.75		TeamMate	16
Aim EC	14		Check	15.25
Varro	13.5		Outrider	14
Harmony SG	13.5		Axial XL	13.25
TeamMate	12.5		Varro	13.25
Tacoma	11.5		Talinor	13.25
Discover NG	11.5		Huskie	13
Olympus	11.25		Glean XP	13
Peak	11.25		Amber	12.5
Express	11.25		RimfireMax	12.5
Axial XL	11.25		Aim EC	12
Talinor	10.75		Tacoma	12
Prowel H2O	10.5		Prowl H20	12
PerfectMatch	10.25		Harmony SG	12
Amber	10.25		Ally XP	11.25
Huskie C.	10.25		Discover NG	11
Ally XP	10		PerfectMatch	10.5
Glean XP	9.75		Express	10
Check	9.5		Goldsky	9.50
Huskie	9.5		Huskie C.	9.50
Sierra	9.25		Peak	9
Outrider	9.25		Olympus	9
Goldsky	9			

Table D				
Crimson Clover Stand Counts After Wheat				
Herbicides 2018	Average Plants/19 in. row		Herbicides 2019	Average Plants/19 in. row
Olympus	9		Axial XL	8.5
Tacoma	9		Talinor	8.25
Varro	8.25		TeamMate	7.75
Express	8		Ally XP	7.5
Harmony SG	7.75		Discover NG	7.5
Glean XP	7.75		Rimfire Max	7.5
Amber	7.5		Huskie	7
Prowel H2O	7.25		Prowl H20	7
Sierra	7.25		Peak	7
Talinor	7		Varro	7
TeamMate	6.75		Huskie C	6.75
Peak	6.75		Check	6.5
PerfectMatch	6.5		Express	6.5
Aim EC	6.5		Goldsky	6
Ally XP	6		Tacoma	6
Discover NG	6		Outrider	6
Rimfire Max	6		Aim EC	5.75
Huskie	6		PerfectMatch	5.75
Huskie C.	5.75		Harmony SG	5.75
Goldsky	5.75		Olympus	5.5
Axial XL	5.5		Amber	4.75
Outrider	5.5		Glean XP	4.25
Check	5.25			

Table E				
Flax Stand Counts After Wheat				
Herbicides 2018	Average Plants/19 in. row		Herbicides 2019	Average Plants/19 in. row
Aim EC	12.75		TeamMate	14.25
Talinor	11.5		Prowl H20	13.75
Harmony SG	11.25		Varro	12.5
TeamMate	11.25		Glean XP	12.5
Amber	11.25		Olympus	12.5
Express	11.25		Peak	11.25
Varro	11.25		Huskie C.	10.25
Peak	11		Outrider	10
Rimfire Max	10.75		Express	10
Outrider	10.75		Discover NG	10
Sierra	10.75		Aim EC	9.25
Axial XL	10.5		Ally XP	9.25
Tacoma	10.5		Check	9.25
Check	10.25		Rimfire Max	9
Huskie C.	10		Amber	8.5
Ally XP	10		Talinor	8.5
Prowl H20	10		Harmony SG	8.5
Olympus	10		Huskie	7.75
Huskie	10		Tacoma	7.75
PerfectMatch	9.25		PerfectMatch	7.75
Glean XP	9		Goldsky	7.5
Goldsky	8.75		Axial XL	7.5
Discover NG	8.5			

Table F				
Radish Stand Counts After Wheat				
Herbicides 2018	Average Plants/19 in. row		Herbicides 2019	Average Plants/19 in. row
Aim EC	6.5		Huskie C.	7.25
Express	6.5		Check	6.5
Olympus	6.25		Ally XP	6.5
PerfectMatch	5.75		PerfectMatch	6.25
Sierra	5.75		Outrider	6
Peak	5.75		Tacoma	5.75
RimfireMax	5.5		Express	5.75
Harmony SG	5.5		Harmony SG	5.5
Amber	5.5		Glean XP	5.5
Varro	5.5		Axial XL	5.25
Glean XP	5.5		Peak	4.75
Discover NG	5.5		Aim EC	4.5
Ally XP	5.25		Huskie	4.5
Tacoma	5		Amber	4.5
Prowl H20	5		Varro	4.5
TeamMate	5		Olympus	4.25
Talinor	4.75		TeamMate	4.25
Huskie C.	4.75		Discover NG	4
Goldsky	4.75		Prowl H20	4
Huskie	4.75		Rimfire Max	3.75
Axial XL	4.5		Goldsky	3.75
Check	4.5		Talinor	3.5
Outrider	4			

Table G				
Rape Stand Counts After Wheat				
Herbicides 2018	Average Plants/19 in. row		Herbicides 2019	Average Plants/19 in. row
Aim EC	10.75		Rimfire Max	10
Glean XP	10.75		Prowl H20	9
Sierra	10.25		TeamMate	8.5
Rimfire Max	10.25		Varro	8.5
TeamMate	10.25		Huskie C.	8.25
Peak	10		Harmony SG	8.25
Tacoma	10		Check	7.75
Check	9.75		PerfectMatch	7.75
Axial XL	9.75		Tacoma	7.5
Talinor	9.5		Outrider	7.5
Huskie	9.5		Discover NG	7.5
Varro	9.5		Goldsky	7.25
Outrider	9.25		Axial XL	7.25
Express	9.25		Ally XP	7.25
Amber	9		Express	7
Goldsky	8.75		Huskie	6.75
Harmony SG	8.5		Peak	6.75
Huskie C.	8.5		Amber	6.5
Ally XP	8.5		Talinor	6.5
Discover NG	8.25		Aim EC	6.25
Prowl H20	8.25		Glean XP	6.25
PerfectMatch	8		Olympus	6
Olympus	6.75			

Table H				
Sunflower Stand Counts After Wheat				
Herbicides 2018	Average Plants/19 in. row		Herbicides 2019	Average Plants/19 in. row
Peak	1.5		Olympus	2.75
Rimfire Max	1.25		Varro	2.75
Olympus	1.25		Huskie	2.5
Huskie C.	1		Axial XL	2.5
Aim EC	1		Glean XP	2.5
TeamMate	1		Talinor	2.5
Sierra	1		Prowl H20	2.25
PerfectMatch	1		Tacoma	2.25
Goldsky	1		TeamMate	2.25
Huskie	1		Outrider	2.25
Varro	1		PerfectMatch	2.25
Ally XP	.75		Express	2
Tacoma	.75		Goldsky	2
Talinor	.75		Ally XP	2
Amber	.75		Peak	2
Express	.75		Huskie C.	2
Outrider	.5		Aim EC	1.75
Glean XP	.5		Harmony SG	1.75
Harmony SG	.5		Check	1.75
Axial XL	.5		Rimfire Max	1.75
Prowl H20	.5		Amber	1.5
Discover NG	.5		Discover NG	1.25
Check	.5			

Table I				
Winter Pea Stand Counts After Wheat				
Herbicides 2018	Average Plants/19 in. row		Herbicides 2019	Average Plants/19 in. row
Olympus	4.75		Tacoma	6.75
Harmony SG	4.5		Rimfire Max	5
Express	4.25		TeamMate	5
Axial XL	4.25		Discover NG	5
Varro	4.25		Huskie	4.75
TeamMate	4		Axial XL	4.75
Aim EC	4		Huskie C.	4.75
Glean XP	4		Ally XP	4.75
Prowl H20	3.75		Check	4.5
Discover NG	3.75		Peak	4.5
Amber	3.75		Glean XP	4.5
Huskie C.	3.75		Varro	4.25
Huskie	3.75		Olympus	3.75
PerfectMatch	3.75		Amber	3.75
Sierra	3.75		PerfectMatch	3.75
Peak	3.75		Harmony SG	3.75
Ally XP	3.5		Outrider	3.75
Rimfire Max	3.5		Aim EC	3.5
Check	3.5		Goldsky	3.5
Outrider	3.5		Express	3.25
Goldsky	3.5		Prowl H20	3
Tacoma	3.25		Talinor	3
Talinor	3.25			

Table J		
PRE Herbicides Applied 2018/2019 SE Farm Corn Silage		
Trade Names	Active Ingredient(s)	Rate (acre)
Atrazine	isopropylamino-s-triazine	1 qt
Atrazine	isopropylamino-s-triazine	1/2 qt
Parallel	metolachlor	2 pt
Glory	metribuzin	8 oz
Pruvin	rimsulfuron	2 oz
Sharpen	saflufenacil	3.5 fl oz
Verdict	saflufenacil+dimethenamid	18 fl oz
Zidua	pyroxasulfone	4 oz
Outlook	dimethenamid-p	21 fl oz
Armezon	topramezone	.75 fl oz
Armezon Pro	topramezone+dimethenamid-p	24 fl oz
Corvus	isoxaflutole+thiencarbazone	5.6 fl oz
Python WDG	flumetsulam	1 oz
Resicore	acetochlor+mesotrione+clopyralid	3 qt
Surestart II	acetochlor+flumetsulam+clopyralid	3 pt
Cinch	s-metolachlor	2 pt
Harmony SG	thifensulfuron	.9 oz
Anthem Maxx	pyroxasulfone+fluthiatmethyl	6.5 fl oz
Permit	halosulfuron	1.33 oz
Warrant	acetochlor	3 qt
Callisto	mesotrione	7.7 fl oz
Acuron	s-metolachlor +Atrazine +mesotrione +bicyclopyrone	3 qt
POST Herbicides Applied 2018/2019 SE Farm Corn Silage		
Balance Flexx	isoxaflutole	6 fl oz
Laudis	tembotrione	3 fl oz
Accent Q	nicosulfuron	.9 oz
Beacon	primisulfuron	.76 oz
Spirit	prosulfuron+primisulfuron	1 oz

Table K				
Winter Pea Stand Counts After Corn Silage				
Herbicides 2018	Average Plants/19 in. row		Herbicides 2019	Average Plants/19 in. row
Atrazine 1lb	10.25		Atrazine 1/2lb	9.5
Cinch	10.25		Pruvin	6.25
Resicore	10		Valor EZ	6.25
Acuron	10		Zidua	6.25
Glory	9.75		Spirit	6
Anthem Max	9.5		Check	5.75
Zidua	9.33		Atrazine 1lb	5.75
Harmony SG	9.25		Sharpen	5.5
Python	9.25		Resicore	5.5
Armezon Pro	9		Callisto	5.25
Check	9		Outlook	5.25
Atrazine 1/2lb	8.75		Cinch	5
Sharpen	8.75		Warrent	5
Permit	8.75		Verdict	5
Pruvin	8.5		Anthem Max	5
Warrant	8.5		Laudis	5
Verdict	8.5		Armezon	5
Parallel	8.25		Glory	5
Corvus	8		Accent Q	4.75
Outlook	8		Beacon	4.75
Callisto	8		Balance Flex	4.75
Armezon	8		Surestart	4.5
Lumax EZ	7.5		Armezon Pro	4.25
Surestart	7.5		Corvus	4
			Permit	4
			Harmony SG	3.75
			Parallel	3.75
			Python WD	3.75
			Acuron	3.5
			Lumax EZ	3.25

Table L				
Radish Stand Counts After Corn Silage				
Herbicides 2018	Average Plants/19 in. row		Herbicides 2019	Average Plants/19 in. row
Surestart	17.5		Resicore	15.75
Outlook	17.33		Beacon	14.25
Warrant	16.75		Zidua	13.75
Python	16.5		Sharpen	13.50
Zidua	16.33		Corvus	12.75
Atrazine 1/2lb	16.25		Acuron	12.25
Check	16		Harmony SG	12
Corvus	15.7		Outlook	12
Acuron	15.5		Laudis	11.75
Verdict	15.25		Anthem Max	11.50
Harmony SG	15.25		Surestart	11.25
Armezon Pro	15.25		Armezon	11.25
Cinch	15		Check	11
Lumax EZ	15		Atrazin 1lb	11
Armezon	14.75		Spirit	11
Sharpen	14.75		Callisto	11
Permit	14.75		Cinch	10.75
Anthem Max	14.75		Permit	10.75
Resicore	14.25		Atrazine 1/2lb	10.75
Glory	14.25		Glory	10.5
Parallel	14.25		Armezon Pro	10.25
Atrazine 1lb	13.75		Balance Flex	10.25
Pruvin	13.25		Parallel	10
Callisto	12.5		Valor EZ	10
			Lumax EZ	9.75
			Python WD	9.75
			Warrant	9.5
			Accent Q	9.5
			Pruvin	9.25
			Verdict	9.25

Table M				
Winfred Stand Counts After Corn Silage				
Herbicides 2018	Average Plants/19 in. row		Herbicides 2019	Average Plants/19 in. row
Python	22.66		Armezon	40
Acuron	20.66		Zidua	36.5
Lumax EZ	20		Callisto	36
Resicore	19.33		Lumax EZ	34
Callisto	19		Laudis	34
Atrazine 1/2lb	19		Anthem Max	33.5
Anthem Max	19		Beacon	32.25
Armezon Pro	18.33		Balance Flex	32.25
Permit	18		Acuron	32
Armezon	18		Surestart	31.75
Sharpen	18		Warrant	31.5
Harmony SG	18		Cinch	31.25
Cinch	17.66		Harmony SG	30.75
Atrazine 1lb	17.66		Glory	30.50
Corvus	17		Verdict	30.50
Check	17		Check	30.25
Outlook	17		Spirit	30.25
Verdict	17		Pruvin	30
Zidua	17		Python WD	30
Surestart	16.66		Permit	29.75
Warrant	16		Corvus	29.5
Pruvin	15.66		Armezon Pro	28.5
Parallel	15.33		Outlook	27.5
Glory	15		Accent Q	27
			Atrazine 1lb	27
			Sharpen	26.5
			Atrazine 1/2lb	26
			Parallel	25.5
			Resicore	24.5
			Valor EZ	23.75

Table N				
Mustard Stand Counts After Corn Silage				
Herbicides 2018	Average Plants/19 in. row		Herbicides 2019	Average Plants/19 in. row
Check	5		Corvus	38.5
Python	4.5		Acuron	37.75
Glory	4.5		Outlook	36.75
Atrazine 1/2lb	4.5		Laudis	36.75
Corvus	4.5		Zidua	36.5
Pruvin	4.5		Pruvin	36.25
Permit	4.25		Balance Flex	36
Armezon	4.25		Accent Q	35.5
Sharpen	4.25		Parallel	35
Sharpen	4.25		Verdict	34.75
Acuron	4.25		Callisto	33.75
Anthem Max	4.0		Anthem Max	33.25
Parallel	4.0		Warrant	33.25
Cinch	4.0		Valor EZ	32.75
Armezon Pro	4.0		Glory	32.75
Lumax EZ	4		Atrazine 1/2lb	32.5
Harmony SG	3.75		Lumax EZ	32.25
Surestart	3.75		Beacon	32.25
Outlook	3.66		Sharpen	32.25
Zidua	3.66		Armezon Pro	31.75
Atrazine 1lb	3.5		Cinch	31.5
Resicore	3.5		Resicore	30.75
Callisto	3.25		Atrazine 1lb	30
Verdict	3.25		Python WD	29.75
Warrant	3		Harmony SG	29.75
			Armezon	29.25
			Surestart	28.25
			Check	28
			Permit	28
			Spirit	27.5

Table O				
Flax Stand Counts After Corn Silage				
Herbicides 2018	Average Plants/19 in. row		Herbicides 2019	Average Plants/19 in. row
Lumax EZ	18		Zidua	38.5
Atrazine 1/2lb	17.5		Warrant	36.75
Zidua	17		Armezon Pro	36
Armezon Pro	17		Harmony SG	35.5
Python	16.75		Corvus	35
Atrazine 1lb	16.5		Balance Flex	34.5
Permit	16.5		Outlook	34.5
Warrant	16.5		Surestart	34.5
Sharpen	16		Resicore	33.75
Anthem Max	15.5		Glory	33.50
Check	15.5		Spirit	33.5
Callisto	15.25		Python WD	33.25
Resicore	15		Permit	31.75
Corvus	14.25		Cinch	31.75
Pruvin	14.5		Sharpen	31.5
Harmony SG	14.25		Acuron	31.25
Acuron	14		Parallel	31
Outlook	14		Verdict	31
Verdict	14		Accent Q	30.5
Armezon	14		Valor EZ	30.25
Surestart	13.75		Laudis	30
Cinch	13.75		Lumax EZ	29.75
Glory	13.5		Anthem Max	28
Parallel	12.25		Check	27.5
			Armezon	27.5
			Atrazine 1/2lb	27.25
			Pruvin	25.25
			Callisto	24.75

Table P				
Oats Stand Counts After Corn Silage				
Herbicides 2018	Average Plants/19 in. row		Herbicides 2019	Average Plants/19 in. row
Check	14.66		Zidua	18
Permit	13.33		Armezon Pro	17.75
Callisto	12.66		Valor EZ	17.5
Outlook	12.5		Cinch	17.25
Pruvin	12.33		Python WD	17
Sharpen	12		Permit	17
Atrazine 1/2lb	11.66		Armezon	16.25
Resicore	11.33		Anthem Max	16
Atrazine 1lb	11.33		Surestart	16
Armezon Pro	11.33		Glory	16
Acuron	11.33		Balance Flex	15.25
Corvus	11.33		Outlook	15.25
Armezon	11.33		Callisto	15.25
Verdict	11.33		Atrazine 1lb	14.75
Lumax EZ	11		Acuron	14.5
Zidua	11		Accent Q	14.25
Anthem Max	10.66		Verdict	14.25
Parallel	10.66		Check	14
Surestart	10.66		Laudis	14
Glory	10.33		Atrazine 1/2lb	14
Warrant	10.33		Warrant	13.75
Python	10		Harmony SG	13.75
Harmony SG	10		Sharpen	13.75
Cinch	9.66		Beacon	13.25
			Spirit	12.75
			Corvus	12.75
			Parallel	12.75
			Resicore	12.5
			Pruvin	12
			Lumax EZ	11.5

Table Q				
Annual Rye Stand Counts After Corn Silage				
Herbicides 2018	Average Plants/19 in. row		Herbicides 2019	Average Plants/19 in. row
Zidua	24.33		Corvus	34.25
Parallel	22.25		Acuron	33.75
Sharpen	21.25		Surestart	33
Lumax EZ	21		Callisto	32.75
Permit	21		Beacon	32.5
Resicore	21		Permit	31.75
Cinch	20.25		Glory	31.25
Atrazine 1/2lb	20		Balance Flex	30.75
Acuron	20		Armezon	30.5
Callisto	20		Cinch	30.5
Outlook	20		Lumax EZ	28.75
Verdict	20		Anthem Max	28.75
Check	19.75		Warrant	28
Atrazine 1lb	19.25		Python WD	27.75
Python	19		Verdict	27.5
Pruvin	18.75		Armezon Pro	26.75
Harmony SG	18.75		Resicore	26.50
Anthem Max	18.5		Outlook	26.25
Warrant	18.5		Sharpen	26.25
Armezon	18.5		Harmony SG	25.75
Corvus	18.25		Pruvin	25.75
Surestart	18		Spirit	24.75
Glory	18		Accent Q	24.25
Armezon Pro	17.25		Atrazine 1/2lb	24.25
			Laudis	24.25
			Zidua	23
			Valor EZ	22.75
			Check	21.25
			Atrazine 1lb	19.5
			Parallel	19

Table R

Rye Stand Counts After Corn Silage

Herbicides 2018	Average Plants/19 in. row		Herbicides 2019	Average Plants/19 in. row
Outlook	19.66		Accent Q	20.5
Harmony SG	19.25		Beacon	19.25
Verdict	18.75		Permit	19
Warrant	18.75		Valor EZ	19
Python	18.5		Callisto	18.75
Armezon	18.25		Lumax EZ	18.75
Check	17.5		Atrazine ½lb	18.5
Permit	17		Resicore	18.5
Atrazine 1/2lb	16.5		Anthem Max	18.25
Cinch	16.5		Corvus	18.25
Corvus	16.25		Pruvin	18.25
Parallel	16		Outlook	18
Armezon Pro	15.75		Verdict	17.75
Callisto	15.75		Zidua	17.75
Anthem Max	15.75		Check	17.75
Atrazine 1lb	15.75		Spirit	17.75
Surestart	15.5		Acuron	17.5
Glory	15.5		Laudis	17.25
Zidua	15.33		Harmony SG	17
Pruvin	15.25		Armezon Pro	16.75
Lumax EZ	15		Atrazine 1lb	16.75
Sharpen	15		Warrant	16.25
Resicore	14.75		Sharpen	16
Acuron	13.5		Surestart	15.75
			Parallel	15.75
			Cinch	15.5
			Armezon	14.75
			Python WD	14.75
			Balance Flex	14.5
			Glory	11.5

SOUTHEAST RESEARCH FARM ANNUAL REPORT
South Dakota State University
2019 Progress Report
Agricultural Experiment Station
Plant Science Department
South Dakota State University, Brookings, SD 57007
Southeast Research Farm, Beresford, SD 57004

2019 Crop Performance Testing Results for Southeast Research Farm: Corn, Soybean, and Oats

Jonathan Kleinjan*, Kevin Kirby, and Shawn Hawks

INTRODUCTION

The results of the SDSU Crop Performance Testing (CPT) program are released each year due in part to sponsorship by the SDSU Extension Service and the South Dakota Agricultural Experiment Station. Corn, soybean, and oat variety trials are conducted annually at the Southeast Research Farm located near Beresford, SD. The oat breeding project manages the oat variety trial. CPT personnel manage the corn and soybean trials.

METHODS

Corn and soybean trials were planted in 30-inch rows with a SRES precision four-row planter. Four-row plots were planted to a length of 20 ft and the center two rows were harvested for grain yield. Small grain variety trials were drilled using John Deere no-till openers set on 8-inch spacing. At harvest, plots were 5 ft wide and 13 ft in length. Additional information about trial management can be found with the trial results.

RESULTS AND DISCUSSION

Results for the corn, soybean, and oat trials are included in the following pages and can also be found on the SDSU extension website: https://extension.sdstate.edu/tags/crop-performance-testing

The five-year average corn yields for this location are 211 and 202 bu/acre, respectively for the early (≤107 day RM) and late (≥108 day RM) maturity tests. Yields in 2019 were below average with early and late test averages of 195 and 170 bu/acre, respectively. The conventional corn trial averaged 177 bu/acre. Yields were reduced due to a combination of late planting and saturated soil conditions throughout the growing season. Soybeans also yielded below the five-year average of 72 bu/acre (Group II trial), with 2019 yields of 66 bu/acre. The conventional soybean trial yields were similar, averaging 64 bu/acre.

The average yield for the oat variety trial was 90 bu/acre, which was in line with the three-year average of 89 bu/acre. Recommended varieties of oats for spring 2020, based on three-year average yields, include: Deon, Warrior, Saddle, and Antigo.

ACKNOWLEDGEMENTS

The efforts of the following SDSU personnel are greatly appreciated: Oat Breeding Project – M. Caffe-Treml, N. Hall; Southeast Research Farm – Brad Rops.

* *Corresponding author: Jonathan.Kleinjan@sdstate.edu*

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NOVEMBER 2019

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2019 South Dakota Corn Hybrid Trial Results Beresford

Jonathan Kleinjan | SDSU Extension Crop Production Associate
Kevin Kirby | Agricultural Research Manager
Shawn Hawks | Agricultural Research Manager

Location:	6 miles west and 3 miles south of Beresford (57432) in Clay County, SD (GPS: 43.043207 -96.895727)
Cooperator:	SDSU Southeast Research Farm - Peter Sexton, Manager
Soil Type:	Egan-Trent silty clay loams, 0-2% slope, non-irrigated
Fertilizer:	80 lb/acre 30-10-10 starter + 150-0-0-12S broadcast preemerge
Yield Goal:	200 bu/acre
Previous crop:	Soybeans
Tillage:	No-till
Row spacing:	30 inches
Seeding Rate:	32,000/acre
Herbicide:	Pre: 32 oz Roundup (glyphosate) + 1.33 pt Dual (metolachlor) + 3.5 oz Sencor (metribuzin) + 1 oz Sharpen (saflufenacil) Post: 12 oz Atrazine + 3 oz Callisto (mesotrione)
Date seeded:	6/6/2019
Date harvested:	11/19/2019
Notes:	Due to the lack of participation, this will likely be the last year of corn hybrid trials at the Beresford location.

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2019 South Dakota Corn Hybrid Trial Results Beresford

Table 1. Glyphosate-resistant corn hybrid performance results (average of 4 replications - **Early Season Trial** (107 day maturity or less) at Beresford, SD.

Hybrid Information		Agronomic Performance					
Brand	Hybrid	Maturity Rating	Yield Bu/A (15.5%)	Moisture	Test Wt. (lbs/bu)	Lodging (%)	Final Stand (plants/A)
Renk Seed	RK642VT2P	103	**205.6**	16.3	54.6	0.4	28700
Renk Seed	RK710DGVT2P	106	**201.8**	16.8	54.6	0.8	29500
Check	CHECK	100	**195.2**	16.5	55.9	0.7	31800
Renk Seed	RK626SSTX	102	**193.8**	16.3	51.8	3.8	31300
Channel	205-63VT2PRIB	105	**187.7**	16.9	53.6	1.4	31400
Renk Seed	RK621VT2P	102	**187.2**	17.0	54.7	6.5	31600
		Trial Average	195.2	16.6	54.2	2.3	30700
		LSD (0.05)†	20.0	0.7	1.0	3.2	1300
		C.V.‡	6.9	2.9	1.2	-	2.9

* Lodging percentage - stalks broken below the ear as a percentage of the final stand.
† Yield or moisture value required (≥LSD) to determine if varieties are significantly different from one another.
‡ C.V. is a measure of variability or experimental error, 15% or less is acceptable.

Table 2. Glyphosate-resistant corn hybrid performance results (average of 4 replications - **Late Season Trial** (108 day maturity or more) at Beresford, SD.

Hybrid Information		Agronomic Performance					
Brand	Hybrid	Maturity Rating	Yield Bu/A (15.5%)	Moisture	Test Wt. (lbs/bu)	Lodging (%)	Final Stand (plants/A)
Channel	210-26STXRIB	110	**190.0**	20.5	52.5	1.4	32300
Check	CHECK	100	**187.6**	17.5	55.1	2.8	31500
Channel	208-38VT2PRIB	108	173.4	18.7	50.8	6.0	30700
Renk Seed	RK807SSTX	111	168.5	21.1	53.5	7.2	31800
Renk Seed	RK765VT2P	108	159.6	18.1	50.8	2.2	30500
Channel	211-66VT2PRIB	111	139.8	24.9	47.9	11.3	31000
		Trial Average	169.8	20.1	51.8	5.1	31300
		LSD (0.05)†	15.7	1.0	1.1	3.1	2400
		C.V.‡	6.1	3.1	1.5	-	5.2

* Lodging percentage - stalks broken below the ear as a percentage of the final stand.
† Yield or moisture value required (≥LSD) to determine if varieties are significantly different from one another.
‡ C.V. is a measure of variability or experimental error, 15% or less is acceptable.

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2019 South Dakota Conventional Corn Hybrid Trial Results Beresford

Jonathan Kleinjan | SDSU Extension Crop Production Associate
Kevin Kirby | Agricultural Research Manager
Shawn Hawks | Agricultural Research Manager

Location:	6 miles west and 3 miles south of Beresford (57432) in Clay County, SD
Cooperator:	SDSU Southeast Research Farm - Peter Sexton, Manager
Soil Type:	Egan-Trent silty clay loams, 0-2% slope, non-irrigated
Fertilizer:	80 lb/acre 30-10-10 starter + 150-0-0-12S broadcast preemerge
Yield Goal:	200 bu/acre
Previous crop:	Soybeans
Tillage:	No-till
Row spacing:	30 inches
Seeding Rate:	32,000/acre
Herbicide:	Pre: 32 oz Roundup (glyphosate) + 1.33 pt Dual (metolachlor) + 3.5 oz Sencor (metribuzin) + 1 oz Sharpen (saflufenacil) Post: 12 oz Atrazine + 3 oz Callisto (mesotrione) + 1% COC + UAN 2.5% V/V
Date seeded:	6/6/2019
Date harvested:	11/19/2019

2019 South Dakota Conventional Corn Hybrid Trial Results Beresford

Table 1. Conventional corn hybrid performance results (average of 4 replications) at Beresford, SD.

Hybrid Information		Agronomic Performance					
Brand	Hybrid	Maturity Rating	Yield Bu/A (15.5%)	Moisture	Test Wt. (lbs/bu)	Lodging (%)	Final Stand (plants/A)
Viking	48-08	108	**190.3**	19.3	51.0	1.2	27100
Federal Hybrids	5570 CONV	105	**189.9**	17.3	55.1	0.4	30300
Federal Hybrids	5280 CONV	102	**185.3**	17.0	53.7	5.7	28200
Federal Hybrids	5550 CONV	105	**185.0**	17.5	54.7	2.2	29400
Federal Hybrids	5445 CONV	104	**182.8**	18.5	52.4	6.6	28300
Check	CHECK	100	**181.7**	17.6	55.8	0.7	31700
Viking	84-05	105	**177.9**	17.1	53.8	6.3	31300
Federal Hybrids	4780 CONV	97	171.3	15.9	53.3	15.6	28500
Federal Hybrids	5008 CONV	100	170.7	19.1	52.7	4.6	31100
Federal Hybrids	4770 CONV	97	170.2	16.2	54.2	1.9	29000
Federal Hybrids	4440 CONV	94	168.4	15.7	54.9	9.8	29900
Federal Hybrids	4800 CONV	98	167.8	17.0	56.1	2.0	27700
Federal Hybrids	4580 CONV	95	166.2	16.3	55.9	26.7	30300
Viking	O.18-06	106	166.0	18.5	56.6	5.2	29400
		Trial Average	176.6	17.3	54.2	6.3	29400
		LSD (0.05)†	15.3	1.1	1.0	3.8	1300
		C.V.‡	6.1	4.5	1.3	-	3.1

* Lodging percentage - stalks broken below the ear as a percentage of the final stand.
† Yield or moisture value required (≥LSD) to determine if varieties are significantly different from one another.
‡ C.V. is a measure of variability or experimental error, 15% or less is acceptable.

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2019 South Dakota Soybean Variety Trial Results Beresford

Jonathan Kleinjan | SDSU Extension Crop Production Associate
Kevin Kirby | Agricultural Research Manager
Shawn Hawks | Agricultural Research Manager

Location:	6 miles west and 3 miles south of Beresford (57432) in Clay County, SD (GPS: 43.045599° -96.899598°)
Cooperator:	SDSU Southeast Research Farm - Peter Sexton, Manager
Soil Type:	Egan-Clarno-Trent complex, 0-2% slopes, non-irrigated
Fertilizer:	None
Previous crop:	Corn
Tillage:	No-till
Row spacing:	30 inches
Seeding Rate:	150,000/acre
Herbicide:	Pre: 32 oz Glyphosate + 1.33 pt Dual (s-metolachlor) + 3.5 oz Dimetric (metribuzin) + 1 oz Sharpen (saflufenacil) Post: 0.3 oz FirstRate (cloransulam) + 10 oz Flexstar (fomesafen) + 9 oz Select Max (clethodim) + 1% UAN + 1% COC
Insecticide:	None
Date seeded:	6/6/2019
Date harvested:	10/25/2019

2019 South Dakota Soybean Variety Trial Results Beresford

Table 1. Glyphosate-resistant soybean variety performance results (average of 4 replications - **Maturity Groups 1 & 2** at Beresford, SD.

Variety Information		Agronomic Performance			
Brand	**Variety**	**Maturity Rating**	**Yield (bu/ac@13%)**	**Moisture (%)**	**Lodging Score (1-5)***
Dyna-Gro Seed	S28XT58	2.8	**74.1**	14.2	1.0
Dyna-Gro Seed	S27EN89	2.7	**73.1**	14.9	1.0
Dyna-Gro Seed	S25XT99	2.5	**71.9**	14.1	1.0
Dyna-Gro Seed	S23XT90	2.3	**70.9**	14.6	1.0
Renk Seed	RS248NX	2.4	67.9	15.0	1.0
Miller Hybrids	19181CBGL	1.9	67.2	14.6	1.0
P3 Genetics	1920E	2.0	66.5	14.7	1.0
P3 Genetics	1920B	2.0	66.3	14.0	1.0
Channel	2820R2X	2.8	65.8	14.4	1.0
Miller Hybrids	2483CE3	2.4	65.2	14.5	1.0
Miller Hybrids	24181CBGL	2.4	64.5	14.6	1.0
Renk Seed	Genesis G2340E	2.3	64.4	15.3	1.0
Channel	2119R2X	2.1	64.0	14.7	1.0
Channel	2418R2X	2.4	63.2	14.4	1.0
Miller Hybrids	1983CE3	1.9	60.8	15.0	1.0
P3 Genetics	1918B	1.8	60.5	15.0	1.0
P3 Genetics	1917B	1.6	58.2	14.8	1.0
Check	CHECK	1.4	52.1	15.2	1.0
		Trial Average	64.7	14.7	1.0
		LSD (0.05)†	3.9	0.3	-
		C.V.‡	4.3	1.7	-

*Lodging Score (1 = no lodging to 5 = flat on the ground).
† Yield or moisture value required (≥LSD) to determine if varieties are significantly different from one another.
‡ C.V. is a measure of variability or experimental error, 15% or less is acceptable.

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2019 South Dakota Conventional Soybean Variety Trial Results Beresford

Jonathan Kleinjan | SDSU Extension Crop Production Associate
Kevin Kirby | Agricultural Research Manager
Shawn Hawks | Agricultural Research Manager

Location:	6 miles west and 3 miles south of Beresford (57432) in Clay County, SD (GPS: 43.045599° -96.899598°)
Cooperator:	SDSU Southeast Research Farm - Peter Sexton, Manager
Soil Type:	Egan-Clarno-Trent complex, 0-2% slopes, non-irrigated
Fertilizer:	None
Previous crop:	Corn
Tillage:	No-till
Row spacing:	30 inches
Seeding Rate:	150,000/acre
Herbicide:	Pre: 32 oz Glyphosate + 1.33 pt Dual (s-metolachlor) + 3.5 oz Dimetric (metribuzin) + 1 oz Sharpen (saflufenacil) Post: 0.3 oz FirstRate (cloransulam) + 10 oz Flexstar (fomesafen) + 9 oz Select Max (clethodim) + 1% UAN + 1% COC
Insecticide:	None
Date seeded:	6/6/2019
Date harvested:	10/25/2019

2019 South Dakota Conventional Soybean Variety Trial Results Beresford

Table 1. Conventional soybean variety performance results (average of 4 replications) - **Maturity Group 1** at Beresford, SD.

Variety Information		Agronomic Performance			
Brand	Variety	Maturity Rating	Yield (bu/ac@13%)	Moisture (%)	Lodging Score (1-5)*
Miller Hybrids	1968	1.9	**67.2**	15.4	1.0
SD AES	Brookings	1.7	**65.4**	15.1	1.8
Sevita International	Candor	1.9	63.3	15.0	1.5
Richland IFC	MK41	1.1	63.0	15.9	2.5
MN AES	EXP M09-285149	1.5	61.3	14.8	1.0
Check	CHECK	1.4	58.7	15.0	1.0
MN AES	EXP M10-238-2036	1.5	56.9	15.1	1.0
Richland IFC	MK146	1.1	56.7	14.6	1.0
MN AES	MN1312CN	1.3	56.6	14.7	1.0
MN AES	MN1806CN	1.8	52.9	14.1	1.0
Richland IFC	MK9101	1.1	49.8	11.8	1.0
Richland IFC	MK1016	1.0	33.3	16.5	2.8
		Trial Average	57.1	14.8	1.4
		LSD (0.05)†	3.1	0.3	-
		C.V.‡	3.9	1.6	-

*Lodging Score (1 = no lodging to 5 = flat on the ground).
† Yield or moisture value required (≥LSD) to determine if varieties are significantly different from one another.
‡ C.V. is a measure of variability or experimental error, 15% or less is acceptable.

2019 South Dakota Conventional Soybean Variety Trial Results Beresford

Table 2. Conventional soybean variety performance results (average of 4 replications) - **Maturity Group 2** at Beresford, SD.

Variety Information		Agronomic Performance			
Brand	**Variety**	**Maturity Rating**	**Yield (bu/ac@13%)**	**Moisture (%)**	**Lodging Score (1-5)***
Viking	O.2518N	2.5	**68.7**	14.2	1.0
Viking	O.2188AT12	2.1	**67.2**	14.7	1.3
Viking	O.2155N	2.1	**66.7**	14.6	1.0
Miller Hybrids	2968	2.9	**65.9**	13.9	1.3
Miller Hybrids	2368	2.3	**64.8**	15.3	1.3
Richland IFC	MK373	2.0	62.9	14.3	1.5
Check	CHECK	1.4	60.9	15.1	1.0
Miller Hybrids	2688	2.6	58.5	21.5	1.0
SD AES	Davison	2.2	56.2	15.2	1.3
		Trial Average	63.5	15.4	1.2
		LSD (0.05)†	5.0	0.7	-
		C.V.‡	5.4	3.0	-

*Lodging Score (1 = no lodging to 5 = flat on the ground).
† Yield or moisture value required (≥LSD) to determine if varieties are significantly different from one another.
‡ C.V. is a measure of variability or experimental error, 15% or less is acceptable.

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2019 South Dakota Oat Variety Trial Results Beresford

Jonathan Kleinjan | SDSU Extension Crop Production Associate
Melanie Caffe-Treml | SDSU Oat Breeder
Kevin Kirby | Agricultural Research Manager
Shawn Hawks | Agricultural Research Manager
Nick Hall | Agricultural Research Manager

Cooperator:	SDSU Southeast Research Farm, Peter Sexton, Manager
Location:	43.043222°, -96.901606°
Soil Type:	Egan-Clarno-Tetonka complex, 0-2% slopes
Previous crop:	Soybeans
Tillage:	Conventional till
Row spacing:	7"
Seeding Rate:	1.2 million PLS/acre
Fertilizer:	
-Starter:	60 lb/acre 30-10-10
-Other:	none
Herbicide:	
-Burndown:	NA
-Post:	1 pt/acre Bronate
Fungicide:	none
Date seeded:	4/26/2019
Date harvested:	8/5/2019

S-0002-02

2019 South Dakota Oat Variety Trial Results Beresford

Table 1. 2019 oat variety performance trial results (average of 4 replications) at Beresford, SD.
Entries are sorted by overall 3-year yield. Varieties yielding in the top 1/3 of the trial are shaded light blue.

Variety	Height (in)	Lodging* (1-5)	Test Wt (lbs)	2017 (bu/a)	2018 (bu/a)	2019 (bu/a)	2-year (bu/a)	3-year (bu/a)
Deon	43	4.0	34.7	127.5	126.6	116.6	121.6	123.6
Warrior	40	1.8	35.4	114.4	106.9	114.7	110.8	112.0
SD140515	41	2.8	36.0	124.7	109.0	98.2	103.6	110.6
Saddle	40	2.0	36.8	114.8	95.4	115.3	105.4	108.5
Antigo	45	4.3	38.7	108.5	101.9	104.4	103.1	104.9
Sumo	41	2.5	38.1	94.8	91.8	118.6	105.2	101.7
CS Camden	41	4.5	28.2	127.3	86.9	68.6	77.7	94.3
Natty	41	4.0	35.7	113.8	83.3	77.5	80.4	91.5
Goliath	44	4.0	31.1	109.0	74.5	64.8	69.6	82.8
Hayden	39	4.8	30.6	104.3	58.9	54.6	56.7	72.6
Newburg	40	4.5	29.6	104.0	64.1	43.2	53.6	70.4
Shelby427	-	5.0	32.3	99.1	64.2	44.2	54.2	69.1
Jury	42	3.8	33.3	94.5	65.1	47.7	56.4	69.1
Jerry	-	4.8	30.5	97.9	58.6	39.4	49.0	65.3
Horsepower	-	4.8	24.6	89.6	50.3	25.1	37.7	55.0
MN Pearl	43	2.8	33.9	-	-	111.3	-	-
Trial Average#	42	3.6	34.1	108.7	89.4	89.9	79.0	88.8
LSD(0.05)†	-	-	2.1	12.5	15.6	13.6	-	-
C.V.%‡	-	-	3.6	7.5	10.6	10.8	-	-

* Lodging score: 1, perfectly standing; to 5, completely flat.
# Trial averages may include values from experimental lines that are not reported.
† Value required (≥LSD) to determine if varieties are significantly different from one another.
‡ C.V. is a measure of variability or experimental error, 15% or less is considered acceptable.

SOUTHEAST RESEARCH FARM ANNUAL REPORT
South Dakota State University
2019 Progress Report
Agricultural Experiment Station
Plant Science Department
South Dakota State University, Brookings, SD 57007
Southeast Research Farm, Beresford SD 57004

WEED CONTROL DEMONSTRATIONS and EVALUATION TESTS for 2019

Southeast South Dakota Research Farm
Paul O. Johnson*, Ext. Weed Science Coordinator; David Vos, SDSU Ag Research Manager, and Jill Alms, SDSU Ag Research Manager

INTRODUCTION

Experiment stations have an important role in the WEED (Weed Evaluation and Extension Demonstration) Project. Plots provide weed control data for the area served by the Southeast South Dakota Research Farm. The station is one of the major sites for corn, soybean and wheat weed control studies. Tests at the station focus on common waterhemp, velvetleaf, marestail and foxtail.

2019 TESTS

Several studies were established to evaluate new weed control technologies. The demonstration plots centered around programs that would answer questions on the glyphosate resistance issue around the state, especially as it relates to waterhemp management in soybeans and corn. A very wet spring was followed by very wet conditions all of the summer.

NOTE:

Data reported in this publication are results from field tests that include product uses, experimental products or experimental rates, combinations or other unlabeled uses for herbicide products. Trade names of products used are listed; there frequently are other brand products available in the market. Users are responsible for applying herbicide according to label directions. Refer to the appropriate pest guide available from regional extension offices or https//extension.sdstate.edu for herbicide recommendations.

* *Corresponding author; Paulo.Johnson@sdstate.edu*

Studies listed below are summarized in the following tables. Information for each study is included as part of the summary.

1. Corn Herbicide Demonstration
2. Corvus/Balance Flexx Comparisons with Acetochlor
3. Capreno/Acetochlor Comparisons
4. Integrated Corn Herbicide Programs
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21. Flexstar with Adjuvants in Soybeans
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23. Common Waterhemp Control in Spring Wheat

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Due to the distance from the SDSU campus, assistance with field preparation and daily oversight of the fields is critical to the success of the weed control research. Field equipment and management of the plot areas are important contributions to the project. Regional Extension field specialists and program technicians provide assistance with tours and utilize the data in direct producer programs, publications and news releases. In addition to the Southeast Farm Report, research results will be published in the annual Weed Control Field Test Data Book, SDSU Pest Management Guides and Weed Control guides updated annually for major South Dakota commodities, and on the internet at https://extension.sdstate.edu

<u>Program input and partial support for field programs is also acknowledged.</u>

South Dakota Soybean Research and Promotion Council

South Dakota Oilseed Initiative

Crop Protection Industries

2019
CORN HERBICIDE DEMONSTRATION
Southeast Research Farm

Treatment	Rate/A	Grft 6/19/19	Vele 6/19/19	Cowh 6/19/19	Vele 7/8/19	Cowh 7/8/19	Yield bu/a 10/28/19
Check	---	0	0	0	0	0	147
Pre & Post							
Corvus + Aatrex & Harness Max + Aatrex + RU Powermax	3.5 oz + 1 pt & 40 oz + 1 pt + 32 oz	96	96	97	99	99	189
Balance Flexx + Harness Xtra 5.6 & Capreno + Aatrex + RU Powermax	3.5 oz + 1.2 qt & 3 oz + 1 pt + 32 oz	97	95	97	99	99	198
Balance Flexx + Harness Xtra 5.6 & DiFlexx + RU Powermax + AMS + NIS	3 oz + 1.2 qt & 8 oz + 32 oz + 2.5% + 0.25%	97	93	98	99	99	195
Verdict & Armezon Pro + Atrazine + RU Powermax + AMS + COC	10 oz & 18 oz + 8 oz + 32 oz + 1.7 lb + 1%	96	87	97	99	99	195
Verdict & Status + RU Powermax + AMS + NIS	12 oz & 4 oz + 32 oz + 1.7 lb + 0.25%	95	92	96	99	99	191
Resicore + Atrazine & Durango + AMS	2.5 qt + 1 pt & 1 qt + 2.5%	96	96	98	99	99	189
Surestart II + Atrazine & Realm Q + Durango + AMS	2 pt + 1 pt & 4 oz + 1 qt + 2.5%	96	88	98	99	99	193
Surestart II + Atrazine & Durango + Resicore + AMS	2 pt + 1 pt & 1 qt + 1.25 qt + 2.5%	97	84	97	99	99	194
Harness & RU Powermax + Atrazine + AMS	1.75 pt & 32 oz + 1 pt + 2.5 lb	97	53	98	99	99	192
Harness & Harness Max + RU Powermax + AMS	1 qt & 40 oz + 32 oz + 2.5%	97	48	98	99	99	191
Harness & ImpactZ + MSO + AMS	1.75 pt & 10.7 oz + 1% + 2.5%	97	59	98	99	99	183
Harness & ImpactZ + Liberty + MSO + AMS	1.75 pt & 8 oz + 22 oz + 0.5% + 2.5%	97	55	98	99	99	184
Acuron & Callisto + RU Powermax + NIS + AMS	1.25 qt & 3 oz + 32 oz + 0.25% + 1.7 lb	96	94	98	99	99	198
Dual II Magnum & Halex GT + NIS + AMS	2 pt & 3.6 pt + 0.25% + 1.7 lb	96	30	98	98	99	190
Dual II Magnum & Shieldex 400SC + RU Powermax + MSO + AMS	1.2 pt & 1.35 oz + 32 oz + 0.5% + 2.5%	93	23	96	96	99	182
Dual II Magnum & Shieldex 400SC + MSO + AMS	1.2 pt & 1.35 oz + 0.5% + 2.5%	94	23	96	80	97	183
Epost							
Anthem Maxx + Callisto + Atrazine	3 oz + 3 oz + 1 pt	63	94	75	99	99	185
Anthem Maxx + Callisto + Stinger	3 oz + 3 oz + 3 oz	50	90	75	99	99	189
LSD (0.05)		5	5	4	1	0	15

2019
CORN HERBICIDE DEMONSTRATION
Southeast Research Farm

RCB: 4 reps
Variety: DKC 50-08 RIB
Planting Date: 5/13/19
Pre: 5/13/19
Epost: 6/14/19 Corn V4, 8-11 in; Grft 3-4lf, 2-4 in; Vele 1-4 lf, 2-3 in; Cowh 2-5 in.
Post: 6/25/19 Corn V5-6, 24 in; Vele 2-15 in; Cowh 1-6 in.

Precipitation: (inches)
Pre: 1st week 1.38 2nd week 2.60

Soil: Silty Clay; 4.3% OM; 6.7 pH

Grft=Green foxtail
Vele=Velvetleaf
Cowh=Common waterhemp

Comments: Objective of the study was to look at program treatments for corn weed control. Heavy velvetleaf and moderate green foxtail and common waterhemp pressure. Wet conditions delayed planting and very wet during the growing season. Some variation in velvetleaf control. No differences in yield except for the check.

2019
CORVUS/BALANCE FLEXX COMPARISONS WITH ACETOCHLOR
Southeast Research Farm

Treatment	Rate/A	Vele 5/30/19	Grft 6/13/19	Vele 6/13/19	Cowh 6/13/19	Grft 6/25/19	Vele 6/25/19	Cowh 6/25/19	Grft 7/8/19	Cowh 7/8/19	Vele 7/8/19	Yield bu/A 10/28/19
Check	---	0	0	0	0	0	0	0	0	0	0	131
Pre												
Corvus + Aatrex	4.5 oz + 1 pt	77	96	97	99	96	98	98	97	95	96	194
Balance Flexx + Aatrex	5 oz + 1 pt	80	97	98	99	93	98	97	91	95	95	191
Harness	3 pt	40	97	68	96	97	72	98	98	97	53	189
Corvus + Harness Xtra 6L	4.5 oz + 1.2 qt	90	98	98	99	96	97	98	97	98	95	195
Balance Flexx + Harness Xtra 6L	5 oz + 1.2 qt	91	98	97	99	97	98	99	97	98	96	203
Harness Max + Aatrex	55 oz + 1 pt	91	98	98	99	96	98	99	95	98	95	199
Acuron	2.5 qt	88	98	98	99	97	98	99	96	97	97	202
Lumax EZ	2.7 qt	93	98	98	99	97	98	99	96	98	96	200
Resicore + Aatrex	2 qt + 1 pt	93	97	98	99	96	98	99	96	98	95	197
LSD (0.05)		8	1	5	1	2	10	1	3	1	5	19

RCB: 4 reps
Variety: DKC 50.08 RIB
Planting Date: 5/13/19
Pre: 5/13/19

Precipitation: (inches)
Pre: 1st week 1.38 2nd week 2.60

Soil: Silty Clay; 4.6% OM; 6.6 pH

Vele=Velvetleaf
Grft=Green foxtail
Cowh=Common waterhemp

Comments: Objective of the study was to look at treatments for corn weed control. Heavy velvetleaf and moderate green foxtail and common waterhemp pressure. Wet conditions delayed planting. Very wet all year long. No yield differences except for check noted. Most treatments provided full season weed control.

2019
CAPRENO/ACETOCHLOR COMPARISONS
Southeast Research Farm

Treatment	Rate/A	Vele 7/2/19	Cowh 7/2/19	Vele 7/16/19	Cowh 7/16/19	Vele 7/29/19	Cowh 7/29/19	Vele 8/7/19	Cowh 8/7/19	Yield bu/A 10/28/19
Check	---	0	0	0	0	0	0	0	0	120
Epost										
Capreno + Aatrex + RU Powermax + Superb HC + AMS	3 oz + 16 oz + 32 oz + 0.5% + 1.7 lb	99	99	99	99	98	99	99	99	196
Laudis + Aatrex + RU Powermax + Destiny HC + AMS	3 oz + 16 oz + 32 oz + 0.5% + 1.7 lb	99	99	99	99	98	99	99	99	199
Harness + RU Powermax + Aatrex + AMS	2 pt + 32 oz + 16 oz + 1.7 lb	99	96	98	95	98	97	99	96	196
Warrant + RU Powermax + Aatrex + AMS	4 pt + 32 oz + 16 oz + 1.7 lb	99	93	98	95	98	97	98	97	202
Capreno + Harness + RU Powermax + Aatrex + Superb HC + AMS	3 oz + 2 pt + 32 oz + 16 oz + 0.5% + 1.7 lb	99	99	99	99	98	99	99	99	205
Capreno + Warrant + RU Powermax + Aatrex + Superb HC + AMS	3 oz + 4 pt + 32 oz + 16 oz + 0.5% + 1.7 lb	99	99	99	99	98	99	99	99	200
Laudis + Harness + RU Powermax + Aatrex + Superb HC + AMS	3 oz + 2 pt + 32 oz + 16 oz + 0.5% + 1.7 lb	99	99	99	99	98	99	99	99	205
Laudis + Warrant + RU Powermax + Aatrex + Superb HC + AMS	3 oz + 4 pt + 32 oz + 16 oz + 0.5% + 1.7 lb	99	99	99	99	98	99	99	99	203
Acuron + RU Powermax + AMS	50 oz + 32 oz + 1.7 lb	99	99	99	99	98	99	99	99	197
Resicore + RU Powermax + Aatrex + AMS	40 oz + 32 oz + 16 oz + 1.7 lb	99	99	99	99	98	99	99	99	195
Halex GT + RU Powermax + AMS	1.8 qt + 32 oz + 1.7 lb	99	98	99	99	99	98	99	99	203
Harness Max + Aatrex + RU Powermax	40 oz + 16 oz + 32 oz	99	99	99	99	98	99	99	99	200
Capreno + Harness + RU Powermax + Aatrex + AMS	3 oz + 2 pt + 32 oz + 16 oz + 1.7 lb	98	99	99	99	98	99	98	99	205
Laudis + Harness + RU Powermax + Aatrex + AMS	3 oz + 2 pt + 32 oz + 16 oz + 1.7 lb	99	99	99	99	98	99	99	99	203
LSD (0.05)		0	2	1	2	1	2	1	2	12

RCB: 4 reps
Variety: DKC 50-08 RIB
Planting Date: 5/13/19
Epost: 6/14/19 Corn V4, 8-11 in; Vele 1-4 lf, 2-3 in; Cowh 2-5 in.

Soil: Clay Loam; 4.4% OM; 6.8 pH

Vele=Velvetleaf
Cowh=Common waterhemp

Comments: Objective of the study was to look at post treatments for corn weed control. Heavy velvetleaf and moderate waterhemp pressure. Wet conditions delayed planting. Very wet all year long. No yield differences except for check. All treatments provided full season weed control.

2019
INTEGRATED CORN HERBICIDE PROGRAMS
Southeast Research Farm

Treatment	Rate/A	Grft 6/13/19	Vele 6/13/19	Cowh 6/13/19	VCRR 6/21/19	Grft 7/2/19	Vele 7/2/19	Grft 10/28/19	Vele 10/28/19	Cowh 10/28/19	Yield bu/A 10/28/19
Pre											
Harness Xtra 5.6L	2.4 qt	99	82	99	0	96	66	--	--	--	198
Harness Xtra 5.6L + Balance Flexx	2 qt + 3 oz	99	98	99	0	96	94	--	--	--	206
Harness Xtra 5.6L + Corvus	2 qt + 3.3 oz	99	97	99	0	96	98	--	--	--	198
Corvus + Atrazine	4.5 oz + 1 qt	98	98	99	0	96	97	--	--	--	211
Corvus + Harness Xtra 5.6L	4.5 oz + 1.6 qt	99	97	99	0	96	98	--	--	--	206
Harness Max + Atrazine	2 qt + 1 qt	99	98	99	0	96	99	--	--	--	206
Acuron	2.5 qt	99	98	99	0	96	98	--	--	--	209
Resicore + Atrazine	2.5 qt + 1 qt	99	97	99	0	96	98	--	--	--	209
Pre & Epost											
Corvus + Atrazine & Harness Max + NIS + AMS	3.3 oz + 1 qt & 1.75 qt + 0.25% + 2.5%	98	97	99	0	97	99	98	99	99	210
Harness Max & Harness Max + NIS + AMS	40 oz & 40 oz + 0.25% + 2.5%	98	98	99	0	96	98	97	97	99	205
Pre & Post											
Harness Max + Atrazine & DiFlexx + MSO + AMS	2 qt + 1 qt & 8 oz + 1% + 2.5%	99	97	99	15	96	99	96	99	99	199
Harness Max + Atrazine & DiFlexx Duo + MSO + AMS	2 qt + 1 qt & 24 oz + 1% + 2.5%	99	98	99	15	97	99	98	99	99	204
Harness Max + Atrazine & Capreno + NIS + AMS	2 qt + 1 qt & 3 oz + 0.25% + 2.5%	99	98	99	0	97	99	98	99	99	199
Harness Xtra 5.6L + Balance Flexx & DiFLexx + MSO + AMS	2 qt + 3 oz & 8 oz + 1% + 2.5%	98	98	99	15	96	99	96	99	99	204
Harness Xtra 5.6L + Balance Flexx & Capreno + NIS + AMS	2 qt + 3 oz & 3 oz + 0.25% + 2.5%	99	97	99	0	96	99	99	99	99	200
Surestart II + Atrazine & RU Powermax + Callisto + NIS + AMS	2 pt + 1 pt & 32 oz + 3 oz + 0.25% + 2.5%	98	78	99	0	97	99	99	99	99	205
Epost											
Harness Xtra 5.6L + Capreno + RU Powermax + NIS + AMS	2 qt + 3 oz + 32 oz + 0.25% + 2.5%	--	--	--	0	99	99	99	99	99	199
Halex GT + Atrazine + NIS + AMS	1.8 qt + 1 qt + 0.25% + 2.5%	--	--	--	0	97	99	99	99	99	199
Check	---	0	0	0	0	0	0	0	0	0	136
LSD (0.05)		1	5	0	--	1	3	2	1	--	10

2019
INTEGRATED CORN HERBICIDE PROGRAMS
Southeast Research Farm

RCB: 4 reps
Variety: DKC 50-08 RIB
Planting Date: 5/13/19
Pre: 5/13/19
Epost: 6/14/19 Corn V4, 8-11 in; Grft 3-4 lf, 2-4 in; Vele 1-4 lf, 2-3 in; Cowh 2-5 in.
Post: 6/19/19 Corn V4-5, 15-18 in; Vele 2-4 in; Cowh 0.5-1.5 in.

Precipitation: (inches)
Pre: 1st week 1.38 2nd week 2.60

Soil: Silty Clay; 4.3% OM; 6.7 pH

Grft=Green foxtail
Vele=Velvetleaf
Cowh=Common waterhemp

Comments: Objective of the study was to look at treatments for corn weed control. Heavy velvetleaf and moderate green foxtail and common waterhemp pressure. Wet conditions delayed planting. Very wet all year long. No yield differences except for check noted. Several treatments provided full season weed control.

2019
LAUDIS WITH ADJUVANTS IN CORN
Southeast Research Farm

Treatment	Rate/A	Vele 6/25/19	Cowh 6/25/19	Vele 7/8/19	Cowh 7/8/19	Vele 7/25/19	Cowh 7/25/19	Yield bu/A 10/28/19
Post								
Laudis + Destiny HC + AMS	3 oz + 1% + 1.5 lb	28	50	82	86	86	97	164
Laudis + MaxSO + AMS	3 oz + 1% + 1.5 lb	28	46	83	86	91	97	169
Laudis + Destiny HC + AMS	1.5 oz + 1% + 1.5 lb	20	40	75	77	87	96	154
Laudis + MaxSO + AMS	1.5 oz + 1% + 1.5 lb	20	40	80	79	88	96	158
Check	---	0	0	0	0	0	0	116
LSD (0.05)		2	2	5	4	2	1	20

RCB: 4 reps
Variety: DKC 50-08 RIB
Planting Date: 5/13/19
Post: 6/19/19 Corn V4-5, 15-18 in; Vele 5-10 in; Cowh 4-10 in.

Soil: Clay Loam; 4.4% OM; 6.8 pH

Cowh=Common waterhemp
Vele=Velvetleaf

Comments: Objective of the study was to look at additive treatments for corn weed control. Heavy velvetleaf and moderate common waterhemp pressure. Wet conditions delayed planting. Very wet all year long. No yield differences except for check noted. Treatments were sprayed late to large weeds to detect control differences.

2019
GLYPHOSATE WITH ADJUVANTS IN CORN
Southeast Research Farm

Treatment	Rate/A	Vele 7/8/19	Cowh 7/8/19	Vele 7/16/19	Cowh 7/16/19
Post					
Aquaneat	18 oz	88	40	90	46
Aquatneat + Full Load	18 oz + 0.375%	94	60	96	66
Aquaneat + Preload + Agrasyst 90	18 oz + 0.125% + 0.25%	94	49	96	58
Aquaneat + Preload + Permeate	18 oz + 0.125% + 0.25%	94	44	96	52
Aquaneat + AgraSyst 90 + AMS	18 oz + 0.25% + 3.4 lb	94	45	96	64
Aquaneat + Permeate + AMS	18 oz + 0.25% + 3.4 lb	94	44	96	56
Aquaneat + MaxSO Con	18 oz + 1%	94	39	96	55
Aquaneat + Zaar	18 oz + 1%	93	30	95	49
Check	---	0	0	0	0
LSD (0.05)		2	11	1	7

RCB: 4 reps
Variety: DKC 50-08 RIB
Planting Date: 5/13/19
Post: 6/19/19 Corn V4-5, 15-18 in; Vele 5-10 in; Cowh 4-10 in.

Soil: Clay Loam; 4.4% OM; 6.8 pH

Cowh=Common waterhemp
Vele=Velvetleaf

Comments: Objective of the study was to look at additive treatments for corn weed control. Heavy velvetleaf and moderate common waterhemp pressure. Wet conditions delayed planting. Very wet all year long. Unloaded glyphosate was sprayed late to large weeds to detect control differences.

2019
ROUNDUP READY SOYBEAN DEMONSTRATION
Southeast Research Farm

Treatment	Rate/A	Vele 7/1/19	Cowh 7/1/19	Vele 7/17/19	Cowh 7/17/19	Yield bu/A 10/9/19
Check	---	0	0	0	0	35
PPI & Post						
Treflan + Dimetric & RU Powermax + AMS + Flexstar	1.5 pt + 0.33 lb & 32 oz + 2 qt + 1 pt	92	98	99	99	60
Prowl H2O + Dimetric & RU Powermax + AMS + Avalanche Ultra	3 pt + 0.33 lb & 32 oz + 2 qt + 1.5 pt	92	98	99	99	58
Pre & Post						
Sonic & Flexstar + Select Max + COC	5 oz & 1 pt + 12 oz + 0.25%	96	98	98	99	61
Authority MTZ & Avalanche Ultra + Section Three + NIS	14 oz & 1.5 pt + 5.33 oz + 0.25%	87	98	83	95	55
Surveil + Dimetric & Durango + AMS	3.25 oz + 4 oz & 1 qt + 2.5%	92	98	99	99	63
Sonic & EverpreX + Durango + AMS	4.5 oz & 1 pt + 1 qt + 2.5%	94	98	99	98	61
Afforia + Dimetric & Abundit Edge + AMS	2.5 oz + 4 oz & 1 qt + 2.5%	82	98	99	98	61
Broadaxe XC + Tricor DF & Flexstar GT + AMS + MSO	25 oz + 5 oz & 56 oz + 3.4 lb + 1%	94	98	99	99	59
Authority MTZ & Anthem Maxx + RU Powermax + COC + AMS	14 oz & 3 oz + 32 oz + 1 pt + 1.7 lb	94	98	99	99	60
Zidua Pro & RU Powermax + AMS	6 oz & 32 oz + 2 qt	93	98	99	99	61
Zidua + Verdict & RU Powermax + Outlook + AMS	2.5 oz + 5 oz & 32 oz + 10 oz + 2 qt	89	97	99	99	60
Fierce & RU Powermax + AMS	3 oz & 32 oz + 2 qt	85	98	99	99	61
Fierce MTZ & RU Powermax + AMS	1 pt & 32 oz + 2 qt	88	98	99	99	61
Dimetric Charged & RU Powermax + AMS	15 oz & 32 oz + 2 qt	87	98	99	99	62
LSD (0.05)		4	1	3	1	3

RCB: 4 reps
Variety: AG 15X9
Planting Date: 6/6/19
PPI/Pre: 6/6/19
Post: 7/1/19 Soy 2-3 tri, 6-7 in; Vele 2-4 in; Cowh 0.5-4 in.

Precipitation: (inches)
PPI/Pre: 1st week 0.40 2nd week 1.19

Soil: Clay; 4.8% OM; 7.0 pH

Vele=Velvetleaf
Cowh=Common waterhemp

Comments: Objective of the study was to look at program treatments for soybean weed control. Very heavy velvetleaf and moderate common waterhemp pressure. Planting was delayed due to wet conditions in the spring. Continued wet conditions all summer had an effect on treatments. Yields and weed control were excellent given the wet growing season.

2019
DICAMBA SOYBEAN DEMONSTRATION
Southeast Research Farm

Treatment	Rate/A	Vele 7/1/19	Cowh 7/1/19	Vele 7/17/19	Cowh 7/17/19	Yield bu/A 10/10/19
Check	---	0	0	0	0	28
Pre & Post						
Authority Supreme & Anthem Maxx + Xtendimax	8 oz & 2 oz + 22 oz	84	95	95	99	58
Authority First & Anthem Maxx + Xtendimax	4 oz & 3 oz + 22 oz	94	98	97	99	59
Valor + Mauler & Xtendimax + RU Pmax + Warrant + OnTarget	2.5 oz + 8 oz & 22 oz + 32 oz + 48 oz + 0.5%	82	97	99	99	58
Prefix & Tavium + RU Pmax + Class Act Ridion	32 oz & 56.5 oz + 27 oz + 1%	56	97	98	99	58
Broadaxe XC + Tricor DF & Tavium + RU Pmax + Class Act Ridion	25 oz + 5 oz & 56.5 oz + 27 oz + 1%	79	98	99	99	57
Boundary & Tavium + Flexstar + RU Pmax + Class Act Ridion	1.8 pt & 56.5 oz + 1 pt + 27 oz + 1%	84	97	99	99	56
Afforia & Abundit Edge + Fexapan + Class Act Ridion	2.5 oz & 32 oz + 22 oz + 1%	73	97	99	99	59
Sonic & Abundit Edge + Fexapan + EverpreX + Intact	6 oz & 32 oz + 22 oz + 1 pt + 0.5%	90	97	99	99	58
Zidua Pro & Engenia Pro + RU Powermax + Class Act Ridion + Superb HC	6 oz & 16 oz + 32 oz + 0.5% + 0.5%	93	98	99	99	56
Verdict + Tricor 4F & Engenia + RU Powermax + Class Act Ridion + Superb HC	5 oz + 4 oz & 12.8 oz + 32 oz + 0.5% + 0.5%	86	97	99	99	57
LSD (0.05)		6	1	2	0	3

RCB: 4 reps
Variety: AG 15X9
Planting Date: 6/6/19
Pre: 6/6/19
Post: 7/1/19 Soy 2-3 tri, 6-7 in; Vele 2-4 in; Cowh 0.5-4 in.

Precipitation: (inches)
Pre: 1st week 0.40 2nd week 1.19

Soil: Clay; 4.8% OM; 7.0 pH

Vele=Velvetleaf
Cowh=Common waterhemp

Comments: Objective of the study was to look at program treatments for soybean weed control. Very heavy velvetleaf and moderate common waterhemp pressure. Planting was delayed due to wet conditions in the spring. Continued wet conditions all summer had an effect on treatments. Yields and weed control were excellent given growing conditions.

2018
LIBERTY LINK/ENLIST SOYBEAN DEMONSTRATION
Southeast Research Farm

Treatment	Rate/A	Vele 7/1/19	Cowh 7/1/19	Vele 7/16/19	Cowh 7/16/19	Vele 7/29/19	Cowh 7/29/19	Yield bu/A 10/9/19
Check	---	0	0	0	0	0	0	41
Pre & Post								
Sonic & Durango + AMS	4.5 oz & 32 oz + 2.5%	93	98	99	99	99	99	64
Sonic & Glufosinate + AMS	4.5 oz & 29 oz + 2.5%	92	99	99	99	99	99	61
Sonic & Enlist Duo + AMS	4.5 oz & 56 oz + 2.5%	95	98	99	99	99	99	61
Sonic & Enlist Duo + AMS	4.5 oz & 75 oz + 2.5%	95	98	99	99	99	99	61
Sonic & Enlist One + Durango + AMS	4.5 oz & 24 oz + 24 oz + 2.5%	94	98	99	99	99	99	61
Sonic & Enlist One + Durango + AMS	4.5 oz & 32 oz + 32 oz + 2.5%	94	98	99	99	99	99	62
Sonic & Enlist One + Glufosinate + AMS	4.5 oz & 24 oz + 29 oz + 2.5%	95	98	99	99	99	99	63
Sonic & Enlist One + Glufosinate + AMS	4.5 oz & 32 oz + 29 oz + 2.5%	93	98	99	99	99	99	63
Fierce & Scout + AMS	3.5 oz & 29 oz + 1.7 lb	94	99	99	99	99	99	60
Boundary & Liberty + AMS	1.8 pt & 29 oz + 1.7 lb	83	98	99	99	98	99	62
Authority MTZ & Cheetah + AMS	14 oz & 29 oz + 1.5 lb	87	99	99	99	99	99	61
Valor & Warrant + Liberty + AMS	2 oz & 1.5 qt + 29 oz + 1.5 lb	89	97	99	99	99	99	59
LSD (0.05)		4	1	0	--	1	1	4

RCB: 4 reps
Variety: 15E920N
Planting Date: 6/6/19
Pre: 6/6/19
Post: 7/1/19 Soy 2-3 tri, 6-7 in; Vele 2-4 in; Cowh 0.5-4 in.

Precipitation: (inches)
Pre: 1st week 0.40 2nd week 1.19

Soil: Clay; 4.6% OM; 6.1 pH

Vele=Velvetleaf
Cowh=Common waterhemp

Comments: Objective of the study was to look at program treatments for soybean weed control. Very heavy velvetleaf and moderate common waterhemp pressure. Planting was delayed due to wet conditions in the spring. Continued wet conditions all summer had an effect on treatments. Yields and weed control were excellent given growing conditions.

2019
LLGT27 SOYBEAN DEMONSTRATION
Southeast Research Farm

Treatment	Rate/A	Grft 7/2/19	Vele 7/2/19	Vele 7/17/19	Cowh 7/17/19	Yield bu/A 10/9/19
Check	---	0	0	0	0	34
Epost						
RU Powermax + AMS	32 oz + 1.7 lb	--	--	99	98	64
Liberty + AMS	32 oz + 1.7 lb	--	--	98	99	65
Liberty + RU Pmax + AMS	32 oz + 32 oz + 1.7 lb	--	--	99	99	63
Pre & Post						
Alite 27 + Dimetric & RU Powermax + AMS	3 oz + 5.33 oz & 32 oz + 1.7 lb	99	99	99	99	61
Alite 27 + Dimetric & Liberty + AMS	3 oz + 5.33 oz & 32 oz + 1.7 lb	99	99	99	99	62
Alite 27 + Dimetric & Liberty + Outlook + AMS	3 oz + 5.33 oz & 32 oz + 12 oz + 1.7 lb	99	99	99	99	60
Alite 27 + Outlook & Liberty + AMS	3 oz + 10 oz & 32 oz + 1.7 lb	99	99	99	99	61
LSD (0.05)		1	--	1	0	6

RCB: 4 reps
Variety: LS14LGT952N
Planting Date: 6/6/19
Pre: 6/6/19
Epost: 7/1/19 Soy 2-3 tri, 6-7 in; Vele 2-4 in; Cowh 0.5-4 in.
Post: 7/12/19 Soy ebloom, 15 in; Cowh 4-10 in.

Precipitation: (inches)
Pre: 1st week 0.40 2nd week 1.19

Soil: Clay; 4.6% OM; 6.1 pH

Grft=Green foxtail
Vele=Velvetleaf
Cowh=Common waterhemp

Comments: Objective of the study was to look at treatments for soybean weed control. Very heavy velvetleaf and moderate common waterhemp pressure. Planting was delayed due to wet conditions in the spring. Continued wet conditions all summer had an effect on treatments. Yields and weed control were excellent given growing conditions.

2019
XTENDFLEX (HT3) SOYBEAN PROGRAMS
Southeast Research Farm

Treatment	Rate/A	Vele 7/1/19	Cowh 7/1/19	Vele 7/17/19	Cowh 7/17/19	Vele 7/29/19	Cowh 7/29/19	Yield (bu/A) 10/16/19
Check	---	0	0	0	0	0	0	52
Pre & Epost								
Authority MTZ & RU Powermax + AMS	14 oz & 32 oz + 2.5%	87	95	99	99	99	99	63
Authority MTZ & Xtendimax + RU Pmax + Class Act Ridion	14 oz & 22 oz + 32 oz + 1%	86	95	99	99	99	99	64
Authority MTZ & Warrant + Xtendimax + RU Powermax + Class Act Ridion	14 oz & 1.5 qt + 22 oz + 32 oz + 1%	85	97	99	99	99	99	65
Epost & Post								
Warrant + Xtendimax + RU Powermax + Class Act Ridion & Xtendimax + RU Powermax + Class Act Ridion	1.5 qt + 22 oz + 32 oz + 1% & 22 oz + 32 oz + 1%	--	--	99	98	99	99	65
Xtendimax + RU Powermax + Class Act Ridion & Xtendimax + RU Powermax + Class Act Ridion	22 oz + 32 oz + 1% & 22 oz + 32 oz + 1%	--	--	99	97	99	99	63
LSD (0.05)		5	1	0	3	0	2	3

RCB: 4 reps
Variety: AG23XFO
Planting Date: 6/6/19
Pre: 6/6/19
Epost: 7/1/19 Soy 2-3 tri, 6-7 in; Vele 2-4 in; Cowh 0.5-4 in.
Post: 7/18/19 Soy ebloom, 20-22 in; Cowh 4-8 in.

Precipitation: (inches)
Pre: 1st week 0.40 2nd week 1.19

Soil: Clay; 4.6% OM; 6.1 pH

Cowh=Common waterhemp
Vele=Velvetleaf

Comments: Objective of the study was to look at treatments for weed control in HT3 soybean. Very heavy velvetleaf and moderate common waterhemp pressure. Planting was delayed due to wet conditions in the spring. Continued wet conditions all summer had an effect on treatments. Yields and weed control were excellent given growing conditions.

2019
ENGENIA PRO PERFORMANCE VS COMPETITORS
Southeast Research Farm

Treatment	Rate/A	Grft 7/8/19	Cwoh 7/8/19	VCRR 7/8/19	Grft 7/16/19	Cowh 7/16/19	Grft 8/13/19	Vele 8/13/19	Cowh 8/13/19
Pre									
Verdict	5 oz	82	93	0	66	93	35	83	88
Pre & Epost									
Verdict & Engenia Pro + RU Powermax + Class Act Ridion + Superb HC	5 oz & 16 oz + 32 oz + 1% + 8 oz	99	98	10	99	99	99	99	99
Verdict & Xtendimax + Dual Magnum + RU Pmax + Class Act Ridion + Superb HC	5 oz & 22 oz + 16 oz + 32 oz + 1% + 8 oz	99	98	23	99	99	99	99	99
Verdict & Xtendimax + Warrant + RU Pmax + Class Act Ridion + Superb HC	5 oz & 22 oz + 48 oz + 32 oz + 1% + 8 oz	99	98	10	99	99	99	99	99
Check	---	0	0	0	0	0	0	0	0
Epost									
Engenia Pro + RU Powermax + Class Act Ridion + Superb HC	16 oz + 32 oz + 1% + 8 oz	98	96	--	98	96	99	99	98
Xtendimax + Dual Magnum + RU Pmax + Class Act Ridion + Superb HC	22 oz + 16 oz + 32 oz + 1% + 8 oz	99	96	--	99	97	99	99	99
Xtendimax + Warrant + RU Pmax + Class Act Ridion + Superb HC	22 oz + 48 oz + 32 oz + 1% + 8 oz	99	95	--	99	97	99	99	98
LSD (0.05)		4	2	2	10	2	7	1	4

Split-Plot: 4 reps
Planting Date: 6/6/19
Variety: AG15X9
Pre: 6/6/19
Epost: 7/2/19 Soy 3 tri, 7-9 in; Cowh 0.5-5 in; Grft 1-10 in; Vele 0.5-5 in.

Precipitation: (inches)
Pre: 1st week 0.40 2nd week 1.19

Soil: Silty Clay; 4.6% OM; 6.6 pH

Cowh=Common waterhemp
Grft=Green foxtail
Vele=Velvetleaf
VCRR=Visual Crop Response Rating
(0=no injury; 100=complete kill)

Comments: Objective of the study was to look at different program treatments for soybean weed control. Very heavy common waterhemp density and moderate velvetleaf and green foxtail pressure. Combination treatments with residual provided very good season long weed control.

2019
POST PERFORMANCE OF ENGENIA PRO VS COMPETITORS
Southeast Research Farm

Treatment	Rate/A	Vele 7/16/19	Cowh 7/16/19	Vele 7/25/19	Cowh 7/25/19	Vele 8/7/19	Cowh 8/7/19	Yield bu/A 10/22/19
Check	---	0	0	0	0	0	0	23
Epost								
Engenia Pro + RU Powermax + Class Act Ridion + Superb HC	16 oz + 32 oz + 1% + 8 oz	96	99	96	99	97	99	61
Xtendimax + Warrant + RU Powermax + Class Act Ridion + Superb HC	22 oz + 48 oz + 32 oz + 1% + 8 oz	93	98	91	98	96	99	60
Xtendimax + Dual Magnum + RU Powermax + Class Act Ridion + Superb HC	22 oz + 16 oz + 32 oz + 1% + 8 oz	92	99	93	98	94	99	59
Prefix + RU Powermax + COC	32 oz + 32 oz + 16 oz	78	99	57	98	46	99	40
Anthem Maxx + RU Powermax + COC	3.25 oz + 32 oz + 16 oz	80	97	59	93	54	92	48
LSD (0.05)		5	2	10	0	9	1	7

RCB: 4 reps
Variety: AG15X9
Planting Date: 6/6/19
Epost: 6/25/19 Soy 1 tri, 3-4 in; Vele cot-2 in; Cowh cot-1 in.

Soil: Silty Clay; 4.6% OM; 6.6 pH

Cowh=Common waterhemp
Vele=Velvetleaf

Comments: Objective of the study was to look at different early post treatments for soybean weed control. Very heavy common waterhemp and velvetleaf pressure. Poor velvetleaf control affected soybean yield.

2019
DIMETRIC CHARGED PRE STUDY
Southeast Research Farm

Treatment	Rate/A	Mata 6/25/19	Vele 6/25/19	Mata 7/16/19	Vele 7/16/19
Pre					
Valor	2.5 oz	30	83	23	35
Dimetric 3L	15 oz	0	70	40	25
Dimetric Charged	15 oz	58	79	60	60
Dimetric Charged + Charger Basic	15 oz + 1.3 pt	75	92	81	63
Check	---	0	0	0	0
LSD (0.05)		8	13	25	20

RCB: 4 reps
Variety: AG20X7
Planting Date: 6/18/19
Pre: 6/6/19

Precipitation: (inches)
Pre: 1st week 0.40 2nd week 1.19

Soil: Silty Clay; 3.5% OM; 6.7 pH

Mata=Marestail
Vele=Velvetleaf

Comments: Objective of the study was to look at different preemergence treatments for weed control in no-till soybeans. Heavy velvetleaf and moderate marestail pressure. Planting was delayed due to wet conditions. Combination treatments performed better than stand alone products.

2019
DIMETRIC CHARGED PLUS SHARPEN for BURNDOWN
Southeast Research Farm

Treatment	Rate/A	Grft 6/25/19	Cowh 6/25/19	Grft 7/2/19	Cowh 7/2/19	Grft 7/8/19	Cowh 7/8/19	Grft 7/16/19	Cowh 7/16/19	Grft 7/29/19	Cowh 7/29/19
Check	---	0	0	0	0	0	0	0	0	0	0
Burndn											
Sharpen	2 oz	48	61	43	40	15	28	20	33	25	30
Sharpen + Dimetric Charged	2 oz + 12 oz	77	97	68	99	45	98	45	98	25	95
Sharpen + Dimetric Charged	2 oz + 15 oz	80	97	70	99	48	98	53	98	23	95
Sharpen + Dimetric Charged	2 oz + 18 oz	80	97	72	99	45	98	55	98	26	95
Sharpen + Dimetric Charged + Strikelock	2 oz + 12 oz + 8 oz	81	98	73	99	46	98	49	98	23	95
Sharpen + Dimetric Charged + Strikelock	2 oz + 15 oz + 8 oz	76	98	62	99	39	98	49	98	23	95
Sharpen + Dimetric Charged + Strikelock	2 oz + 18 oz + 8 oz	82	98	70	99	50	98	59	98	25	95
LSD (0.05)		6	1	12	--	14	5	12	7	9	4

RCB: 4 reps
Burndn: 6/19/19 Cowh 2-8 in.

Soil: Clay Loam; 4.4% OM; 6.8 pH

Precipitation: (inches)
Burndn: 1st week 2.52 2nd week 0.40

Grft=Green foxtail
Cowh=Common waterhemp

Comments: Objective of the study was to look at different burndown treatments for soybean weed control. Very heavy common waterhemp and moderate green foxtail pressure. Burndown with residual broadleaf control provided season long waterhemp control.

2019
DIMETRIC CHARGED PLUS STRIKELOCK for BURNDOWN
Southeast Research Farm

Treatment	Rate/A	Grft 6/25/19	Vele 6/25/19	Cowh 6/25/19	Grft 7/2/19	Vele 7/2/19	Cowh 7/2/19	Grft 7/16/19	Cowh 7/16/19	Grft 7/29/19	Cowh 7/29/19	Vele 7/29/19
Check	---	0	0	0	0	0	0	0	0	0	0	0
Burndn												
RU Powermax + Class Act NG	32 oz + 2.5%	75	89	70	99	99	73	88	36	97	0	96
RU Powermax + Class Act NG + Dimetric Charged	32 oz + 2.5% + 12 oz	98	97	98	99	99	99	97	96	90	92	88
RU Powermax + Class Act NG + Dimetric Charged	32 oz + 2.5% + 15 oz	98	97	98	99	99	99	97	96	89	93	90
RU Powermax + Class Act NG + Dimetric Charged	32 oz + 2.5% + 18 oz	98	97	99	99	99	99	96	98	92	96	92
RU Powermax + Class Act NG + Dimetric Charged + Strikelock	32 oz + 2.5% + 12 oz + 8 oz	98	98	99	99	99	99	94	97	83	94	88
RU Powermax + Class Act NG + Dimetric Charged + Strikelock	32 oz + 2.5% + 15 oz + 8 oz	98	98	99	99	99	99	97	97	91	96	88
RU Powermax + Class Act NG + Dimetric Charged + Strikelock	32 oz + 2.5% + 18 oz + 8 oz	98	96	99	99	99	99	97	98	93	98	93
LSD (0.05)		1	3	2	1	--	1	2	3	4	3	4

RCB: 4 reps
Burndn: 6/19/19 Cowh 2-8 in; Vele 2-8 in; Grft 2-8 in.

Soil: Silty Clay; 4.6% OM; 6.6 pH

Precipitation: (inches)
Burndn: 1st week 2.52 2nd week 0.40

Grft=Green foxtail
Cowh=Common waterhemp
Vele=Velvetleaf

Comments: Objective of the study was to look at different adjuvant treatments for soybean weed control. Very heavy velvetleaf and common waterhemp density and moderate green foxtail pressure. Treatments with residual provided very good season long weed control.

2019
PREEMERGENCE SOYBEAN HERBICIDE COMPARISONS
Southeast Research Farm

Treatment	Rate/A	Grft 6/25/19	Vele 6/25/19	Grft 10/9/19	Cowh 10/9/19	Vele 10/9/19	Yield (bu/A) 10/9/19
Check	---	0	0	0	0	0	27
Pre & Post							
Boundary &	2 pt &	93	30	99	99	99	59
Tavium + RU Pmax + Class Act Ridion + Intact	56.5 oz + 26 oz + 1% + 0.5%						
Prefix &	2.5 pt &	95	40	99	99	99	58
Tavium + RU Pmax + Class Act Ridion + Intact	56.5 oz + 26 oz + 1% + 0.5%						
Prefix + Tricor DF &	2.5 pt + 6 oz &	96	58	99	99	99	58
Tavium + RU Pmax + Class Act Ridion + Intact	56.5 oz + 26 oz + 1% + 0.5%						
Broadaxe XC + Tricor DF &	25 oz + 6 oz &	97	53	99	99	99	59
Tavium + RU Pmax + Class Act Ridion + Intact	56.5 oz + 26 oz + 1% + 0.5%						
Zidua Pro &	6 oz &	98	91	99	99	99	58
Tavium + RU Pmax + Class Act Ridion + Intact	56.5 oz + 26 oz + 1% + 0.5%						
Valor XLT &	3.3 oz &	95	81	99	99	99	58
Tavium + RU Pmax + Class Act Ridion + Intact	56.5 oz + 26 oz + 1% + 0.5%						
Fierce XLT &	4 oz &	93	81	99	99	99	60
Tavium + RU Pmax + Class Act Ridion + Intact	56.5 oz + 26 oz + 1% + 0.5%						
Sonic &	6.4 oz &	95	93	99	99	99	60
Tavium + RU Pmax + Class Act Ridion + Intact	56.5 oz + 26 oz + 1% + 0.5%						
Broadaxe XC &	29 oz &	98	76	99	99	99	60
Tavium + RU Pmax + Class Act Ridion + Intact	56.5 oz + 26 oz + 1% + 0.5%						
LSD (0.05)		6	6	1	--	1	3

RCB: 4 reps
Variety: AG15X9
Planting Date: 6/6/19
Pre: 6/6/19
Post: 7/2/19 Soy 2-3 tri, 6-7 in; Vele 1-4 in.

Soil: Clay; 4.6% OM; 7.4 pH

Precipitation: (inches)
Pre: 1st week 0.40 2nd week 1.19

Grft=Green foxtail
Vele=Velvetleaf
Cowh=Common waterhemp

Comments: Objective of the study was to look at pretreatments for soybean weed control. Very heavy velvetleaf and moderate common waterhemp pressure. Planting was delayed due to wet conditions in the spring. Continued wet conditions all summer had an effect on treatments. Yields and weed control were excellent given growing conditions.

2019
WEED CONTROL COMPARISONS IN XTEND SOYBEANS
Southeast Research Farm

Treatment	Rate/A	Vele 7/2/19	Cowh 7/2/19	Vele 7/8/19	Cowh 7/8/19	VCRR-Necrosis 7/8/19	Vele 7/16/19	Cowh 7/16/19	Vele 7/29/19	Cowh 7/29/19	Yield (bu/A) 10/9/19
Check	---	0	0	0	0	0	0	0	0	0	29
Pre & Post											
Boundary & Tavium + RU Powermax + Class Act Ridion + Intact	1.8 pt & 56.5 oz + 28.4 oz + 1% + 0.5%	54	95	97	99	15	99	99	99	99	56
Broadaxe XC & Tavium + RU Powermax + Class Act Ridion + Intact	25 oz & 56.5 oz + 28.4 oz + 1% + 0.5%	78	97	96	99	13	98	99	99	99	58
Prefix & Tavium + RU Powermax + Class Act Ridion + Intact	32 oz & 56.5 oz + 28.4 oz + 1% + 0.5%	52	96	97	99	15	99	99	98	99	56
Valor & Xtendimax + RU Powermax + Class Act Ridion + Intact	2 oz & 22 oz + 28.4 oz + 1% + 0.5%	62	96	96	99	5	99	98	99	99	58
Zidua Pro & Engenia + RU Powermax + Class Act Ridion + Intact	4.5 oz & 12.8 oz + 28.4 oz + 1% + 0.5%	96	98	99	99	5	99	99	99	99	60
LSD (0.05)		10	1	2	1	2	1	1	1	1	3

RCB: 4 reps
Variety: AG15X9
Planting Date: 6/6/19
Pre: 6/6/19
Post: 7/2/19 Soy 2-3 tri, 6-7 in; Vele 1-4 in; Cowh 0.5-4 in.

Precipitation: (inches)
Pre: 1st week 0.40 2nd week 1.19

Soil: Clay; 4.8% OM; 7.0 pH

Cowh=Common waterhemp
Vele=Velvetleaf

Comments: Objective of the study was to look at treatments for soybean weed control. Very heavy velvetleaf and moderate common waterhemp pressure. Planting was delayed due to wet conditions in the spring. Continued wet conditions all summer had an effect on treatments. Yields and weed control were excellent given growing conditions.

2019
DICAMBA, GLUFOSINATE and 2,4-D BAREGROUND COMPARISONS
Southeast Research Farm

Treatment	Rate/A	Vele 6/25/19	Vele 7/2/19	Cowh 7/2/19	Vele 7/8/19	Cowh 7/8/19	Vele 7/25/19	Cowh 7/25/19	Vele 8/7/19	Cowh 8/7/19	Vele 8/13/19	Cowh 8/13/19
Check	---	0	0	0	0	0	0	0	0	0	0	0
Pre & Epost												
Engenia & Select Max + COC + AMS	12.8 oz & 9 oz + 1% + 2.5 lb	69	38	13	33	28	40	0	0	0	0	0
Enlist One & Select Max + COC + AMS	32 oz & 9 oz + 1% + 2.5 lb	91	58	38	38	50	43	0	0	0	0	0
Engenia Pro & Select Max + COC + AMS	16 oz & 9 oz + 1% + 2.5 lb	80	88	96	70	96	48	86	0	77	0	80
Epost & Post												
Select Max + COC + AMS & Engenia + NIS	9 oz + 1% + 2.5 lb & 12.8 oz + 0.25%	--	--	--	--	--	65	61	50	43	38	40
Select Max + COC + AMS & Enlist One + NIS	9 oz + 1% + 2.5 lb & 32 oz + 0.25%	--	--	--	--	--	69	68	77	75	54	61
Select Max + COC + AMS & Liberty + AMS	9 oz + 1% + 2.5 lb & 32 oz + 2.5 lb	--	--	--	--	--	86	91	74	75	35	33
LSD (0.05)		12	12	21	16	13	11	3	9	6	13	8

RCB: 4 reps
Pre: 6/6/19
Epost: 7/2/19
Post: 7/18/19 Cowh 16-24 in; Vele 16-26 in.

Precipitation: (inches)
Pre: 1st week 0.40 2nd week 1.19

Soil: Clay Loam; 4.4% OM; 6.8 pH

Cowh=Common waterhemp
Vele=Velvetleaf

Comments: Objective of the study was to look at different timing of treatments for soybean weed control. Very heavy common waterhemp and velvetleaf pressure. Treatments worked early, but with excess moisture more weed flushes developed.

2019
NO-TILL PROGRAM COMPARISONS IN ROUNDUP XTEND SOYBEANS
Southeast Research Farm

Treatment	Rate/A	Mata 6/25/19	Mata 7/2/19	Vele 7/2/19	Colq 7/2/19	Grft 7/8/19	Vele 7/8/19	Cowh 10/9/19	Vele 10/9/19	Yield (bu/A) 10/9/19
Check	---	0	0	0	0	0	0	0	0	14
Pre & Post										
RU Powermax + Xtendimax + NIS + OnTarget & RU Powermax + Select Max + NIS + AMS	32 oz + 22 oz + 0.25% + 0.5% & 32 oz + 9 oz + 0.25% + 1.5 lb	99	99	50	99	40	38	97	99	60
RU Powermax + Xtendimax + Fierce EZ + NIS + OnTarget & RU Powermax + Select Max + NIS + AMS	32 oz + 22 oz + 6 oz + 0.25% + 0.5% & 32 oz + 9 oz + 0.25% + 1.5 lb	99	97	93	99	88	85	99	99	65
RU Powermax + Xtendimax + Fierce MTZ + NIS + OnTarget & RU Powermax + Select Max + NIS + AMS	32 oz + 22 oz + 1 pt + 0.25% + 0.5% & 32 oz + 9 oz + 0.25% + 1.5 lb	99	98	91	99	95	87	99	99	66
RU Powermax + Xtendimax + Authority MTZ + NIS + OnTarget & RU Powermax + Anthem Maxx + Select Max + NIS + AMS	32 oz + 22 oz + 11 oz + 0.25% + 0.5% & 32 oz + 2.5 oz + 9 oz + 0.25% + 1.5 lb	99	98	92	99	55	88	99	99	63
RU Powermax + Xtendimax + Authority First + NIS + OnTarget & RU Powermax + Select Max + NIS + AMS	32 oz + 22 oz + 4.5 oz + 0.25% + 0.5% & 32 oz + 9 oz + 0.25% + 1.5 lb	99	99	96	99	79	96	97	99	63
LSD (0.05)		--	1	6	--	15	11	3	1	7

RCB: 4 reps
Variety: AG20X7
Planting Date: 6/18/19
Pre: 6/6/19 Mata 3-6 in; Colq 1-5 in; Vele 1-6 in; Grft 2-4 in; Cowh 1-4 in.
Post: 7/18/19 Soy 4-5 tri, 12-15 in; Mata 5-14 in; Vele 2-15 in; Grft 4-12 in.

Precipitation: (inches)
Pre: 1st week 0.40 2nd week 1.19

Soil: Clay; 4.8% OM; 7.0 pH

Mata=Marestail
Colq=Common lambsquarters
Vele=Velvetleaf
Grft=Green foxtail
Cowh=Common waterhemp

Comments: Objective of the study was to look at different preemergence treatments for weed control in no-till soybeans. Heavy velvetleaf density and moderate marestail, lambsquarter and waterhemp pressure. Planting was delayed due to wet conditions. Several treatments provided season long control.

2019
FLEXSTAR WITH ADJUVANTS IN SOYBEANS
Southeast Research Farm

Treatment	Rate/A	Vele 7/16/19	Cowh 7/16/19	Vele 7/25/19	Cowh 7/25/19
Post					
Flexstar + MSO	1 pt + 1%	96	98	95	96
Flexstar + MaxSO	1 pt + 1%	95	97	94	96
Flexstar + MSO	0.5 pt + 1%	88	97	90	87
Flexstar + MaxSO	0.5 pt + 1%	90	97	90	89
Check	---	0	0	0	0
LSD (0.05)		2	2	1	5

RCB: 4 reps
Variety: AG15X9
Planting Date: 6/6/19
Post: 7/2/19 Soy 3 tri, 7-9 in; Cowh 0.5-8 in; Vele 1-9 in.

Soil: Silty Clay; 4.6% OM; 6.6 pH

Cowh=Common waterhemp
Vele=Velvetleaf

Comments: Objective of the study was to look at different adjuvant treatments for soybean weed control. Very heavy velvetleaf and moderate common waterhemp pressure. Planting was delayed due to wet conditions in the spring. Continued wet conditions all summer had an effect on treatments. Excellent weed control at full rates.

2019
ADJUVANTS IN SOYBEANS
Southeast Research Farm

Treatment	Rate/A	Vele 8/7/19	Cowh 8/7/19	Vele 8/13/19	Cowh 8/13/19
Post					
Fexapan + RU Powermax + Full Load + Vaporlock + OnTarget	11 oz + 16 oz + 0.375% + 0.25% + 0.5%	96	93	95	91
Fexapan + RU Powermax + Leeway II + Vaporlock	11 oz + 16 oz + 0.625% + 0.25%	99	95	98	95
Engenia + RU Powermax + Full Load + Vaporlock	6.4 oz + 16 oz + 0.375% + 0.25%	97	94	96	94
Engenia + RU Powermax + Leeway II + Vaporlock	6.4 oz + 16 oz + 0.625% + 0.25%	98	94	98	94
Xtendimax + RU Powermax + Full Load + Vaporlock + OnTarget	11 oz + 16 oz + 0.375% + 0.25% + 0.5%	97	93	95	94
Xtendimax + RU Powermax + Leeway II + Vaporlock	11 oz + 16 oz + 0.625% + 0.25%	98	94	98	94
Enlist Duo + Full Load	2.65 pt + 0.375%	99	97	93	91
Enlist Duo + Full Load Complete	2.65 pt + 0.375%	99	97	94	93
Enlist Duo + AMS	2.65 pt + 3.4 lb	99	96	95	92
Check	---	0	0	0	0
LSD (0.05)		3	2	4	2

RCB: 4 reps
Planting Date: 6/6/19
Post: 7/18/19 Soy 20-24 in; Cowh 8-34 in; Vele 6-24 in.

Soil: Clay; 4.6% OM; 7.4 pH

Cowh=Common waterhemp
Vele=Velvetleaf

Comments: Objective of the study was to look at different adjuvant treatments for soybean weed control. Very heavy velvetleaf and moderate common waterhemp pressure. Planting was delayed due to wet conditions in the spring. Continued wet conditions all summer had an effect on treatments. Weed control was excellent given growing conditions.

2019
COMMON WATERHEMP CONTROL IN SPRING WHEAT
Southeast Research Farm

Treatment	Rate/A	Cowh 7/2/19	Colq 7/2/19	VCRR 7/2/19	Cowh 7/16/19	Colq 7/16/19	Cowh 7/29/19	Colq 7/29/19
Check	---	0	0	0	0	0	0	0
Post								
Quelex + NIS	0.75 oz + 0.25%	64	83	0	65	99	66	98
WideMatch	16 oz	50	85	0	51	98	30	98
WideMatch + Quelex + NIS	16 oz + 0.75 oz + 0.25%	85	86	0	79	99	86	99
WideMatch + 2,4-D ester LV6	16 oz + 8 oz	97	99	10	99	99	99	99
WideMatch + Harmony 50SG + Express 50SG + NIS	16 oz + 0.2 oz + 0.2 oz + 0.25%	82	99	0	79	99	76	99
Pixxaro EC	6 oz	75	99	0	89	99	74	99
Pixxaro EC + NIS	6 oz + 0.25%	78	99	0	85	99	83	99
Pixxaro EC +Destiny HC	6 oz + 1%	83	99	0	81	99	85	99
Pixxaro EC + 2,4-D ester LV6	6 oz + 8 oz	98	99	8	99	99	98	99
GF-4030 + NIS	14 oz + 0.25%	87	99	0	80	99	83	99
GF-4030 + 2,4-D ester LV6	14 oz + 8 oz	97	99	10	99	99	99	99
OpenSky + NIS + AMS	16 oz + 0.5% + 20 oz	78	96	0	77	99	65	99
OpenSky + Quelex + NIS + AMS	16 oz + 0.75 oz + 0.5% + 20 oz	84	98	0	82	99	84	98
Huskie + AMS	11.3 oz + 20 oz	97	99	0	98	99	94	99
LSD (0.05)		7	2	2	8	1	8	0

RCB: 4 reps
Variety: Advance
Planting Date: 5/7/19
Post: 6/19/19 Sp Wheat 4-5 lf tiller, 8-12 in; Cowh 2-8 in; Colq 2-7 in.

Soil: Clay Loam; 4.4% OM; 6.8 pH

Cowh=Common waterhemp
Colq=Common lambsquarters
VCRR=Visual Crop Response Rating
(0=no injury; 100=complete kill)

Comments: Objective of the study was to look at weed control programs for waterhemp control in small grain. Heavy waterhemp and moderate lambsquarter pressure. Most combination treatments provided season long waterhemp weed control.

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Interactions of Silage Variety and Inclusion Level on Animal Growth Performance, Carcass Traits, and Beef Production per Acre of Cropland in Steers Harvested at a Common Fatness Endpoint

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Objective

The experimental objective was to determine the interactions of silage variety and inclusion level in cattle finishing diets have on agronomic returns to cropland when fed to beef cattle.

Approach

High grain content finishing diets were fed to steers for an average of 133 d, in order to, evaluate the interaction of corn silage variety and inclusion level in finishing diets on agronomic returns to cattle feeders.

A 2 (silage variety) × 2 (silage inclusion level) factorial arrangement of treatments was used of factors: silage variety (Conventional or Enogen Feed Corn) and inclusion level (12 or 24% DM basis). There were 5 replicate pens of 6 to 12 steers assigned to each treatment.

Cattle

A total of 192 steers and 48 steers per treatment were used. There were two populations of steers sourced from a South Dakota sale barn used in this study. Source 1 steers (n=150 steers with a pay weight of 919 lbs, first 3 pen replicates, n=10 steers/pen; and pen replicate 4, n=6 steers/pen) and Source 2 steers (n=55 steers with a pay weight of 970 lbs; pen replicate 5; 12 steers/pen) were received on March 25, 2019. Cattle were processed on March 28, 2019. Processing included: individual BW measurement, application of a unique identification tag, vaccination against respiratory diseases (Bovi-Shield Gold 5, Zoetis, Parsippany, NJ) and clostridial species (Ultrabac 7/Somubac, Zoetis). On April, 2, 2019, steers were administered pour-on moxidectin and administered a steroidal implant (200 mg trenbolone acetate and 28 mg estradiol benzoate).

Feeding

Steers were fed once daily. Steers were stepped up to the final diet over a 21 d period. The final diets fed are shown in Table 1. Bunks were managed to be slick at 0800h most mornings. Feed intake and diet formulations were summarized at weekly intervals. Steers that were removed from the study or that died during the study were assumed to have consumed feed equal to the pen mean DMI up to the point of removal or death.

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Targeted inclusion of silage in the test diets was achieved. Actual diet formulation is based upon weekly DM analyses of diet ingredient samples and corresponding feed batching records. Diets presented in Table 1 are actual DM diet formulations for the finishing diets fed along with tabular nutrient and energy values (NASEM, 2016).

Management of Pulls

All steers that were pulled from their home pen for health evaluation were then monitored in individual hospital pens prior to being returned to their home pens. When a steer was moved to a hospital pen the appropriate amount of feed from the home pen was removed and transferred to the hospital pen. If the steer in the hospital returned to their home pen, this feed remained credited to the home pen. If the steer did not return to their home pen, all feed that was delivered to the hospital pen was deducted from the feed intake record for that particular pen back to the date the steer was hospitalized.

Production variables

Steer BW was recorded for each animal at the time of study initiation (individual BW), d 28 (pen BW), d 63 (individual BW), and the morning of shipment on d 126 or d 140 (individual BW) for the calculation of live growth performance. Body weights were measured prior to the morning feeding; a 3% pencil shrink was applied to final BW, carcass-adjusted performance was calculated from HCW/0.625.

Performance adjusted NE (paNE) was calculated from daily energy gain (EG; Mcal/d): $EG = ADG^{1.097}\ 0.0557W^{0.75}$, where W is the mean equivalent shrunk BW [kg;(NRC, 1984)]. Maintenance energy (EM) was calculated by the equation: $EM = 0.077W^{0.75}$. Dry matter intake is related to energy requirements and dietary NEm according to the following equation: $DMI = EG/(0.877NEm - 0.41)$, and can be resolved for estimation of dietary NEm by means of the quadratic formula $x = (-b - \sqrt{b2} - 4ac)/2c$, where $a = -0.41EM$, $b = 0.877EM + 0.41DMI + EG$, and $c = -0.877DMI$ (Zinn and Shen, 1998). Dietary NEg was derived from NEm by the following equation: $NEg = 0.877NEm - 0.41$ (Zinn, 1987).

Termination

Cattle were shipped when they were visually appraised to have 0.50 in of back fat (BF). Cattle were shipped in two groups on August 6, 2019 (12% inclusion) after 126 DOF and August 20, 2019 (24% inclusion) after 140 DOF and harvested the following day at Tyson Fresh Meats in Dakota City, NE. Steers were comingled at the time of shipping and remained as such until 0700h the morning following shipping. Individual steer identity was tracked through the harvest facility. Hot carcass weight was recorded at the hot scale during the tag transfer procedure. Video image data was obtained from the plant for ribeye area (REA), backfat (BF), and USDA marbling scores. Dressing percentage was calculated as: HCW/(final BW × 0.97). Estimated empty body fat percentage was calculated using carcass traits (Guiroy et al., 2002). Estimated proportion of closely trimmed boneless retail cuts from carcass round, loin, rib, and chuck (Retail Yield) was also calculated from carcass traits (Murphey et al., 1960).

Beef production per acre of crop production was calculated from actual intake of corn silage and corn for each pen. These calculations were done using the weekly diet compositions and DMI records. Corn yield (bu/acre) was estimated from corn silage yield using the following equation: wet yield (T/acre) × 8. Actual corn silage yield (wet) was 20.4 and 18.8 T/acre for conventional and enogen, respectively. Cropland required was the sum of pounds consumed/yield calculated for corn and corn silage. Beef production per acre was then calculated as: (carcass adjusted final BW-Initial BW)/acres.

Statistical Analyses

Growth performance was calculated on a deads and removals- excluded basis. Growth performance and carcass traits were analyzed as a randomized complete block design using the GLIMMIX procedure of SAS 9.4 (SAS Inst. Inc., Cary, NC) with pen as the experimental unit. The model included fixed effects of block (pen replicate), silage variety, inclusion level and their interaction. Least squares means were generated using the LSMEANS statement of SAS. Data means were separated and denoted to be different using the pairwise comparisons PDIFF and LINES option of SAS when a significant preliminary F-test was detected. An α of 0.05 determined significance and tendencies are discussed from 0.05 to 0.10.

RESULTS

Animal Growth Performance

There was no silage × inclusion interaction ($P \geq 0.15$) detected for any live or carcass adjusted growth performance traits. Silage variety did not influence final live or carcass adjusted BW ($P \geq 0.54$), ADG ($P \geq 0.35$), DMI ($P = 0.54$), or F:G ($P \geq 0.65$). Silage variety had no influence on paNE values ($P \geq 0.55$) or observed/expected NE values ($P \geq 0.53$). Steers fed 24% silage had greater final live and carcass adjusted BW ($P \leq 0.03$), however, steers fed 24% inclusion of silage required an extra 14 DOF to reach a similar compositional endpoint as the 12% inclusion steers, that ultimately translated into poorer ($P = 0.04$) live basis ADG for the high inclusion steers. Daily DMI did not differ ($P = 0.86$) due to silage inclusion level. Steers fed 12% silage had improved live ($P = 0.01$) and carcass adjusted ($P = 0.04$) F:G compared to the 24% inclusion steers. Steers fed 24% inclusion tended to have lower ($P \leq 0.07$) paNE values compared to 12% inclusion steers, and observed/expected NE values did not differ ($P \geq 0.52$) due to silage inclusion level.

Carcass trait responses and beef production per acre of cropland

There was no silage × inclusion interaction ($P \geq 0.06$) detected for any carcass traits or beef production per acre of cropland. Silage variety did not influence ($P \geq 0.19$) dress, HCW, REA, BF, marbling scores, KPH percentage, estimated EBF, final BW at 28% EBF, calculated USDA YG, or retail yield. Silage variety did influence ($P = 0.01$) beef production per acre of cropland, where the conventional variety produced greater beef per acre of cropland (1892 vs. 1765 ± 23.0 lbs of beef/acre cropland). No differences ($P \geq 0.06$) were detected for dress, REA, marbling score, KPH percentage, estimated EBF, or final BW at 28% EBF due to silage inclusion level. Silage inclusion level did alter ($P \leq 0.04$) HCW, BF, USDA calculated YG, retail yield, and beef production per acre of cropland.

Conclusions:

These data indicate that silage variety has no influence on animal growth performance or carcass traits, but silage variety does impact beef production per acre of cropland, primarily attributable to differing wet silage yield, that in turn impacts corn yield (bu/acre). Cattle fed greater inclusion level of silage had greater HCW and beef production per acre of cropland compared to the low inclusion of silage. Which is an important agronomic concern for feedlots in the upper Midwest that grow a large proportion of their own feed.

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Table 1. Actual diet formulations fed.[1]

	Step 1 (d 1 to 7)				Step 2 (d 8 to 14)				Step 3 (d 15 to 21)				Finisher (d 22 to harvest)			
	Conventional		Enogen		Conventional		Enogen		Conventional		Enogen		Conventional		Enogen	
	12	24	12	24	12	24	12	24	12	24	12	24	12	24	12	24
Dry rolled corn, %	35.33	27.60	34.56	27.22	44.01	37.12	43.37	36.12	51.87	44.97	51.99	45.17	65.15	52.89	65.02	52.69
Modified distillers grains with solubles, %	15.11	15.29	14.79	14.55	15.18	15.18	14.92	14.82	20.43	20.46	20.47	20.56	19.29	19.66	19.26	19.58
Silage, %	11.24	22.75	13.36	26.38	11.77	23.54	13.03	25.71	11.77	23.59	11.57	23.24	11.48	23.26	11.65	23.56
Hay, %	34.31	30.35	33.46	28.12	25.12	20.17	24.81	19.56	11.98	7.01	12.00	7.05	--	--	--	--
Liquid Supplement, % [2]	4.01	4.01	3.83	3.73	3.92	3.99	3.87	3.79	3.95	3.97	3.97	3.98	4.08	4.19	4.07	4.17
DM, %	67.80	61.05	69.28	63.81	67.63	61.33	68.46	62.80	65.69	59.66	65.65	59.58	65.82	58.98	67.10	60.31
CP, %	13.49	13.45	13.34	13.14	13.29	13.22	13.21	13.05	14.20	14.11	14.21	14.14	13.75	13.88	13.74	13.85
NDF, %	36.61	38.80	36.84	38.71	31.88	33.55	32.09	33.92	26.62	28.32	26.57	28.24	19.63	24.11	19.68	24.20
ADF, %	20.58	21.86	20.73	21.80	17.22	18.17	17.38	18.42	12.92	13.87	12.88	13.81	8.14	11.01	8.18	11.07
ASH, %	6.53	6.68	6.45	6.51	5.91	6.04	5.90	5.96	5.20	5.30	5.20	5.30	4.45	4.92	4.45	4.92
EE, %	4.12	4.05	4.10	4.00	4.23	4.16	4.21	4.14	4.59	4.52	4.59	4.53	4.69	4.57	4.68	4.56
NEm, Mcal/cwt	82.40	81.03	82.29	81.10	85.81	84.71	85.63	84.50	90.94	89.87	90.98	89.94	95.46	92.47	95.43	92.40
NEg, Mcal/cwt	51.94	51.00	51.88	51.14	55.27	54.61	55.13	54.44	60.33	59.68	60.36	59.74	64.73	62.23	64.70	62.17

[1] All values except DM on a DM basis.
[2] Provided 30 g/ton of monensin as well as vitamins and minerals to exceed requirements (NASEM, 2016).

Table 2. Live and carcass adjusted animal growth performance.

	Silage (S)			Inclusion (I)			*P*-value		
Item	Conventional	Enogen	SEM	12	24	SEM	S	I	S × I
Pens	10	10	-	10	10	-	-	-	-
DOF	133	133	-	126	140	-	-	-	-
Live Basis[1]									
Initial BW, lb	928	926	1.2	927	927	1.2	0.24	0.80	0.49
Final BW, lb	1350	1355	6.4	1341	1365	6.4	0.54	0.02	0.24
ADG, lb	3.17	3.23	0.046	3.28	3.13	0.046	0.35	0.04	0.17
DMI, lb	22.63	22.76	0.153	22.67	22.71	0.153	0.54	0.86	0.59
F:G	7.16	7.11	0.083	6.96	7.31	0.083	0.65	0.01	0.15
Carcass Basis[2]									
Final BW, lb	1397	1396	7.8	1383	1410	7.8	0.99	0.03	0.37
ADG, lb	3.52	3.54	0.055	3.61	3.45	0.055	0.80	0.06	0.27
F:G	6.44	6.49	0.092	6.31	6.61	0.092	0.74	0.04	0.32
pa NE, Mcal/cwt[3]									
Maintenance	88.77	89.34	0.668	89.99	88.13	0.668	0.55	0.07	0.21
Gain	59.25	59.76	0.586	60.32	58.69	0.586	0.55	0.07	0.22
Actual trial NE Mcal/cwt									
Maintenance	92.87	92.80	-	94.23	91.44	-	-	-	-
Gain	62.14	61.97	-	63.19	60.92	-	-	-	-
Observed/expected NE[4]									
Maintenance	0.96	0.96	0.007	0.95	0.96	0.007	0.49	0.37	0.25
Gain	0.95	0.96	0.009	0.95	0.96	0.009	0.55	0.53	0.20

[1] Final BW shrunk 3% to account for digestive tract fill.
[2] Calculated from HCW/0.625.
[3] pa=performance adjusted.
[4] paNE/tabular NE.

Table 3. Carcass trait responses and beef production per acre of cropland.

	Silage (S)			Inclusion (I)			*P*-value		
Item	Conventional	Enogen	SEM	12	24	SEM	S	I	S × I
Dress, %[1]	64.67	64.38	0.191	64.47	64.50	0.191	0.30	0.70	0.83
HCW, lb	873	873	4.9	864	882	4.9	0.99	0.03	0.37
REA, in^2	13.14	13.17	0.111	13.20	13.11	0.111	0.86	0.57	0.22
BF, in	0.54	0.55	0.018	0.52	0.57	0.018	0.81	0.02	0.25
Marbling	532	510	12.7	519	522	12.7	0.25	0.85	0.39
KPH, %	1.80	1.76	0.018	1.79	1.77	0.018	0.19	0.56	0.91
EBF, %	30.87	30.90	0.250	30.53	31.25	0.250	0.93	0.06	0.55
AFBW, lb	1268	1267	5.9	1267	1267	5.9	0.86	0.99	0.82
YG	3.33	3.33	0.044	3.23	3.43	0.044	0.94	0.01	0.06
Retail Yield, %[2]	49.82	49.86	0.098	50.04	49.63	0.098	0.80	0.01	0.06
Beef/Acre	1892	1765	23.0	1791	1866	23.0	0.01	0.04	0.40

[1] HCW/final BW shrunk 3%.

[2] As a percentage of HCW.

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Effects of Phase Feeding Lysine During Gestation on Lightweight Piglet Post-Wean Performance

Tiffany Bruhn[1], Hyatt Frobose[2], and Crystal Levesque*[1]

INTRODUCTION

Nutritional status of the sow during gestation plays a vital role in performance of her offspring. As lysine is the first limiting amino acid in swine diets, it can be used as an indicator of capacity for protein deposition in both maternal and conceptus tissues. Common practice for feeding during pregnancy is a single gestation diet formulated to meet the relative requirements of standardized ileal digestible lysine (SID Lys) for primiparous females. Based on previous research conducted at SDSU, current industry standards may be over supplying nutrients to multiparous females during early and mid-gestation while under supplying needs to all parities during late gestation. It is of the utmost importance that requirements are met during gestation to ensure minimal nutrient waste and allow piglets the best opportunity to thrive. The aim of this study was to determine how piglet post-wean performance was impacted by altering Lys levels during gestation.

METHODS

The portion of this study conducted at the Southeast Research Farm was part of an ongoing trial at the SDSU Swine Education and Research Facility. During this study, both primiparous and multiparous females were blocked by parity, balanced by weight, and assigned to one of three feeding regimens as follows: Control (CON): 12 g SID Lys/d, Phase Feeding 1 (PF1): 12 g SID Lys/d d2 – 89 and 17 g SID Lys/d d90 – 110 d of gestation, and Phase Feeding 2 (PF2): 10, 8.5, and 7 g SID Lys/d d2 – 89 for gilts, parity 1 and parity 2+, respectively and 17 g SID Lys/d d90 – 110 d of gestation. All sows received the same lactation diets until weaning at which time piglets were removed and placed in group pens of 6-8 pigs/pen in the on-site wean to finish facility for 49 days. On day 49, all animals were weighed and the smallest 67 were moved to the Southeast Research Farm to be finished as they were not ideal for use in the impending finishing trial set for the others. Pigs were housed in pens of 4-5 animals and individual

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weights were recorded once each month along with feed disappearance.

RESULTS and DISCUSSION

Altering Lys intake during gestation had minimal impact on performance of lightweight pigs housed at SERF in this study (Table 1). Though not statistically different, at D147 post-wean it should be noted that PF1 and PF2 pigs had an average body weight 4 kg and 2 kg heavier than those of CON pigs and consistently 6 – 10% difference in gain:feed. These improved weights could have the potential to improve overall barn efficiency in a commercial production unit. By implementing new feeding strategies to better meet sow requirements there is a potential to improve piglet performance primarily during the late finishing stages while also decreasing waste through excreted nutrients during pregnancy.

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Table 1. Offspring post-wean performance from sows fed differing lysine content during gestation

	Sow Treatment				
Items	Control	PF1	PF2	SEM	P-value
Body weight, kg					
D49	19.09	19.93	19.34	2.52	0.93
D63	32.10	32.34	31.60	1.56	0.94
D91	54.36	57.39	54.47	2.49	0.61
D118	81.24	85.24	82.48	3.16	0.72
D147	116.20	120.43	118.24	3.75	0.69
Daily gain, kg					
D49-63	0.63	0.65	0.62	0.03	0.68
D64-91	0.86	0.89	0.88	0.03	0.68
D92-118	1.02	1.03	1.04	0.03	0.95
D119-147	1.18	1.21	1.23	0.05	0.66
Daily feed intake, kg					
D49-63	2.20	2.09	2.00	0.16	0.64
D64-91	2.60	2.66	2.56	0.15	0.89
D92-118	2.81	2.86	2.96	0.15	0.71
D119-147	3.61	3.65	3.79	0.19	0.68
Gain:Feed					
D49-63	0.30	0.33	0.32	0.03	0.48
D64-91	0.36	0.37	0.36	0.03	0.98
D92-118	0.33	0.35	0.35	0.02	0.34
D119-147	0.34	0.38	0.36	0.03	0.52

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Mint Oil, Yeast Cell, and ɣ-tocopherol Supplementation in Gestation and Lactation Diets on Offspring Performance During the Post-Wean Period

Lily P. Hernandez[1], Dr. James L. Dunn[2], Dr. Joel Wenninghoff[2], and Dr. Crystal L. Levesque[*1]

INTRODUCTION

Weaning is a period of high stress in a young animal's life due to sudden social, environmental, and dietary changes. This period of elevated stress is one of several linked to the occurrence of oxidative stress, defined as an imbalance between the production of free radicals and the body's antioxidant defense system, with the former being higher. If left untreated, reduction in growth has been observed. Our lab previously determined inclusion of feed additives with antioxidant activity in both sow and nursery diets improved offspring growth in the post-wean period. The current study was conducted to determine if supplementing antioxidant-rich feed additives (yeast cell, mint oil, and ɣ-tocopherol) in sow gestation and lactation diets only would have carry-over effects on offspring post-weaning performance.

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METHODS

This study encompassed two blocks of animals; block 1 offspring were housed at the Southeast Research Farm, block 2 offspring were kept at the South Dakota State University Education and Research Facility, Brookings, SD. For the purpose of this report, only pigs kept at Southeast Farm are included.

A total of 256 pigs (6.09 ± 1.34 kg BW) were allotted to 19 pens (13 to 14 pigs/pen; 4 to 5 pens/treatment) within maternal dietary treatment [Control diet (CON), control + yeast cell at 0.15% (YC), control + mint oil at 10 ppm (MO), and control + ɣ-tocopherol at 200 ppm (GT)]. Pens were balanced for both weight and litter as much as possible. At d29 post-wean, stocking density of pens were reduced to 5 pigs/pen. Animals retained were those that were deemed light and heavy at weaning. Pigs and facilities were checked once daily by a trained technician. Veterinary treatments, if any, were recorded.

Pigs were fed a common diet within a 9-phase feeding program: Phase 1, 5d; Phase 2, 4-6d; Phase 3, 7-13d; Phase 4, 10-23d; Phase 5, 19-25d; Phase 6, 16-23d; Phase 7, 21-24d; Phase 8, 12-20d; and Phase 9, 4-10d. All diets were formulated to meet nutrient requirements of weaned pigs; Phase 1 and 2 were provided in pellet form with all following phases provided as a meal and Paylean was added to Phase 9. Water was provided ad libitum. The trial concluded at d126 post-wean and animals were marketed in two batches

Body weight was recorded at the end of each diet phase until d42 and then monthly until trial completion. Due to miscommunication regarding feed weighbacks, feed disappearance and gain:feed was only calculated for the entire trial period. With the use of quartiles, animals were assigned to one of three categories (light, average or heavy) based on BW up to d29 post-wean. Time required for newly weaned piglets to eat was assessed during the first four days after weaning where biscuits containing ferric oxide were crumbled to match sizing of Phase 1 pelleted feed and added at 0.5% of the total amount allotted per pen. By use of rectal swab, fecal color change for each individual pig was measured.

Variables of particular interest included rate of gain, indication of consumption, and weight category distribution. Data was analyzed using the mixed model procedure of SAS considering the effect of dietary supplementation where the pen is the experimental unit and random effect. Tukey's adjustment was used for means separation test. Fecal color evaluation and weight category data was assessed using the Proc Freq procedure in SAS.

RESULTS AND DISCUSSION

Up to d29 post-wean, a pattern was noted that pigs out of the MO group were, or tended to be, heavier than animals from the GT group. Following the trimming of pig numbers at d29, data was divided into light and heavyweight animals. Lightweight animals out of the YC group tended to be lighter ($P < 0.10$) than MO and GT, with CON falling intermediate at d42. No effect of maternal treatment on BW was noted for heavyweight pigs throughout the remainder of the trial; however, pigs from YC, MO, and GT groups were approximately 3, 8 and 6 kg heavier at d126 than pigs from CON sows.

ADG was not different at d4, but it was detected that pigs from each group had lost weight. This may be a result of limited feed consumption in the first few days post-wean evidenced by the low number of pigs on full feed at d3 (i.e. 2 to 10%) meaning that more than 90% had little or no fecal color change. It takes approximately 24h for the red color to become evident in the feces after consumption of the pellets. Given the lack of veterinary treatments, the low proportion of red-colored feces detected implies that while pigs had likely consumed some feed most were not on full feed by day 2. An aversion to the biscuit causing them to eat around it may also have contributed to the low red-colored feces. Pigs of the MO group tended to gain more ($P < 0.10$) than the GT group in the first 2 weeks. YC pigs had higher gains ($P < 0.05$) at d29 than GT, however at d42 they gained less ($P < 0.05$). Pigs of the YC group also tended to gain less ($P < 0.10$) than pigs of the CON group. No effect of maternal dietary treatment was detected for ADG from d70 to d126 for heavyweight pigs.

Pigs of the MO group tended to consume more feed ($P < 0.10$) over the entire trial period compared to all other groups. G:F for the entire study was not different among treatment groups.

Distribution of pigs based on weight categories up to d29 post-wean is illustrated in Figure 1. For all three weigh periods, close to half of the animals fell within the average weight range. No difference by treatment was detected at d4 and d14. However, numerically it appears that there are a smaller number of pigs considered to be light in the MO group compared to other treatment groups. Less pigs of the MO group fell in the light category compared to the other groups at d29.

CONCLUSION

The results of this portion of the study suggest a carryover effect of maternal nutrition in gestation and lactation on offspring performance in the post-wean period. While supplementation of antioxidant rich feedstuff, in particular mint oil, in gestation and lactation diets, may aid the dam in maintaining the wellbeing of her antioxidant defense system, maternal carry-over better prepares the offspring for future stressors.

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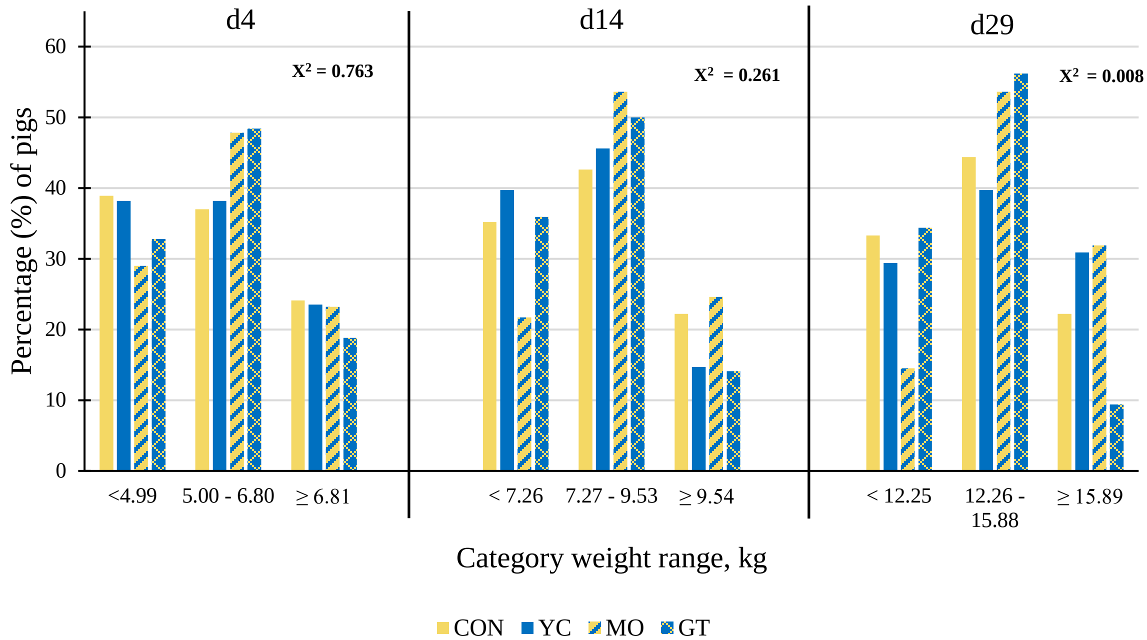
Table 1. Performance of nursery pigs combined up to d29 and performance of light and heavyweights from d42 to d126 post-wean

Items	Control	Citristim	Mint Oil	γ tocopherol	SEM	P-value
Body weight, kg						
d4	6.08^{ab}	5.79^{b}	$6.24^{a,x}$	$5.86^{b,y}$	0.11	0.025
d14	8.39^{ab}	8.09^{b}	8.81^{a}	8.06^{b}	0.17	0.013
d29	14.17^{ab}	$14.60^{a,x}$	15.10^{a}	$13.50^{b,y}$	0.33	0.011
Daily gain, kg/d						
d0 – 4	-0.02	-0.02	-0.01	-0.05	0.03	0.730
d4 – 14	0.23^{xy}	0.23^{xy}	0.26^{x}	0.22^{y}	0.01	0.087
d14 – 29	0.38^{ab}	0.43^{a}	0.42^{ab}	0.36^{b}	0.02	0.038
d0 – 29	0.32	0.33	0.32	0.34	0.01	0.158
			Lightweight pigs			
Body weight, kg						
d42	$18.3^{x,y}$	15.1^{y}	19.1^{x}	18.8^{x}	1.6	0.027
d70	44.6	43.2	45.4	46.0	1.8	0.537
d98	74.4	70.0	71.4	74.6	2.3	0.238
d126	104.6	100.3	101.1	106.5	2.7	0.177
Daily gain, kg/d						
d29 – 42	0.141	0.123	0.092	0.175	0.04	0.220
d42 – 70	1.00	1.03	0.97	1.01	0.05	0.573
d70-98	1.04^{a}	0.94^{c}	0.91^{b}	1.02^{ac}	0.03	0.006
d98-126	1.03	1.04	1.02	1.02	0.06	0.979
d0-29	0.24	0.24	0.24	0.24	0.02	0.968
			Heavyweight pigs			
Body weight, kg						
d42	28.8	28.4	29.3	26.2	1.84	0.532
d70	58.3	61.5	61.4	58.4	3.03	0.532
d98	87.2	89.9	90.5	89.3	3.92	0.807
d126	112.1	115.7	120.4	118.7	4.64	0.276
Daily gain, kg/d						
d29 – 42	0.26^{a}	0.12^{b}	0.18^{ab}	0.18^{ab}	0.03	0.038
d42 – 70	1.04^{x}	1.20^{y}	1.16^{xy}	1.17^{xy}	0.06	0.054
d70-98	0.92	0.98	1.01	1.07	0.05	0.128
d98-126	0.95	1.01	1.09	1.11	0.06	0.181
d0-29	0.82	0.72	0.94	0.83	0.09	0.227
Daily Feed Intake, kg/d						
d0 - 126	7.02^{y}	7.13^{y}	7.79^{x}	7.08^{y}	0.23	0.056
Gain:Feed						
d0 – 126	0.11	0.10	0.10	0.11	0.01	0.912
Eaters at d3[1], %	1.8	7.5	10.3	4.7		

[1]Eaters: defined as pigs with red-colored feces indicating pig on full feed. Calculated as a percentage of pigs/treatment.

Figure 1. Distribution (%) of light, average, and heavy pigs at each weigh period up to d29 after weaning[1]



[1]Average-weight pigs were sold d30 post-wean to condense number of pigs per pens, weight category distribution was evaluated prior to d30 only.