South Dakota State University
South Dakota Agricultural Experiment Station

ANNUAL PROGRESS REPORT 2022

SOUTHEAST SOUTH DAKOTA EXPERIMENT FARM

SOUTH DAKOTA AGRICULTURAL EXPERIMENT STATION

SOUTHEAST RESEARCH FARM
GROWING IDEAS HARVESTING ANSWERS

SOUTH DAKOTA STATE UNIVERSITY



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

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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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 Joslyn Fousert. 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 Péter Kovács, Jason Clark, Sara Bauder, Anthony Bly, David Karki, Paul O. Johnson, Dave Vos, Jill Alms, Dalitso Yabwalo, Melanie Caffe, Adam Varenhorst, Philip Rozeboom, John McMaine, Warren Rusche, Zachary Smith, Bob Thaler, Eric Weaver, 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, John Fahlberg, Jonathan Hagena, David Ostrem, Todd Bye, Lee Brockmueller, Travis Machmiller, Norm Uherka, Chuck Wirth, Shane Merrill, Shane Nelson, Greg Kleinhans, John Shubeck, 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. William Gibbons, David Wright, Dept. Head Agronomy, Hort. and Plant Science, and Bob Thaler Acting, 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 2022 Annual Report, as well as Annual Reports from other years, are available on website: https://openprairie.sdstate.edu/agexperimentsta_rsp/

OUTREACH ACTIVITIES

Dakota Farm Show Booth; January

Fall Field Tour; September

Summer Field Day; July

Extension Conference / Annual Meeting; December

INTRODUCTION ……………...…………………………………………………..Peter Sexton
Farm Supervisor

As one year ends and we prepare for the next one with a new cycle of research and production, it is well to take a step back and consider the big picture of where we are headed. The strategic goals of the farm as determined by the farm board ten years ago are:

1) *Improve character of the soil (soil quality) - including drainage and tillage systems appropriate for the area.*
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 including hort. work as opportunity permits.*

The farm has tried to address the questions of improving soil quality along with optimizing productivity by working with no-till and cover crops, and installation of drainage plots for measuring water quality in tile lines. The farm has also established plots looking at the effects on soil quality of integrating grazing with grain crop production. The farm has invested in improving feedlot facilities, and participated in trials to evaluate the use of a novel feed grain (hybrid rye) in cattle rations. The farm has expanded outreach events by hosting forage field days and sponsoring extension seminars at the Dakota Farm Show, and the annual meeting of the farm has been reworked to try and make it more attractive to our farmer audience. The farm has started to work with horticultural crops with setting up of a small high tunnel and with field plots under drip irrigation. These are the ways the Southeast Farm has tried to address the above stated goals. It is beyond the scope of this introduction, but it is important to reflect on how the broader environment has changed over the last 10 years, and what opportunities and adjustments should be considered for the research objectives and strategic goals the farm pursues. We seem to have more swings in economic policy, climate, and market supply chains. It's good to reflect on the importance of resilience and to remember the everlasting things. In the meantime, we continue to go forward one day at a time thinking of Ben Franklin's words "distrust not Providence".

This annual report is part of the outreach effort of the Southeast Farm. It represents the work of many faculty and staff at SDSU and of the crew here at the Southeast Farm. We hope you find it useful and of benefit for your operation. In case you would like to visit the farm for a plot tour, our 2023 field days are scheduled for:

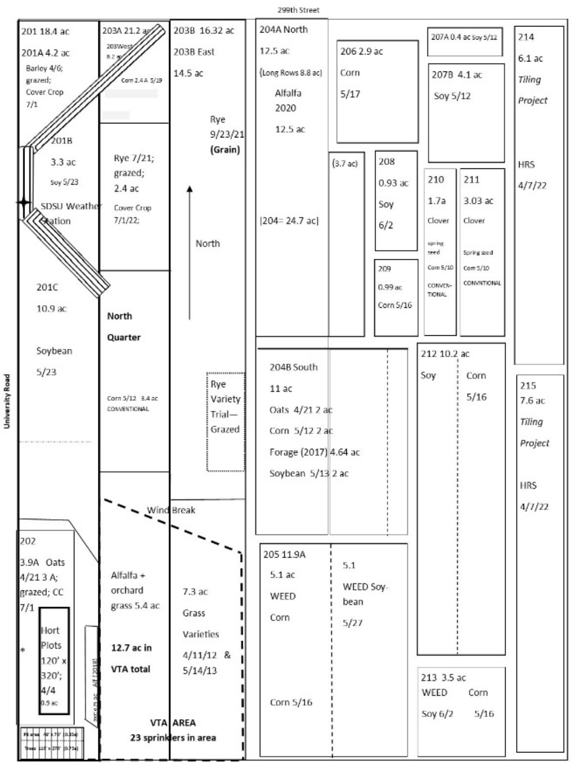
SUMMER FIELD DAY - JULY 11th (focus on grain crops)

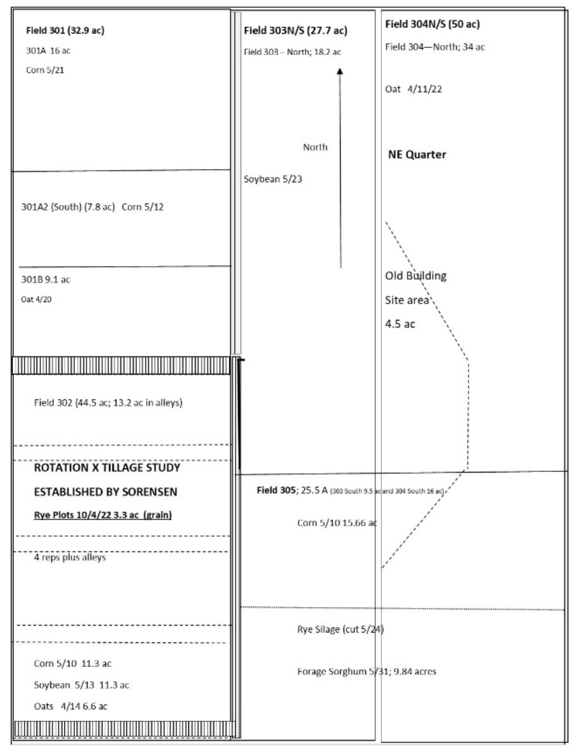
FALL FIELD DAY - SEPTEMBER 14th (focus on forages and livestock)

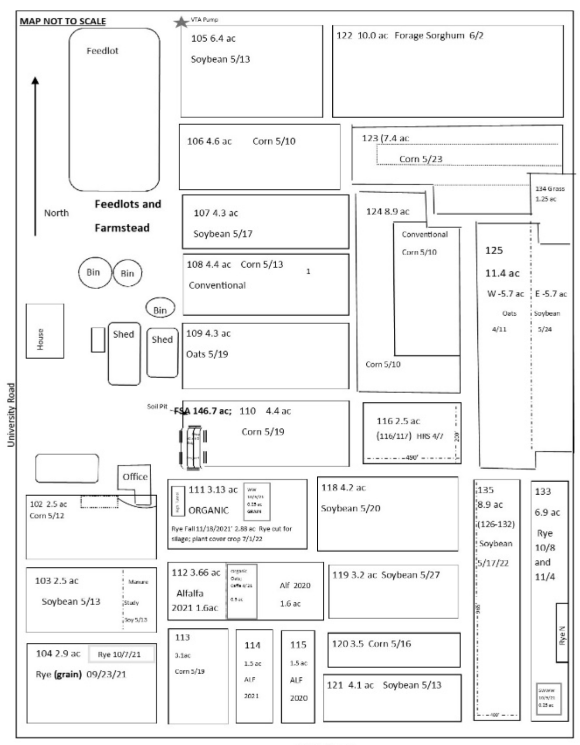
We hope you will be able to make it to the field days to learn about our research work and share your own ideas and suggestions on how to move forward with things.

SDSU Southeast Research Farm, Beresford, SD

2022 Land Use Maps (maps not drawn to scale)







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Southeast Research Farm, Beresford, SD 57004

Weather and Climate Summary; SDSU Southeast Farm Beresford, SD 2022

Ruth Stevens*, Peter Sexton,
Brad Rops, Scott Bird, Garold Williamson,
Joslyn Fousert, and Dr. Rueben Behnke[1]

The weather during 2022 contributed to severe drought conditions at the SDSU Southeast Research Farm (SERF). The drought affected all crops during the growing season. Early spring had unusually windy conditions; with April having only 4 days that did not have 30 mph or higher wind gusts. On May 12, a derecho traveled over a large area of eastern South Dakota. SERF recorded winds at 82 mph during that storm. Drought conditions have been present at different levels for three years with SERF recording a rainfall deficit of 23.6" during that period (Jan 2020 – Dec 2022).

The 2022 weather, long-term climate information and Ag Weather Summary[1] for the Southeast Farm is summarized in tables and figures found on pages 2 through 6.

Average temperatures compared to daily temperatures are highlighted in Figure 1, and monthly temperature averages are shown in Table 1.

Annual precipitation for 2022 at SERF was 14.74" (58% of normal), (Table 2 and 3). Growing season precipitation measured from April through September was 55% of normal (-8.6"). SERF received 14" of snowfall in 2022; 4" in first half of year, and 10" in last half of year.

The coldest and hottest temperatures of the year were recorded on December 22 & 23 (-18°F) and August 3 (101°F) respectively, a 119-degree temperature range (Table 3). Frost-free season at the farm in 2022 was 139 days on a 32°F basis and 166 days on a 28°F-basis. The last spring frost/freeze was on Apr 26 (21°F). The first fall frost/freeze occurred on October 8 (25°F). The average annual high temperature was 59°F and average annual low temperature was 34°F; which were (+0.9 and -1.1 degrees, respectively).

The 2022 growing season (April – October) accumulation of growing degree units (GDU's) was 3303 units, which is 112% (+337) of average (Fig. 5). Evaporation recorded at the SERF from May through September was 43.1" (Fig. 6 & 7); while receiving 9.7" of rainfall during the same period.

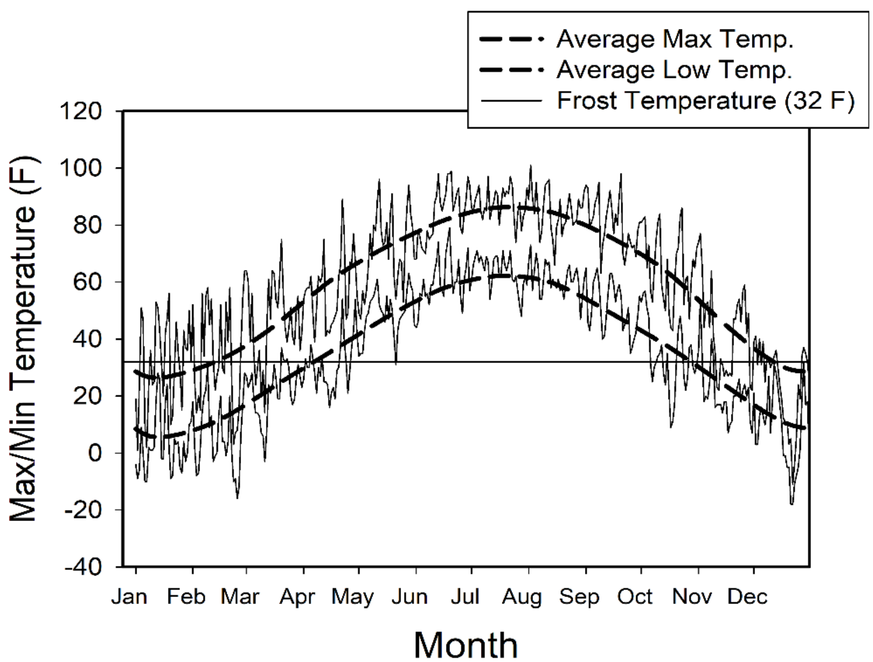
* *Corresponding author: ruth.stevens@sdstate.edu;*
[1]*Mesonet Research Climatologist, mesonet.sdstate.edu*

Table 1. Temperatures[a] at the Southeast Research Farm - 2022

	2022 Average Air Temps. (°F)		70-year Average Air Temps. (˚F)		Departure from 70-year Average (˚F)	
	Maximum	Minimum	Maximum	Minimum	Maximum	Minimum
January	31.6	3.0	26.7	6.0	+4.9	-3.0
February	33.9	5.4	31.8	10.8	+2.1	-5.4
March	46.6	21.8	44.3	23.0	+2.3	-1.2
April	57	30.4	59.8	34.9	-2.8	-4.5
May	71	48.8	71.8	47.4	-0.8	+1.4
June	83.8	60	81.7	58.1	+2.1	+1.9
July	87.5	63.6	86.0	62.2	+1.5	+1.4
August	85	61	83.9	59.4	+1.1	+1.6
September	81.2	51.4	75.7	49.5	+5.5	+1.9
October	65.5	34.3	63.2	37.3	+2.3	-3.0
November	44.8	22.1	45.4	23.7	-0.6	-1.6
December	24.3	8.9	30.9	11.6	-6.6	-2.7

[a] Computed from daily observations

Figure 1. 2022 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[a] at the Southeast Research Farm - 2022

Month	Precipitation 2022 (inches)	70-year Average	Departure from Avg. (inches)
January	0.13	0.45	-0.32
February	0.19	0.77	-0.58
March	1.41	1.46	-0.05
April	0.73	2.51	-1.78
May	3.13	3.52	-0.39
June	1.20	4.09	-2.89
July	1.89	3.06	-1.17
August	1.81	3.03	-1.22
September	1.70	2.80	-1.10
October	0.56	1.92	-1.36
November	0.49	1.11	-0.62
December	1.50	0.68	+0.82
Totals as of Oct 31	14.74	25.40	-10.66

[a] Computed from daily observations

Table 3. 2022 Climate Summary Southeast Research Farm, Beresford, SD

Annual Precipitation (inch)	14.74	58% (-10.68)
Growing Season Precip (Apr-Sep, inch)	10.46	55% (-8.56)
Jan-Mar (inch)	1.73	+5% (-.96)
Apr-Jun (inch)	5.06	50% (-5.07)
Jul-Sep (inch)	5.40	61% (+3.50)
Oct-Dec (inch)	2.55	69% (1.16)
Annual Snow (inch); (Jan-Jun/Jul-Dec)	14.1	4.2/9.9
Growing Degree Units (GDU); Apr – Oct (50 degree basis)	3303	111% (+337)
Minimum / Maximum Air Temp, ºF	-18°F Dec 22/23	101°F Aug 3
Last Spring Frost; 32º / 28º basis	31°F May 22	21°F Apr 26
First Fall Frost; 32º / 28º basis	31°F Oct 7	25°F Oct 8
Frost Free Period (days); 32º / 28º basis	139	166
Average Annual High / Low	59/34	+0.9 / -1.1

* % of Normal

Figure 2. 2022 Monthly Precipitation; Southeast Farm, Beresford, SD

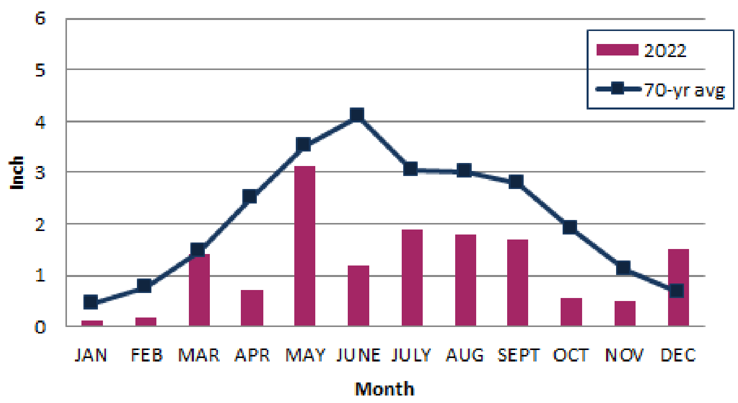


Figure 3. 2022 Cumulative Precipitation, Southeast Farm, Beresford, SD

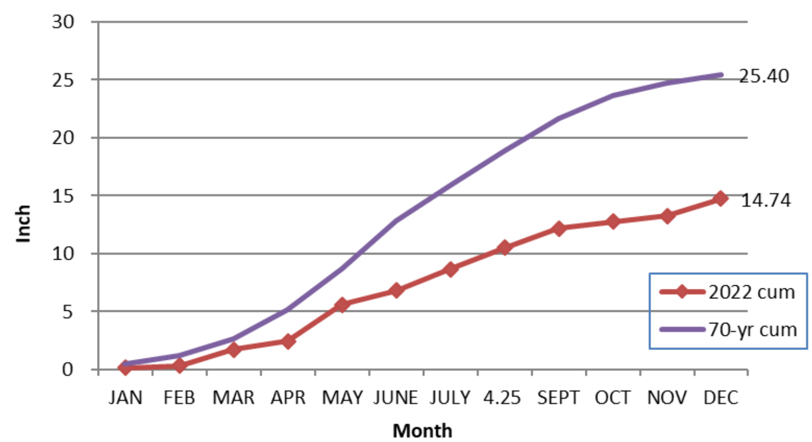


Figure 4. 2022 Growing Degree Units (GDU's); Southeast Farm, Beresford SD

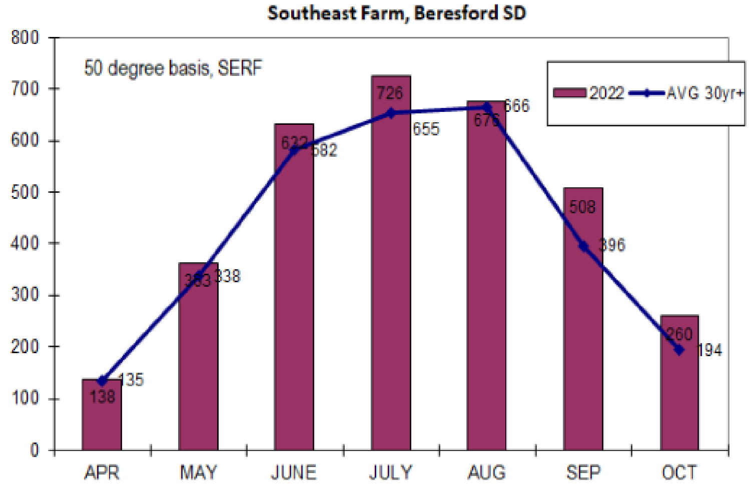


Figure 5. 2022 Cummulative GDU's;
Southeast Farm, Beresford, SD

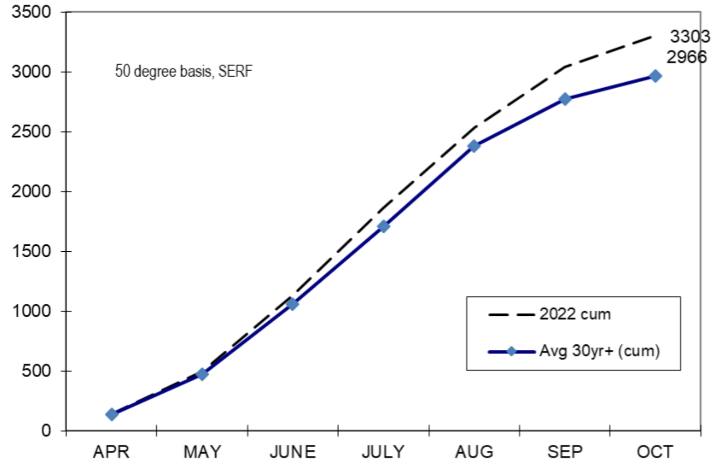


Figure 6. 2022 Growing Season (May-Sep)
Rainfall vs. Evaporation
Southeast Farm

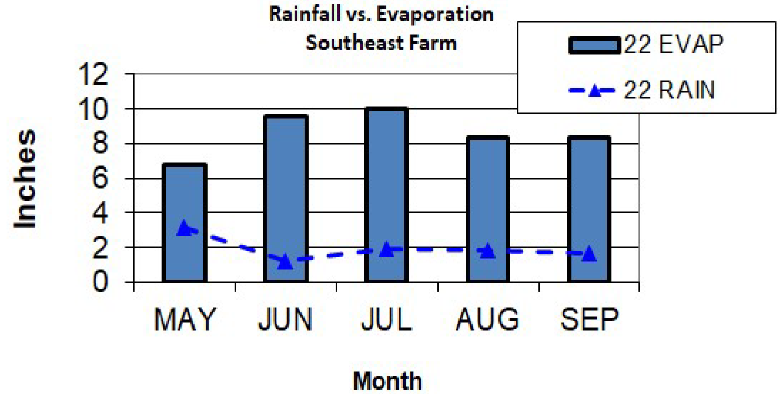
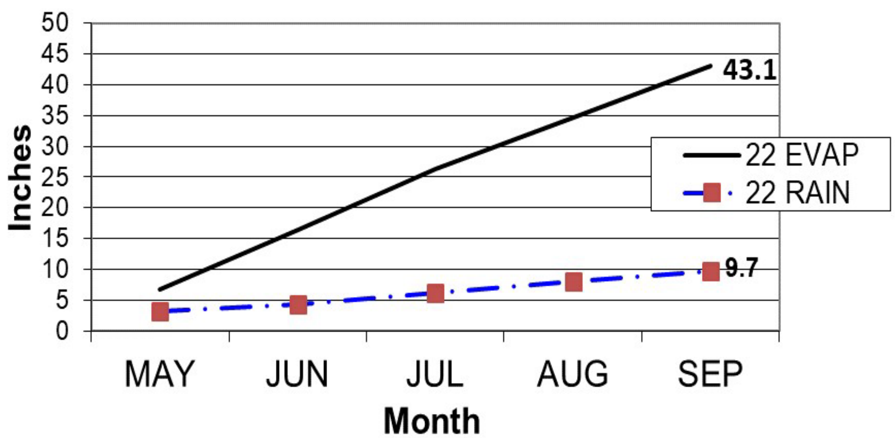


Figure 7. 2022 Growing Season (May-Sep)
Cumulative Rainfall vs. Evaporation
Southeast Farm



2022 Ag Weather Summary

Precipitation (May-September)

Total	7.44 in
Departure from Normal	-10.09 in
Greatest Daily Rainfall	0.80 in, Sep 15
Days with Precipitation	66 of 153

Reference Evapotranspiration

Total	34.88 in

Growing Season

Growing Degree Days	2923
Departure from Normal	+ 318
Stress Degree Days	346
Frost-Free Season	May 23 to Oct 6 (137 days)
Normal Season Frost-Free Season	Apr 11 to Oct 24 (197 days)

Air Temperature

Average	47°F
Departure from Normal	+1°F
Maximum	101°F, Aug 2
Minimum	-18°F, Dec 22
Frost Days	174

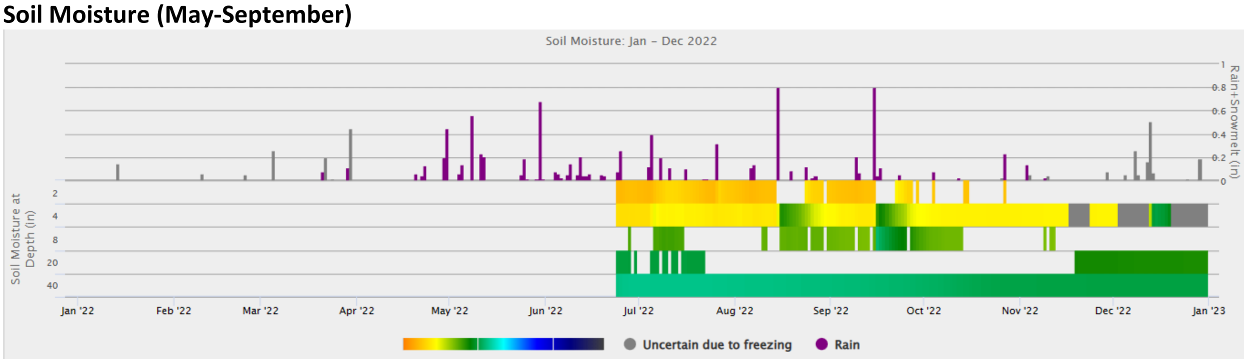
Soil Temperature

Average (4 in, bare)	58°F
Maximum (4 in, bare)	95°F, Jul 15
Minimum (4 in, bare)	12°F, Dec 25
First ≥ 40°F Daily Average (4 in, bare)	NA
First ≥ 50°F Daily Average (4 in, bare)	NA
Max Frost Depth (sod)	NA
Frost-Free Season	NA

Wind

Maximum Gust (3 second)	82 mph, May 12
Maximum Speed (5 minute)	56 mph, May 12

Soil Moisture (May-September)



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Long-Term Rotation and Tillage Study: Observations on Corn and Soybean Yields in 2022

Peter Sexton*, Brad Rops,
Ruth Stevens, and Garold Williamson.

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 4-year flex rotation (currently corn-soybean-oat-winter rye); note the three year and flex rotations have not been constant over the years. The advantages of no-till are many: savings on fuel, equipment and labor; 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 2022 season which was marked by severe drought stress. Severe stress developed during the growing season and limited crop yields.

METHODS

As mentioned above, 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 4-year 'flex' rotation has been in a corn-soybean-oat-winter wheat/rye sequence.

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

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wet conditions in the fall prevented chisel plowing corn stubble, the tilled plots were disked in the spring and then field cultivated.

Since 2013 the tilled and no-till plots have been split plus/minus the use of a 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 harvest going to corn.

Yield was determined using a Zurn small plot combine (model 150) from the center 5' of corn plots and from the center 5' of soybean plots, running the whole length of the plot. A sample was kept for determination of moisture and test weight. Stand counts were taken from 10' of row out of each plot. Data were 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. The F-test for rotation by tillage interaction used the rotation by tillage by replication term in the denominator; all other interaction terms were evaluated using the residual error term in the F-test. This report will only address results from the 2022 growing season.

RESULTS and DISCUSSION

Corn Yields. The Southeast Research Farm experienced severe drought in 2022, receiving only 14.7" of rain versus an average rainfall of 25.4" for the calendar year. During the major period of crop growth, June, July, and August, the farm received 4.9" of rain versus a 70-year average of 10.2" of rainfall during these three critical months. Yields were severely impacted and along with rainfall, were about half of expected. Across rotation and tillage treatments, corn in this trial averaged 86.6 bu/ac of grain production (Table 1). There was significant tillage by rotation interaction with no-till plots showing a positive response to lengthening rotation, while the tilled plots showed a trend to have better yields in the two-year rotation. Over the past few seasons, the farm has been baling small-grain straw for use in bedding livestock, and one may postulate that this removal of K in the straw had more effect on the tilled plots than in the no-till plots given that no-till systems tend to have stronger mycorrhizal networks than do tilled systems. In any case there was a clear interaction between rotation length and no-till management in this study in the 2022 season. Overall the no-till plots yielded 26.4 bu/ac more than did the tilled plots with an average yield of 97.1 bu/ac for the no-till plots versus 75.7 bu/ac for the tilled plots (Table 2). There was a trend for the cover crop treatment to yield more relative to the no-cover crop control, particularly in longer rotations, but this difference was not statistically significant.

Soybean Yields. Similar to corn, soybean produced significantly more under no-till management in this study in the 2022 season, with a trend for the no-till plots to show better yields with longer rotation, while the tilled plots did not (Table 1 and 2). The reason for the negative trend with lengthening rotation under tilled management is not clear, but it may be postulated, as noted above, that this due to greater K availability under no-till management; however, this is only a hypothesis at this point that needs to be evaluated further. Average yields in the study was 27.1 bu/ac, about half of anticipated. The no till treatment on average yielded 6.9 bu/ac better soybean yields relative to the tillage treatment (Table 2). The cover crop treatment did show any appreciable trends for improved soybean yield in the 2022 season in this trial.

ACKNOWLEDGEMENT

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

Table 1. Stand, test weight, grain moisture, 100-seed weight, and yield of corn in the 2022 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. Note there was a significant tillage by rotation interaction where the no-till plots showed better yield with longer rotation lengths, while the conventional tillage plots did not, and in fact tended to show lower yield under longer rotations in the 2022 season at this site.

Rotation	Tillage	Cover Crop	Stand	Test Wt	Moisture	100-Seed Wt.	Yield
(yr)			(plt/ac)	(lb/bu)	(%)	(g)	(bu/ac)
4	NT	Y	29040	58.1	14.9	28.5	118.5
4	NT	N	30129	58.0	11.9	27.5	109.7
4	CT	Y	28677	58.4	10.5	28.6	79.9
4	CT	N	27225	58.0	11.3	29.6	70.3
3	NT	Y	29040	58.9	13.2	27.9	92.2
3	NT	N	30129	58.6	12.3	27.7	87.1
3	CT	Y	29040	57.8	11.7	28.0	64.8
3	CT	N	28314	58.9	11.9	29.9	60.6
2	NT	Y	28314	58.3	10.3	26.3	80.4
2	NT	N	29403	58.9	10.7	27.7	95.0
2	CT	Y	28677	59.3	10.7	29.1	86.8
2	CT	N	27225	59.5	10.6	30.2	88.8
		Mean	*28768*	*58.6*	*11.7*	*28.4*	*86.6*
		CV (%)	*5.8*	*2.4*	*5.4*	*3.3*	*14.7*
		Rotation (A)	*NS*	*<0.05*	*<0.05*	*NS*	*<0.05*
		Tillage (B)	*<0.05*	*NS*	*<0.01*	*<0.01*	*<0.01*
		Cover Crop (C)	*NS*	*NS*	*<0.05*	*<0.05*	*NS*
		AxB	*NS*	*NS*	*<0.05*	*NS*	*<0.05*
		BxC	*NS*	*NS*	*<0.01*	*<0.05*	*NS*
		AxC	*<0.05*	*NS*	*<0.05*	*NS*	*NS*
		AxBxC	*NS*	*NS*	*<0.01*	*NS*	*NS*

Table 2. Comparison of average stand at harvest, test weight, moisture, 100-seed weight and yield for tillage treatments and cover crop use across all other treatments for corn grown in a long-term tillage by rotation study at the Southeast Research Farm in Beresford, South Dakota for the 2022 growing season. Note there was a significant tillage by rotation interaction where the no-till plots showed better yield with longer rotation lengths, while the conventional tillage plots did not, and in fact tended to show lower yield under longer rotations in the 2022 season at this site.

Tillage	Stand	Test Wt	Moisture	100-Seed Wt.	Yield
	(plt/ac)	(lb/bu)	(%)	(g)	(bu/ac)
NT	29343	58.5	12.2	27.6	97.1
CT	28193	58.6	11.1	29.2	75.7
Mean	*28768*	*58.6*	*11.7*	*28.4*	*86.6*
P-value	*<0.05*	*NS*	*<0.01*	*<0.01*	*<0.01*

Cover Crop	Stand	Test Wt	Moisture	100-Seed Wt.	Yield
	(plt/ac)	(lb/bu)	(%)	(g)	(bu/ac)
Y	28798	58.5	11.9	28.1	88.1
N	28738	58.6	11.4	28.8	85.3
Mean	*28768*	*58.6*	*11.7*	*28.4*	*86.6*
P-value	*NS*	*NS*	*<0.05*	*<0.05*	*NS*

Table 3. Stand, test weight, grain moisture, 100-seed weight, and yield of soybean in the 2022 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 rotation length has varied for soybeans in previous years, but since 2012 soybeans have been on a 2, 3, or 4 year rotation length as per the rotation length indicated. Winter rye is used as a cover proceeding soybeans in this study.

Rotation Length	Tillage	Cover Crop	Stand	Test Wt	Moisture	100-Seed Wt.	Yield
(yr)			(plt/ac)	(lb/bu)	(%)	(g)	(bu/ac)
4	NT	Y	125453	57.1	11.5	14.6	34.7
4	NT	N	121968	56.8	11.3	14.8	32.9
4	CT	Y	109771	55.3	11.8	16.3	20.2
4	CT	N	124146	53.2	11.4	16.8	20.6
3	NT	Y	117612	56.7	11.3	15.5	29.6
3	NT	N	123275	56.5	11.5	15.2	29.4
3	CT	Y	114998	53.3	11.8	16.8	22.0
3	CT	N	125889	53.5	12.3	16.7	21.3
2	NT	Y	127195	54.9	11.7	15.2	28.5
2	NT	N	109771	55.2	12.3	15.2	28.1
2	CT	Y	111514	53.3	13.2	16.3	29.8
2	CT	N	122404	52.7	12.6	16.9	27.9
		Mean	*119500*	*54.9*	*11.9*	*15.9*	*27.1*
		CV (%)	*11*	*2.5*	*10.7*	*4.1*	*8.1*
		Rotation (A)	*NS*	*NS*	*NS*	*NS*	*NS*
		Tillage (B)	*NS*	*NS*	*NS*	*<0.01*	*<0.01*
		Cover Crop (C)	*NS*	*NS*	*NS*	*NS*	*NS*
		AxB	*NS*	*NS*	*NS*	*NS*	*<0.05*
		BxC	*<0.05*	*NS*	*NS*	*NS*	*NS*
		AxC	*NS*	*NS*	*NS*	*NS*	*NS*
		AxBxC	*NS*	*NS*	*NS*	*NS*	*NS*

Table 4. Comparison of average stand at harvest, test weight, moisture, 100-seed weight and yield for tillage treatments and cover crop use across all other treatments for soybeans grown in a long-term tillage by rotation study at the Southeast Research Farm in Beresford, South Dakota for the 2022 growing season.

Tillage	Stand	Test Wt	Moisture	100-Seed Wt.	Yield
	(plt/ac)	(lb/bu)	(%)	(g)	(bu/ac)
NT	120879	56.2	11.6	15.1	30.5
CT	118120	53.6	12.2	16.6	23.6
Mean	*119500*	*54.9*	*11.9*	*15.9*	*27.1*
P-value	*NS*	*NS*	*NS*	*<0.01*	*<0.01*

Cover Crop	Stand	Test Wt	Moisture	100-Seed Wt.	Yield
	(plt/ac)	(lb/bu)	(%)	(g)	(bu/ac)
Y	117757	55.1	11.9	15.8	27.5
N	121242	54.6	11.9	15.9	26.7
Mean	*119500*	*54.9*	*11.9*	*15.9*	*27.1*
P-value	*NS*	*NS*	*NS*	*NS*	*NS*

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Comparison of Radish, a Grass-Based Cover Crop Blend, and Winter Rye as Cover Crops on Yield of the Following Corn Crop

Peter Sexton*, Brad Rops,
and Garold Williamson

INTRODUCTION

The objective of this trial was to compare the effect of several different cover crops following small grain harvest (oats) on yield of the following corn crop. In previous work at the Southeast Farm, corn following radish or a cool season broadleaf blend in which radish is a major component, has in most years shown a yield benefit on the order of 8 to 14 bu/ac. In the previous season (2021), we observed for the first time a trend for a yield decline in corn following use of radishes as a cover crop versus a no cover-crop control. In the season reported here (2022), corn yields were measured following a radish cover crop, a grass-broadleaf blend, red clover previously underseeded into oats, and a winter rye cover crop, versus a no cover crop control.

METHODS

Red clover was blended with urea and spun onto the field ahead of oat planting. The other cover crop treatments were direct seeded into oat stubble on 07 September, 2021 using a no-till drill. Glyphosate was applied at a low rate (16 oz/ac) across the field after harvest to control weeds while trying to conserve the clover that was present. The control and non-clover cover crop plots received a second application of glyphosate at 32 oz/ac to virtually terminate the red clover underseeding in those plots. Individual plots were 15' wide by 200' long and were laid out in a randomized complete block design with three replications. The grass-broadleaf blend was 30 % oats, 11 % pearly millet, 24 % radish, 24 % dwarf essex rapeseed, and 11 % vetch. Corn (line DKC54-36) was planted on 13 May, 2022, and a burndown herbicide mixture was applied two days later (May 15th). Nitrogen was surface banded at planting at a rate of 51 lb N/ac as UAN. Urea was applied at 217 lbs/ac (100 lbs N/ac) on 21 April, 2022. Initially it was intended to side dress the corn with more N during the growing season; however, because of severe drought stress which developed in June, it was decided not to apply additional N fertilizer to this field.

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Plots were harvested on 17 October, 2022 using a two-row small plot combine (Zurn model 150) taking out the two center rows of each plot. Data were subjected to standard ANOVA using the Proc GLM subroutine in SAS statistical software.

RESULTS

The glyphosate treatment to control weeds stunted the red clover underseeding and limited its growth. So results relative to corn yield following red clover in this study should be viewed accordingly. Similar to last season, all the cover crop treatments were numerically lower yielding than the no cover-crop control (Table 1). The simplest explanation for this is that this is a function of the severe drought the corn crop experienced in 2022. The cover crop treatments withdrew moisture in the fall that was not recharged in the spring, leading to a trend of lower yields with the use of cover crops. The yield of corn following winter rye as a cover crop was over 40 bu/ac lower than was observed for corn following the other cover crop treatments. The rye in this case was allowed to grow into the spring, which means it would have used even more moisture than the winter-killed cover crops.

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Table 1. Stand, grain moisture, test wt., 100-seed wt., and grain yield at harvest for corn following four different cover crop treatments, along with a no-cover crop control. The cover crops were established the previous season (2021) following oats at the Southeast Research Farm in Beresford, South Dakota. The rye treatment was burned down shortly after corn planting.

Cover Crop	Stand	Moisture	Test Wt.	100-Seed Wt.	Yield
	(plt/ac)	(%)	(lb/bu)	(g)	(bu/ac)
Control	27878	13.7	61.3	27.7	119.5
Radish	28459	14.1	61.6	28.0	113.2
Grazing Blend	25555	14.2	61.8	28.0	111.3
Red Clover	26136	14.5	61.3	27.7	110.9
Rye	30782	17.2	60.1	27.3	69.4
Mean	*27762*	*14.8*	*61.2*	*27.7*	*104.9*
CV (%)	*8.4*	*4.8*	*0.6*	*4.3*	*8.2*
P-value	*NS*	*<0.01*	*<0.01*	*NS*	*<0.01*
LSD (0.10)	----	*1.1*	*0.5*	----	*13.0*

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Effects of Grazing and Cover Crops on Grain Yield - Intermediate Term Study - 2022 Results

Peter Sexton*, Sandeep Kumar, Brad Rops, Garold Williamson, and Ruth Stevens

INTRODUCTION

The effects of use of cover crops and grazing on crop yield are studied in a trial begun by Dr. Sandeep Kumar in 2017 at the SDSU Southeast Research Farm (SERF). The trial plots are in a three-crop rotation: corn, soybean, and oats. Following oats, a cover crop treatment is imposed and at the end of the season, grazing is imposed as another treatment, so there are three basic treatments: control (no cover crop and no grazing); cover crops without grazing; cover crops with grazing. Studies on the impact of these treatments on soil properties are on-going. This report only addresses measurement of grain yields in the 2022 season, which was a drought year.

METHODS

Plot size in this study is 60’ by 120', laid out in a randomized complete block design. 'Warrior' oats were planted on 21 April, 2022 at a seed rate of 110 lb/ac. Corn (line PIO622AML) was planted in 30" rows on 12 May, 2022 at a seed rate of 33,000 seeds/ac. Soybeans (Variety AG26XFl), were planted in 30" rows on 13 May, 2022 at a seed rate of 140,000 seeds/ac. Yield samples were taken using a small plot combine (Zurn, model 150, Westernhausen, Germany) with a sample width of 10' (two passes) for oats, and 5' (one pass) for corn and soybeans. Yield data was subjected to ANOVA using the Proc GLM subroutine in SAS statistical software.

RESULTS and DISCUSSION

This season was marked by severe drought. The Southeast Research Farm received 14.7" of moisture in 2022, making it the third driest calendar year out of the last 70 years (farm records go back to 1953). The 70-year average annual rainfall is 25.4". In this environment yields were low, averaging only 70, 31, and 52 bu/ac respectively for the corn, soybeans, and oats, respectively, in these plots (Tables 1, 2, and 3). There were no significant treatment effects on grain yield observed; however, corn yields tended to be higher in the no-cover crop control treatment (Table 1). This is consistent with the cover crop composition trial covered elsewhere in this report, where the control treatment (no cover crop) was showed higher yields than plots that had different cover crops in them (radish, grass-based mix, and winter rye as cover crops). This trend is most likely a result of the cover crop using fall moisture,

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which was conserved in the no cover crop plots. The cover crop treatment is only imposed after oats and ahead of corn - the soybean and oat plots were not preceded by a cover crop and did not show appreciable numeric differences in yield.

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Table 1. Stand at maturity, grain moisture, test weight, and yield for corn grown in a trial comparing the use of cover crops, and cover crops with grazing, versus a no cover crop control at the SDSU Southeast Research Farm in the 2022 growing season. The plots are grown in a corn-soybean-oat rotation with the cover crops placed after the oat crop in the sequence. This season was marked by severe drought with low yields. This trial was initiated in the 2016 growing season.

Treatment	Stand at Harvest	Moisture	Test Wt.	Yield
	(plt/ac)	(%)	(lb/bu)	(bu/ac)
Control	30492	14.5	57.8	81.5
Cover Crop	32235	15.2	58.7	69.4
Grazed Cover Crop	30057	13.5	58.7	58.9
Mean	*30928*	*14.4*	*58.4*	*70.0*
CV (%)	*9.0*	*3.1*	*1.6*	*21.5*
LSD (0.10)	*NS*	*0.62*	*NS*	*NS*

Table 2. Stand at maturity, plant height, grain moisture, 100-seed weight, test weight, and yield for soybeans grown in a trial comparing the use of cover crops, and cover crops with grazing, versus a no cover crop control at the SDSU Southeast Research Farm in the 2022 growing season. The plots are grown in a corn-soybean-oat rotation with the cover crops placed after the oat crop in the sequence. This season was marked by severe drought and low yields. This trial was initiated in the 2016 growing season.

Treatment	Stand at Harvest	Height	100-Seed Wt.	Moisture	Test Wt.	Yield
	(plt/ac)	(in)	(g)	(%)	(lb/bu)	(bu/ac)
Control	107158	21.8	15.6	8.8	56.2	30.3
Cover Crop	112821	21.7	15.7	8.7	54.4	30.0
Grazed Cover Crop	113256	20.8	16.2	8.9	51.2	31.3
Mean	*111078*	*21.4*	*15.9*	*8.8*	*53.9*	*30.5*
CV (%)	*16.5*	*8.8*	*4.5*	*6.1*	*6.8*	*21.7*
LSD (0.10)	*NS*	*NS*	*NS*	*NS*	*NS*	*NS*

Table 3. Plant height, 100-seed weight, grain moisture, test weight, and yield for oats grown in a trial comparing the use of cover crops, and cover crops with grazing, versus a no cover crop control at the SDSU Southeast Research Farm in the 2022 growing season. The plots are grown in a corn-soybean-oat rotation with the cover crops placed after the oat crop in the sequence. This season was marked by severe drought and low yields. This trial was initiated in the 2016 growing season.

Treatment	**Height**	**100-Seed Wt.**	**Moisture**	**Test Wt.**	**Yield**
	(in)	(g)	(%)	(lb/bu)	(bu/ac)
Control	29.3	2.85	11.5	31.6	50.4
Cover Crop	30.0	2.63	10.7	32.1	54.9
Grazed Cover Crop	31.3	2.78	10.6	32.2	53.4
Mean	*30.2*	*2.8*	*10.9*	*32.0*	*52.9*
CV (%)	*5.0*	*7.5*	*6.3*	*5.0*	*9.7*
LSD (0.10)	*NS*	*NS*	*NS*	*NS*	*NS*

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Observations on the Effects of Fall Grazing, and Planting Date, on Yield of Hybrid Rye

Peter Sexton*, Brad Rops,
and Garold Williamson

INTRODUCTION

Hybrid rye is a potential alternative crop for our area for diversifying the corn-soybean rotation. It increases the potential for integrating grazing livestock with grain production. Along with the potential for grazing cover crops in the fall after grain harvest, there is also potential for grazing the rye grain crop itself in the late fall of the establishment year. In order to evaluate the effect of establishment year, fall grazing on grain yield of hybrid rye a simple experiment was run to compare yield in grazed and ungrazed plots of winter rye. These plots were seeded in late September, grazed in late November, and harvested for grain the following July.

In another part of the farm, one field was seeded on September 23, 2021 while another nearby field was delayed in planting due to other research projects until October 8, 2021. In the second field, several strips were set aside for later planting and were not seeded until November 4, 2021. This set of three planting dates gives an initial observation on the relation of planting date to grain yield in our area.

METHODS

'Tayo' hybrid rye was planted on September 24, 2021, in one field, and in alternating strips 30' wide by 182 feet in length on October 8, 2021, and November 4, 2021 in a nearby field (same quarter section). The first field was harvested on 18 July, 2022 and the plots in the second field on July 19, 2022 using a small plot combine (Zurn, model 150) to obtain yield samples.

In the grazing observation, 'Tayo' hybrid winter rye was direct seeded into soybean stubble on September 24, 2021. An electric fence was set up creating a 'checker board' perimeter of blocks 100' in length and width. Cattle were introduced to the grazed area on November 25, 2021 and allowed to graze the rye essentially to the ground. Biomass samples (three cuts of 3 square feet) were taken on December 28, 2021 from grazed and ungrazed areas. Seven yield samples were taken from either side of the grazed blocks and data analyzed as a completely randomized design using the Proc GLM subroutine in SAS statistical software.

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RESULTS AND DISCUSSION

Rye biomass after grazing was 360 lb/ac in late December, while it was 1530 lb/ac in the ungrazed area, so the cattle removed about 1200 lb/ac of forage. The ungrazed tested 92 % TDN on a dry matter basis. In the following summer, by the time the crop headed out there was no discernable visual difference between the grazed and ungrazed portions of the field (Fig. 1). Grain yields of the fall- grazed and ungrazed plots were virtually the same; the grazed plots averaged 93.6 bu/ac, while across the fence ungrazed plots averaged 93.8 bu/ac (CV of 2 %). Further testing should be done, but at this point it appears there may be good potential for grazing fall-seeded hybrid rye, provided it is well established (seeded in a timely manner and has adequate moisture for growth), without impacting grain yield the following summer. This appears to be a case where if properly managed the same crop can serve a dual purpose of providing high-quality forage in the fall, and grain production the following year. The trial should be repeated to see if this holds true in years with higher moisture and greater yield potential.

Plotting yields versus planting date across the two fields sampled, there was strong negative relation with delayed planting associated with decreased yield in these fields (Fig. 2). This suggests that planting in a timely manner will be important for maximizing yield of hybrid rye. This relationship is likely even stronger in a drought year, such as 2022, then it would be in a cooler year with greater moisture availability. That is because one would expect delayed planting in Oct. and November to delay maturity of the rye in our environment, and in a drought year that means the later planted plots would have a greater exposure to drought stress during the summer as they go into grain filling.

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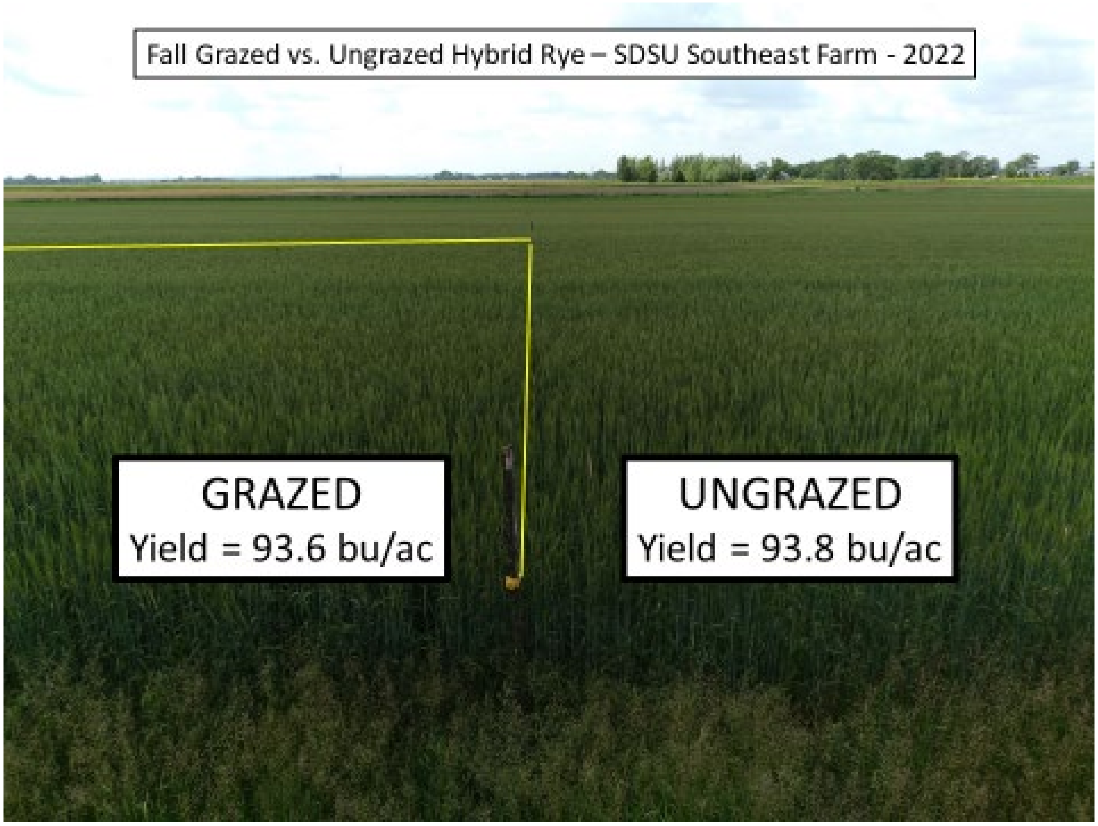

Fig. 1. Adjoining fall-grazed and ungrazed blocks of hybrid rye at the SDSU Southeast Research Farm in Beresford, South Dakota in the 2022 growing season. The yellow line demarcates where the fence was set up during the grazing period.

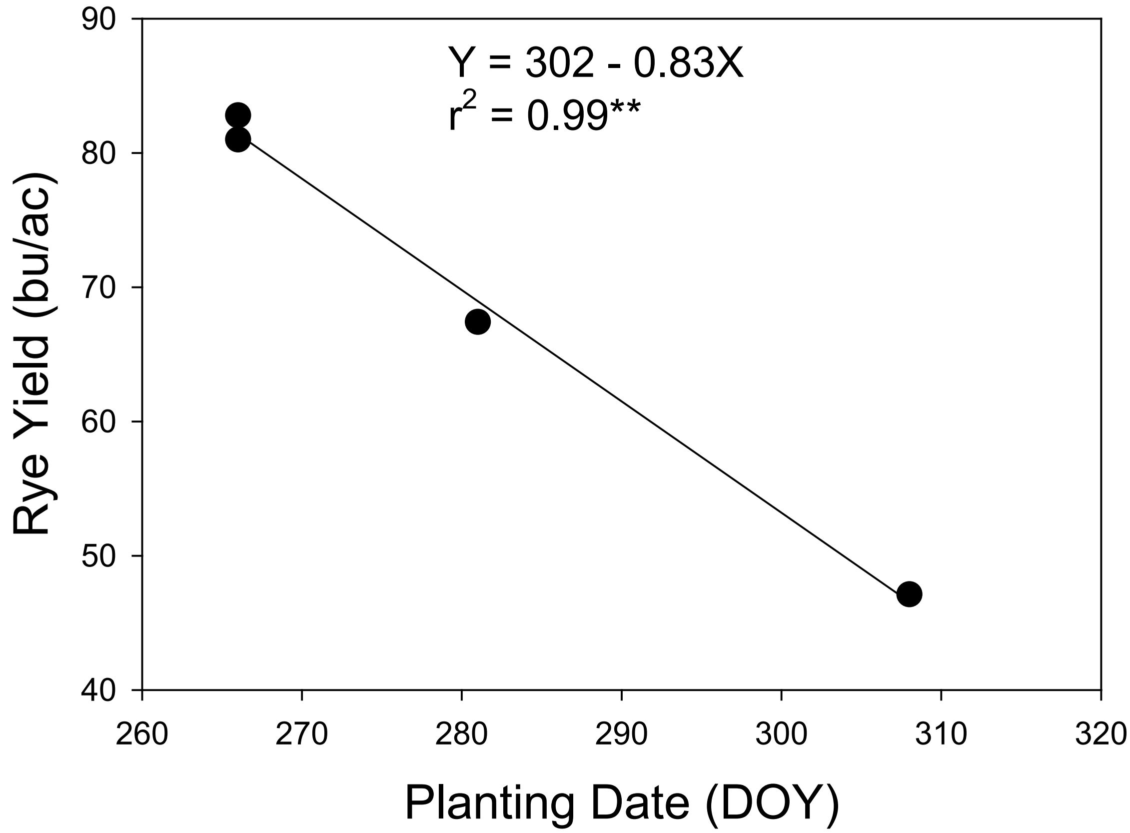

Fig. 2. Association between planting date and yield of hybrid rye observed across different fields at the Southeast Research Farm in Beresford, South Dakota. Plots were seeded in the fall of 2021 into good moisture and harvested in the summer of 2022. The 2022 growing season was marked by severe drought stress, which would have accentuated the negative effect of delayed planting on rye grain yield.

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Winter Rye Grain Variety Trials in the 2022 Season and Comparison of Hybrid versus Open-Pollinated Lines over the Last Four Seasons

Peter Sexton*, Brad Rops,
David Karki, and Joslyn Fousert

INTRODUCTION

With the advent of high-yielding lines of hybrid rye there appears to be some potential for this crop to be profitable in our region. Recent feeding trials at the SDSU Southeast Research Farm with beef cattle and with swine indicate it has potential as a component of livestock rations. If this market develops, then there would be scope for rye grain production to expand in our work area. Rye would be a valuable addition to the corn-soybean rotation. It is very competitive with weeds and adding a third crop would disrupt the lifecycle of pests such as the western and northern corn rootworms. It is a cool-season grass with a fibrous root system which would benefit soil health. For farmers with livestock, it would provide an opportunity to produce straw, a place to put manure in the late summer, and potential to produce a cover crop for fall or winter grazing. Given its potential, it seems appropriate to conduct research with this crop to further evaluate its yield potential. With this in mind, variety trials were conducted at several sites in southeastern South Dakota (Artesian, Tyndall, and Beresford) to compare lines of rye for grain yield production in our environment. Two trials were conducted at Beresford, one in a field that was grazed in the fall, and at a separate location at the farm in a field that was not grazed.

METHODS

At each site rye was direct-seeded using a small plot drill. Plot size was 5 by 20' and plots were laid out in a randomized complete block design with four replications. Fall 2021 planting dates were as follows: Tyndall, September 29; Artesian, September 28; Beresford (Southeast Research Farm) grazed site and, ungrazed sites September 22. At the Beresford site, fertilizer was applied as AMS/UREA/MAP (33-16-16 NPK). Yields were determined at maturity by harvesting the plots with a small plot combine (Zurn Model 150).

RESULTS

One would expect adding a small grain to the rotation would improve yields of the

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following crops as well as spread out workloads and diversify income streams. From a farming system point of view, it looks like rye has strong potential to improve soil health and if the feed market for it develops, then it may have a substantial place in our cropping systems. The more we have to contend with herbicide resistant weeds, the more attractive rye will become, as it is very competitive with weeds and allows for another mode of action to control them. Analysis across sites (Table 1) shows the grain lines 'Receptor' and 'Tayo' were among the highest yielding lines and showed good lodging resistance. There were significant site by line interactions. Yields from each site are shown together in Table 2. Agronomic data along with grain yield are shown for the ungrazed site at Beresford, the grazed site at Beresford, the Artesian site, and the site at Tyndall in Tables 3, 4, 5, and 6, respectively. Among the lines bred for good quality grain production, 'Receptor' and 'Tayo' were consistently among the top yielding lines at each site. 'Propower' is a forage line that was not bred for production of milling quality grain.

Analysis of yield data from variety trials conducted over the last four seasons, two of which were drought years (2021 and 2022) and one of which had excessive moisture (2019), shows that the hybrid lines consistently out-yielded the open pollinated lines (Table 7). The yield of the top-yielding hybrid line averaged 92.2 bu/ac across four seasons, while that of the top-yielding open pollinated line was 59.3 bu/ac, a difference of 32.9 bu/ac in favor of hybrid rye. Comparison of average yields pooled as a class for the hybrid versus open pollinated lines showed a similar yield difference (28.0 bu/ac) in favor the hybrid lines. This difference increased with better growing conditions (47.7 bu/ac in 2020) and was less in poorer growing conditions (14.6 bu/ac in 2021 which suffered drought both during initial establishment and during grain filling). However, in both circumstances (good and poor growing conditions), there was a clear advantage of hybrid rye over open-pollinated lines in terms of grain yield potential.

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Table 1. Pooled analysis of data from a set of rye variety trials conducted across four sites in southeastern South Dakota in 2022 by the SDSU Southeast Research Farm in Beresford, South Dakota. The sites were as follows: Beresford - not grazed, Beresford - fall grazed, Artesian, and Tyndall. Average fall stand rating (visual rating of percent stand in Oct.), height, lodging score, grain moisture, test weight, and grain yield are shown Site by variety interaction for yield was statistically significant. 'Overland' winter wheat was included as a check in these trials.

Line	**Fall Stand Rating**	**Height**	**Lodging Score**	**100-Seed Wt.**	**Moisture**	**Test Wt.**	**Grain Yield**
	(%)	(in)	(0 to 10)	(g)	(%)	(lb/bu)	(bu/ac)
Receptor	88	45.6	**2.3**	1.78	11.6	52.5	**80.2**
Propower	81	45.6	**1.7**	2.03	11.3	52.1	**78.1**
Bono	89	43.7	3.1	1.89	11.0	52.4	**78.1**
Tayo	86	45.1	**2.3**	1.87	11.7	51.2	**77.6**
Aviator	89	52.7	2.5	2.00	11.7	51.6	74.4
Progas	91	48.9	**1.8**	2.49	11.4	51.0	73.9
Serafino	89	45.2	3.4	1.75	11.2	51.6	73.6
Hazlet	93	52.0	3.2	2.20	11.1	52.0	55.0
Danko	95	47.5	3.4	2.08	11.4	52.2	54.9
ND Gardener	92	50.3	3.4	2.09	11.2	51.6	54.3
Dylan*	92	53.5	3.9	1.93	11.1	51.3	54.1
Elbon*	93	50.5	**2.0**	2.14	11.4	52.9	53.6
Rymin*	93	53.4	3.6	1.95	11.1	51.0	52.3
Overland	94	37.8	3.1	2.84	11.6	54.7	48.8
Aroostook	94	50.5	2.7	1.98	11.1	51.8	48.3
Mean	90.6	48.2	2.7	2.07	11.3	52.0	64.1
CV (%)	---	4.8	31.8	5.4	7.1	2.4	7.5
LSD (0.10)	---	1.4	0.6	0.06	0.5	0.7	3.1
Site * Line	---	NS	<0.01	<0.01	NS	<0.01	<0.01

Table 2. Grain yield from rye variety trials conducted at four sites in southeastern South Dakota in 2022 by the SDSU Southeast Research Farm. Each site had four replications laid out in a randomized complete block design. The two sites in Beresford were in two different areas of the Southeast Research Farm, one of which was subjected to heavy grazing pressure in the late fall of 2022 while the other was not grazed. 'Overland' winter wheat was included as a check in these trials.

LINE	**Beresford ungrazed YIELD**	**Beresford grazed YIELD**	**Artesian YIELD**	**Tyndall YIELD**	**AVERAGE across sites YIELD**
	(bu/ac)	(bu/ac)	(bu/ac)	(bu/ac)	(bu/ac)
Receptor	**83.2**	**81.1**	**73.8**	**82.7**	**80.2**
Propower	**85.4**	**80.7**	**69.5**	**77.0**	**78.1**
Bono	79.7	**78.5**	**71.2**	**83.1**	**78.1**
Tayo	**82.8**	**81.0**	**69.1**	**77.7**	**77.6**
Aviator	**85.6**	**80.7**	60.0	71.2	74.4
Progas	80.5	75.0	66.7	73.5	73.9
Serafino	**83.0**	75.4	62.5	73.2	73.6
Hazlet	62.1	61.2	43.9	52.8	55.0
Danko	66.9	56.8	44.8	51.2	54.9
ND Gardener	65.2	58.3	51.0	42.8	54.3
Dylan*	59.7	57.9	44.7	53.8	54.1
Elbon*	62.4	56.8	49.6	45.5	53.6
Rymin*	61.5	58.2	40.2	49.5	52.3
Overland	40.8	58.0	51.7	34.0	48.8
Aroostook	56.5	51.5	43.2	41.9	48.3
Mean	71.4	67.4	56.2	61.6	64.1
CV (%)	5.3	4.8	8.8	10.6	7.5
LSD (0.10)	5.2	3.9	6.8	7.8	3.1
Site * Line	n/a	n/a	n/a	n/a	<0.01

Table 3. Fall stand rating (visual rating of percent stand in Oct.), height, lodging score, grain moisture, test weight, and grain yield for a rye variety trial conducted at Beresford by the SDSU Southeast Research Farm in 2022. This field was not grazed.

Beresford - not grazed

Line	Fall Stand Rating	Height	Lodging Score	100-Seed Wt.	Moisture	Test Wt.	Grain Yield
	(%)	(in)	(0 to 10)	(g)	(%)	(lb/bu)	(bu/ac)
Aviator	90	50.5	1.8	2.03	10.9	52.8	**85.6**
Propower	80	44.0	1.0	1.98	10.8	53.0	**85.4**
Receptor	87	43.3	2.4	1.65	11.0	52.7	**83.2**
Serafino	90	43.6	2.4	1.78	10.6	52.5	**83.0**
Tayo	85	43.1	1.6	1.75	10.9	51.7	**82.8**
Progas	92	47.2	1.9	2.50	10.6	51.9	**80.5**
Bono	89	42.1	3.3	1.78	10.8	52.8	79.7
Danko	95	44.9	1.8	2.18	10.6	53.3	66.9
ND Gardener	95	49.3	3.9	2.05	10.4	52.1	65.2
Elbon*	95	49.3	2.3	2.13	10.7	53.7	62.4
Hazlet	94	48.9	3.1	2.25	10.4	53.3	62.1
Rymin*	96	50.8	3.0	2.03	10.6	52.4	61.5
Dylan*	94	50.4	3.9	1.95	10.4	52.4	59.7
Aroostook	95	49.2	3.5	1.98	10.3	52.1	56.5
Overland	95	37.5	1.5	2.60	10.8	52.2	40.8
Mean	91.4	46.3	2.5	2.04	10.7	52.6	71.4
CV (%)	---	3.6	36.5	5.2	2.6	3.4	5.3
LSD (0.10)	---	2.0	1.3	0.13	0.3	NS	5.2

Table 4. Fall stand rating (visual rating of percent stand in Oct.), height, lodging score, grain moisture, test weight, and grain yield for a rye variety trial conducted at Beresford by the SDSU Southeast Research Farm in 2022. This field was grazed in the fall (76 % of shoot weight removed by cattle in November).

Beresford - Fall Grazed

Line	**Fall Stand Rating**	**Height**	**Lodging Score**	**100-Seed Wt.**	**Moisture**	**Test Wt.**	**Grain Yield**
	(%)	(in)	(0 to 10)	(g)	(%)	(lb/bu)	(bu/ac)
Receptor	88	43.8	2.1	1.68	10.5	53.1	**81.1**
Tayo	88	42.5	1.6	1.83	10.8	52.3	**81.0**
Aviator	90	51.0	1.4	2.05	11.0	52.9	**80.7**
Propower	83	43.3	1.3	2.03	10.5	52.9	**80.7**
Bono	88	40.3	3.0	1.83	10.6	53.2	**78.5**
Serafino	87	42.5	2.9	1.73	10.5	52.5	75.4
Progas	91	44.3	1.1	2.40	10.6	51.9	75.0
Hazlet	94	48.5	2.4	2.25	10.5	53.6	61.2
ND Gardener	90	46.8	2.9	1.95	10.1	52.9	58.3
Rymin*	91	50.0	2.8	2.08	10.5	52.5	58.2
Overland	94	37.0	1.4	2.80	10.1	57.3	58.0
Dylan*	91	52.8	2.6	2.03	10.3	52.7	57.9
Danko	95	46.3	2.5	2.05	10.6	53.4	56.8
Elbon*	94	49.3	1.9	2.05	10.4	53.7	56.8
Aroostook	96	47.8	2.8	1.83	10.2	52.2	51.5
Mean	90.6	45.7	2.2	2.04	10.5	53.1	67.4
CV (%)	---	5.4	22.9	4.4	1.5	1.0	4.8
LSD (0.10)	---	2.9	0.6	0.11	0.2	0.4	3.9

Table 5. Fall stand rating (visual rating of percent stand in Oct.), height, lodging score, grain moisture, test weight, and grain yield for a rye variety trial conducted at Artesian, South Dakota, by the SDSU Southeast Research Farm in 2022.

Artesian, South Dakota

Line	**Fall Stand Rating**	**Height**	**Lodging Score**	**100-Seed Wt.**	**Moisture**	**Test Wt.**	**Grain Yield**
	(%)	(in)	(0 to 10)	(g)	(%)	(lb/bu)	(bu/ac)
Receptor	90	49.0	3.3	1.85	13.1	52.2	**73.8**
Bono	89	46.8	4.5	1.98	13.1	52.0	**71.2**
Propower	75	48.3	3.5	1.95	12.5	51.2	**69.5**
Tayo	84	48.3	4.0	1.95	13.2	50.6	**69.1**
Progas	91	52.8	3.0	2.43	12.6	50.3	66.7
Serafino	88	49.0	5.3	1.68	12.3	50.6	62.5
Aviator	88	55.0	4.8	1.85	12.9	50.2	60.0
Overland	96	39.5	2.0	2.90	12.3	56.9	51.7
ND Gardener	93	53.8	3.5	2.13	12.3	50.9	51.0
Elbon*	96	53.8	2.0	2.13	12.6	52.4	49.6
Danko	97	51.3	6.3	1.95	12.4	51.1	44.8
Dylan*	95	58.3	5.8	1.70	12.2	49.4	44.7
Hazlet	94	58.0	5.3	1.98	12.0	50.1	43.9
Aroostook	98	53.3	2.0	2.08	12.4	51.5	43.2
Rymin*	98	58.5	5.8	1.63	12.1	48.7	40.2
Mean	91.3	51.7	4.1	2.01	12.5	51.2	56.2
CV (%)	---	4.9	29.1	7.1	2.5	1.1	8.8
LSD (0.10)	---	3.0	1.6	0.17	0.4	0.7	6.8

Table 6. Fall stand rating (visual rating of percent stand in Oct.), height, lodging score, grain moisture, test weight, and grain yield for a rye variety trial conducted at Tyndall, South Dakota, by the SDSU Southeast Research Farm in 2022.

Tyndall, South Dakota

Line	Fall Stand Rating	Height	Lodging Score	100-Seed Wt.	Moisture	Test Wt.	Grain Yield
	(%)	(in)	(0 to 10)	(g)	(%)	(lb/bu)	(bu/ac)
Bono	90	45.5	1.5	1.98	9.4	51.6	**83.1**
Receptor	88	46.5	1.5	1.95	11.7	51.8	**82.7**
Tayo	88	46.5	2.0	1.95	11.9	50.5	**77.7**
Propower	86	46.8	1.0	2.15	11.6	51.3	**77.0**
Progas	90	51.5	1.3	2.63	11.7	50.1	73.5
Serafino	91	45.8	3.0	1.83	11.5	50.7	73.2
Aviator	88	54.3	2.3	2.08	11.9	50.7	71.2
Dylan*	88	52.5	3.3	2.05	11.5	50.5	53.8
Hazlet	91	52.8	2.0	2.33	11.5	51.1	52.8
Danko	94	47.8	3.0	2.15	12.1	51.1	51.2
Rymin*	88	54.3	2.8	2.08	11.3	50.5	49.5
Elbon*	88	49.8	1.8	2.28	12.1	51.7	45.5
ND Gardener	89	51.5	3.5	2.23	11.9	50.5	42.8
Aroostook	90	51.8	2.5	2.03	11.4	51.6	41.9
Overland	91	37.0	1.5	3.08	13.3	52.3	34.0
Mean	89.2	48.9	2.2	2.18	11.6	51.1	61.6
CV (%)	---	5.1	33.4	4.5	13.2	3.0	10.6
LSD (0.10)	---	3.0	1.0	0.12	NS	NS	7.8

Table 7. Comparison of grain yields for hybrid versus open-pollinated lines of rye compiled from variety trials conducted out of the SDSU Southeast Research Farm over the past four seasons (2019 through 2022). The columns on the left-hand side compare yield averages for the hybrid and open pollinated lines, while the columns on the right-hand side compare yields of the top-yielding hybrid and open pollinated lines from the rye variety trials conducted in southeast South Dakota over this period of time.
Statistical comparison of hybrid versus open pollinated lines showed the differences were statistically significant ($P < 0.05$) for both average yields, and for the highest yielding lines of each class.

Year	Hybrid Average	OP Average	Difference
	(bu/ac)	(bu/ac)	(bu/ac)
2019	84.0	49.0	35.0
2020	105.3	67.7	37.6
2021	54.8	38.7	16.1
2022	76.6	53.2	23.4
Mean	80.2	52.2	28.0
Hybrid vs. OP			
P-value	0.011		
CV (%)	10.8		

Year	Best Hybrid	Best OP	Difference
	(bu/ac)	(bu/ac)	(bu/ac)
2019	105.0	61.0	44.0
2020	125.0	77.3	47.7
2021	58.4	43.8	14.6
2022	80.2	55.0	25.2
	92.2	59.3	32.9
	Hybrid vs. OP		
	P-value	0.025	
	CV (%)	14.6	

SOUTHEAST RESEARCH FARM ANNUAL REPORT
South Dakota State University
2022 Progress Report
Agricultural Experiment Station
Plant Science Department
South Dakota State University, Brookings, SD 57007
Southeast Research Farm, Beresford, SD 57004

WARM SEASON ANNUAL FORAGES REPORT - 2022 GROWING SEASON; SDSU SOUTHEAST RESEARCH FARM, BERESFORD, SOUTH DAKOTA

Brad Rops, Sara Bauder,
Joslyn Fousert, and Peter Sexton*

INTRODUCTION

This report provides a summary of dry matter yields observed in a trial with warm-season annual forages established at the SDSU Southeast Research Farm in the summer of 2022. The season was marked by extreme drought at the Beresford site, with rainfall received from April through August being only about half of average.

METHODS

Plots were laid out in a randomized complete block design with six replications using a plot size is 5' by 25'. Plots were direct-seeded on June 25, 2022 into barley that had previously been grazed and then burned down with glyphosate (June 15, 2022). Because of previous difficulty getting teff established, the teff plots were tilled with a garden tractor and seeded on June 27th. Whole plot yields from four of the replications were taken using a forage harvester (Model SMW-SCH-48; Swift Machine & Welding, Swift Current, Saskatchewan, Canada) on August 20th. Subsamples of fresh material were weighed and dried at 140° F to determine percent moisture. Cattle were allowed to graze the remaining two replications along with the rest of the field for one week (August 22 to August 29). In the two grazed replications, a subsample of 3 ft^2 was taken from each plot immediately before, and after, grazing. From this a percentage of biomass grazed was calculated for each plot in the two grazed replications. All yield data are presented on a dry weight basis. The means were individually compared to the highest yielding line and separated with an LSD test ($P < 0.10$) using SAS statistical software. Regrowth of the plots was not evaluated due to extreme drought conditions which severely restricted recovery after cutting.

RESULTS

Cumulative rainfall from January 1 through August 31, 2022 was 8.45" below average in this growing season. Across all the treatments, the average forage production was 1770 lb/ac, with the higher yielding lines producing from 2199 to 2700 lb/ac (Table 1). There were significant differences among sudangrass, and sorghum-sudangrass

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hybrids, in percent of biomass grazed. Under the severe drought conditions experienced this year, the cover crop blends with a strong brassica component tended to produce less forage on a dry matter basis and were not preferred by cattle (young replacement heifers) in this trial. It should be kept in mind that the cattle had access to the whole field, so they were not compelled to graze these plots. The relative grazing pressure and the extent the cattle are acclimated to a given forage are both factors to consider in reflecting on the grazing preference data.

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Table 1. Height, dry matter yield, and percent dry matter loss with grazing observed in a warm-season forage trial conducted at the Southeast Research Farm in the 2022 growing season. Lines are ranked by dry matter production. The percent grazed values are based on two replications which were hand sampled (3 ft^2 per plot) before and after grazing. Values that are in **bold** text are not significantly different from the highest yielding line in each category. Lines are ranked according to dry matter production.

Line	Type	Height	Dry Matter Yield	% Grazed
		(in)	(lb/ac)	(%)
Sorghum Partners SP4555 BMR	BMR sorghum x sudangrass	49.8	**2700**	**74**
Sorghum Partners Sordan 79	hybrid sorghum x sudangrass	48.3	**2507**	58
Viking 0.210	sorghum x sudangrass	36.2	**2447**	**85**
SudX BMRDS	hybrid sorghum x sudangrass	38.4	**2283**	50
Piper	sudangrass	49.4	**2250**	24
Viking 200	sorghum x sudangrass	46.8	**2213**	50
Exp. Variety 1- Gayland Ward	sorghum x sudangrass	43.8	**2199**	53
Viking 150	sorghum x sudangrass	44.8	2052	**77**
Viking 0.510	sudangrass	40.6	2025	50
Viking 100	sorghum x sudangrass	44.2	2014	48
Hay N Graze BMRDS	hybrid sorghum x sudangrass	41.4	2002	56
S&W EXP SWSB8801	sorghum x sudangrass	38.0	1948	40
Kattle Kandy BMRDW	sorghum x sudangrass	35.0	1915	**82**
Exp. Variety 2 IS28- Blue River Seed	sorghum x sudangrass	42.2	1799	**80**
Viking 232	sorghum x sudangrass	37.4	1778	64
Turbo Sudangrass	sudangrass	34.3	1717	**87**
Viking 300	sorghum x sudangrass	39.5	1665	**92**
Viking 0.225	sorghum x sudangrass	34.6	1597	65
Sorgo Sugar BMR	sorghum x sudangrass	38.0	1579	49
Sorghum Partners SP4105 BMR	hybrid forage sorghum	36.4	1540	62
Premium Graze	warm season blend	21.7	1245	59
Sorghum Partners Sordan Headless	hybrid forage sorghum	32.0	1186	58
Beef Builder	CC Blend with brassicas	12.3	1011	31
HyGain Grazer	CC Blend with brassicas	12.6	937	8
ECO Graze Plus	CC Blend with brassicas	11.0	936	35
Eragrostis Teff	Teff Grass	15.0	482	**97**
	Mean	*36.0*	*1770*	*59*
	CV (%)	*19.4*	*27.8*	*27.1*
	LSD (0.10)	*8.2*	*585*	*28.2*

SOUTHEAST RESEARCH FARM ANNUAL REPORT
South Dakota State University
2022 Progress Report
Agricultural Experiment Station
Plant Science Department
South Dakota State University, Brookings, SD 57007
Southeast Research Farm, Beresford, SD 57004

ALFALFA VARIETY TRIAL REPORT - 2020, 2021, AND 2022 GROWING SEASONS; SDSU SOUTHEAST RESEARCH FARM, BERESFORD, SOUTH DAKOTA

Sara Bauder, Brad Rops,
and Peter Sexton*

INTRODUCTION

This report provides a summary of alfalfa yields observed in a variety trial established at the SDSU Southeast Research Farm in the spring of 2020 and conducted through the 2022 season. Lines of interest were submitted by different alfalfa seed companies for inclusion in the trial. Alfalfa is an important crop for ruminant nutrition in our region, and it is critical for profitable dairy production.

METHODS

The plots were laid out in a randomized complete block design with six replications with a plot size is 5' by 18'. Plots were seeded on April 9, 2020. Whole plot yields were taken using a forage harvester (Model SMW-SCH-48; Swift Machine & Welding, Swift Current, Saskatchewan, Canada). Cutting dates were as follows: year one, July 9 and August 21, 2020; year two, May 28, June 28, and August 2, 2021; year three, May 27, June 30, and August 3, 2022. A fourth cutting was not taken in in the second and third years of the trial because drought conditions limited growth. Subsamples of fresh material were weighed and dried at 140° F to determine percent moisture. All yield data are presented on a dry weight basis. Some plots had skipped rows due to a planter row plugging, in order to correct for this, yields in these plots were adjusted on a percent basis using the average difference between the plots with and without skipped rows. The means were individually compared to the highest yielding line and separated with an LSD test ($P < 0.10$) using SAS statistical software.

RESULTS

Temperature and rainfall data for the last three seasons are shown in Table 1, and Table 2, respectively. Cumulative rainfall over this three-year period is shown in Fig. 1, showing cumulative development of drought conditions over time. There were significant differences in the first cutting of 2022, but with the extreme drought stress experienced this last season, varietal differences in total dry matter production for the 2022 season

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were not statistically significant (Table 3). Total dry matter yields across the three years of the study of the top 50% of the entries are shown in Table 4.

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Table 1. Temperatures[a] at the Southeast Research Farm - 2020, 2021, and 2022.

2020 Season	2020 Average Air Temps. (°F)		68-year Average Air Temps. (˚F)		Departure from 68-year Average (˚F)	
	Maximum	Minimum	Maximum	Minimum	Maximum	Minimum
January	26.7	10.5	26.6	5.9	+0.1	+4.6
February	33.4	14.3	32.0	11.0	+1.4	+3.3
March	48.0	26.9	44.2	23.0	+3.8	+3.9
April	57.6	30.2	59.9	35.0	-2.3	-4.8
May	66.4	47.1	71.8	47.3	-5.4	-0.2
June	86.7	62.9	81.6	58.0	+5.1	+4.9
July	86.4	69.3	86.0	62.2	+0.4	+7.1
August	85.2	59.2	83.8	59.4	+1.4	-0.2
September	76.2	47.5	75.6	49.4	+0.6	-1.9
October	55.6	29.3	63.1	37.3	-7.5	-8.0
November	50.5	24.7	45.3	23.7	+5.2	+1.0
December	38.1	11.8	30.8	11.6	+7.3	+0.2

[a] Computed from daily observations

2021 Season	2021 Average Air Temps. (°F)		69-year Average Air Temps. (˚F)		Departure from 69-year Average (˚F)	
	Maximum	Minimum	Maximum	Minimum	Maximum	Minimum
January	31.8	17.6	26.7	6.0	+5.1	+11.6
February	20.3	-0.2	31.8	10.8	-11.5	-11.0
March	52.0	27.2	44.3	23.1	+7.7	+4.1
April	59.3	33.0	59.9	35.0	-0.6	-2.0
May	70.1	47.3	71.8	47.3	-1.7	0.0
June	88.4	59.4	82.9	58.9	+3.8	+4.0
July	85.4	62.9	87.2	63.1	-0.8	+6.2
August	85.8	61.4	85.1	60.3	+0.1	-1.1
September	79.8	51.8	76.8	50.2	-0.6	-2.7
October	65.8	40.2	64.1	37.9	-8.5	-8.6
November	50.5	25.0	46.1	24.0	+4.4	+0.7
December	38.0	16.5	31.4	11.8	+6.7	0.0

[a] Computed from daily observations

2022 Season, through September.

	2022 Average Air Temps. (°F)		70-year Average Air Temps. (˚F)		Departure from 70-year Average (˚F)	
	Maximum	Minimum	Maximum	Minimum	Maximum	Minimum
January	31.6	3.0	26.7	6.0	+4.9	-3.0
February	33.9	5.4	31.8	10.8	+2.1	-5.4
March	46.6	21.8	44.3	23.0	+2.3	-1.2
April	57	30.4	59.8	34.9	-2.8	-4.5
May	71	48.8	71.8	47.4	-0.8	+1.4
June	83.8	60	81.7	58.1	+2.1	+1.9
July	87.5	63.6	86.0	62.2	+1.5	+1.4
August	85	61	83.9	59.4	+1.1	+1.6
September	81.2	51.4	75.7	49.5	+5.5	+1.9

[a] Computed from daily observations

Table 2. Precipitation at the Southeast Research Farm - 2020, 2021, and 2022 seasons.

2020 Season

Month	Precipitation 2020 (inches)	68-year Average (inches)	Departure from Avg. (inches)
January	0.39	0.45	-0.06
February	0.08	0.79	-0.71
March	2.73	1.45	+1.28
April	0.55	2.54	-1.99
May	2.16	3.55	-1.39
June	3.23	4.19	-0.96
July	1.95	3.08	-1.13
August	1.23	3.04	-1.81
September	0.35	2.81	-2.46
October	0.70	1.92	-1.22
November	0.91	1.13	-0.22
December	0.26	0.66	-0.40
Totals	14.54	25.61	-11.07

2021 Season

Month	Precipitation 2021 (inches)	69-year Average	Departure from Avg. (inches)
January	1.01	0.46	+0.55
February	0.30	0.78	-0.48
March	2.33	1.46	+0.87
April	2.45	2.53	-0.08
May	2.07	3.53	-1.46
June	0.71	4.14	-3.43
July	3.02	3.08	-0.06
August	3.88	3.05	+0.83
September	3.05	2.82	+0.23
October	3.32	1.94	+1.38
November	0.19	1.12	-0.93
December	1.26	0.67	+0.59
Totals	23.59	25.58	-1.99

[a] Computed from daily observations

2022 Season

Month	Precipitation 2022 (inches)	70-year Average	Departure from Avg. (inches)
January	0.13	0.45	-0.32
February	0.14	0.77	-0.63
March	1.41	1.46	-0.05
April	0.73	2.51	-1.78
May	3.13	3.52	-0.39
June	1.20	4.09	-2.89
July	1.89	3.06	-1.17
August	1.81	3.03	-1.22
September	1.70	2.80	-1.10
October	0.56	1.92	-1.36
Totals as of Oct 31	12.70	23.63	-10.93

[a] Computed from daily observations

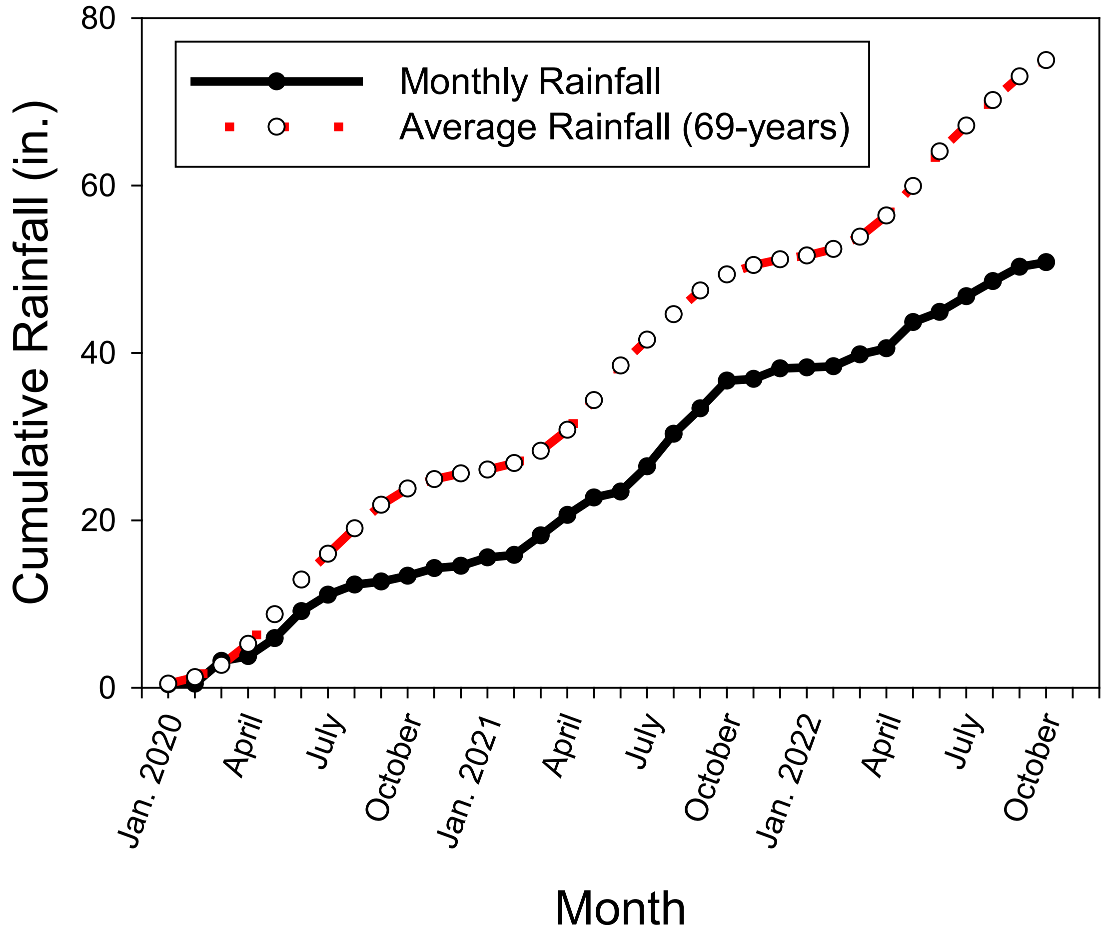

Fig. 1. Cumulative monthly rainfall relative to 69-year average rainfall at the SDSU Southeast Research Farm in Beresford, South Dakota, across the most recent three growing seasons (2020, 2021, and 2022). The difference between the lines is 24.1" at this writing (October 31, 2022).

Table 3. Dry matter yields from an alfalfa variety trial conducted at the Southeast Farm in Beresford, South Dakota in the 2022 season. Plots were established in the spring of 2020, making this the third season of the trial. Plots were harvested on May 27, June 30, and Aug. 3 of 2022. Yields were strongly impacted by drought stress. Data from the top 50 % of the entries are shown.

Line	**First Cutting**	**Second Cutting**	**Third Cutting**	**Total**
	(tons/ac)	(tons/ac)	(tons/ac)	(tons/ac)
Viking 342	**2.45**	**0.66**	0.08	3.19
GA440XQ	**2.37**	**0.69**	0.08	3.15
Viking 394	**2.43**	0.63	0.07	3.13
DB Rush Hour	**2.38**	0.61	0.11	3.10
DSX174083	**2.33**	0.62	0.09	3.04
DB 540 Salt	**2.34**	0.63	0.06	3.03
Check (Vernal)	**2.47**	0.51	0.05	3.02
C04153364	2.08	**0.78**	0.14	3.00
DSX174082	**2.29**	0.61	0.09	2.99
Bluebird	**2.27**	0.61	0.08	2.96
DSX174085	**2.29**	0.59	0.07	2.95
HybriForce-4420	**2.25**	**0.65**	0.05	2.95
Mean	*2.27*	*0.60*	*0.07*	*2.94*
CV (%)	*10.8*	*25.0*	*116.5*	*12.5*
LSD (0.10)	*0.24*	*0.14*	*NS*	*NS*

Table 4. Total dry matter yields across three seasons from an alfalfa variety trial conducted at the Southeast Farm in Beresford, South Dakota. Plots were established in the spring of 2020, and the study was continued through the 2021 and 2022 growing seasons. This period was marked by below-average rainfall much of the time, and drought stress impacted yields, particularly in the third year of the study. Data from the overall top 50 % of the entries are shown, along with the check ('Vernal').

ENTRY	2020 Total	2021 Total	2022 Total	Combined Total
	ton/ac	ton/ac	ton/ac	ton/ac
DSX174083	**3.15**	**4.76**	3.04	**10.95**
GA440XQ	**2.99**	**4.58**	3.15	**10.72**
DSX174082	**3.11**	**4.50**	2.99	**10.60**
Viking Organic 5200	**2.99**	**4.80**	2.77	**10.56**
Viking 394	2.75	**4.29**	3.13	**10.18**
DB Rush Hour	2.88	**4.16**	3.10	**10.14**
HybriForce-4400	**3.00**	**4.22**	2.90	**10.12**
Red Falcon	**2.94**	**4.27**	2.85	**10.06**
DB HeavyWeight	**2.93**	**4.15**	2.91	9.99
DB 540 Salt	2.63	**4.27**	3.03	9.92
Viking 342	2.58	**4.14**	3.19	9.91
C04153364	2.76	**4.10**	3.00	9.86
check (Vernal)	**2.92**	3.36	3.02	9.31
Mean	*2.87*	*4.06*	*2.94*	*9.88*
CV (%)	*7.9*	*15.9*	*12.5*	*9.7*
LSD (0.10)	*0.265*	*0.62*	*NS*	*0.92*

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SORGHUM AND SORGHUM/SUDAN SILAGE TRIAL - 2022 GROWING SEASON; SDSU SOUTHEAST RESEARCH FARM, BERESFORD, SOUTH DAKOTA

Brad Rops, Sara Bauder,
Joslyn Fousert, and Peter Sexton*

INTRODUCTION

This report provides a summary of dry matter yields observed in a trial with forage sorghum and sorghum-sudan lines raised for silage at the SDSU Southeast Research Farm in the summer of 2022. The season was marked by extreme drought at the Beresford site, with only 4.9" of rain received over the summer (June thru August) versus a 70-year of average of 10.2" over those same months.

METHODS

Plots were laid out in a randomized complete block design with four replications using a plot size of 10’ by 30’, consisting of four 30-inch rows. Plots were direct-seeded on June 17, 2022 into rye stubble that had been cut for silage and then burned down with glyphosate on May 27, 2022. On June 8, 100 lb/ac of N was applied as urea. Weeds were controlled by hand labor. The sorghum-sudangrass lines were hand harvested at the boot stage by cutting two 10' sections of row from the inner rows of each plot on 17 August, 2022. These whole samples were weighed in the field, and then a subsample of four plants was immediately chipped; the material was mixed, and then a sample was weighed fresh and then dried at 140˚ F and weighed again for determination of percent moisture. The forage sorghum plots were harvested in the same manner on 3 October, 2022, when the lines were in the soft dough stage. Height data was collected at harvest from the ground to the tip of the tallest leaves held vertically along the stem. All yield data are presented on a dry weight basis. The means were individually compared to the highest yielding line and separated with an LSD test ($P < 0.10$) using SAS statistical software.

RESULTS

Cumulative rainfall from January 1 through September 31, was 9.55" below average in this growing season. Across all the treatments, the average forage production was 6290 lb/ac, with an estimated silage yield of 9 tons per acre (Table 1). Within this, the sorghum-sudan lines averaged 3580 lb/ac of dry matter; the forage sorghum lines averaged 9170 lb/ac of dry matter; the two corn lines included in the trial averaged 5720 lb/ac of dry matter. The sorghum-sudan lines averaged 17.8 % dry matter at harvest, which means in a production environment they would need to have been allowed to wilt

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before chopping to make good silage. The forage sorghum lines averaged 31.9 % dry matter at harvest. The drought stress experienced this year at the Southeast Farm was a factor which negatively influenced forage production.

By way of comparison of planting forage sorghum versus soybeans for grain, two soybean lines (one early - 'H15XF2', and one late - 'H28X8') were included in the trial as checks for potential soybean yield following a rye silage crop. The early line yielded 19.9 bu/ac, and the late line had < 5 bu/ac yield, due to the drought. Clearly forage sorghum was the better choice as a double crop following rye silage in this season with severe drought stress.

ACKNOWLEDGEMENTS

The authors appreciate the contributions of the SD Agricultural Experiment Station to support this research work.

Table 1. Dry matter and calculated silage yields from a forage sorghum and sorghum/sudangrass variety trial conducted at the SDSU Southeast Research Farm in 2022. The plots were planted into a field of rye that had been cut for silage in late May and then burned down with glyphosate. The 2022 season was marked by extreme drought stress which limited yields. Silage yield was calculated assuming 35% dry matter in the crop. Height data was collected at harvest from the ground to the tip of the tallest leaves held vertically along the stem.

Line	Species	Harvest Date	Height	Dry Wt.	SILAGE
			(in)	(lb/ac)	(ton/ac)
NK300	Sorghum	10/3/22	60.7	**10179**	**14.54**
Ranch King BMR	Hybrid Sorghum	10/3/22	68.5	**10096**	**14.42**
SPBD703	Sorghum	10/3/22	68.3	**9430**	**13.47**
SP2774 BMR	Sorghum	10/3/22	**91.1**	**9397**	**13.42**
SPBD702	Sorghum	10/3/22	61.8	**9297**	**13.28**
Viking 401	Sorghum	10/3/22	71.1	8507	12.15
Ranchers Elite DW	Hybrid Sorghum	10/3/22	47.2	7303	10.43
P0622AM	Corn - 106 d	10/3/22	70.3	5808	8.30
DKC45-94	Corn - 95 d	10/3/22	68.0	5636	8.05
Viking 200	Sorghum Sudan	8/17/22	72.6	4180	5.97
Viking 150	Sorghum Sudan	8/17/22	73.6	3950	5.64
Exp Var 1-Ward	Sorghum Sudan	8/17/22	61.8	3785	5.41
Viking 300	Sorghum Sudan	8/17/22	64.1	3655	5.22
Kattle Kandy DMRDW	Sorghum Sudan	8/17/22	54.0	3417	4.88
Viking O. 225	Sorghum Sudan	8/17/22	55.1	3112	4.45
Sorgo Sugar BMR	Sorghum Sudan	8/17/22	60.1	2956	4.22
	Mean		*65.5*	*6294*	*8.99*
	CV (%)		*10.5*	*17.6*	*17.6*
	LSD (0.10)		*8.1*	*1313*	*1.88*

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Winter Annual Forage Variety Trial - 2022 Season

Peter Sexton*, Brad Rops,
and Sara Bauder

INTRODUCTION

Winter annual forages can offer opportunity for producing forage relatively early in the season and allow for double cropping if moisture is adequate. Forage taken as hay, silage or by grazing can be followed with soybeans, forage sorghum, or other warm season forages. Also, winter annuals will use up residual nitrogen in the fall, protect soil from wind and water erosion, and keep living roots in the soil benefiting soil microbiology. This trial evaluates several lines of interest of rye and triticale for forage production, along with two winter wheat lines for comparison. This is the fourth season that the Southeast Farm has conducted a winter annual forage variety trial.

METHODS

Several varieties of hybrid rye, open-pollinated (OP) rye, triticale and two winter wheat varieties were no-till drilled into soybean stubble on September 23, 2021. Plots were laid out in a randomized complete block design with four replications. Plot size was 5’ by 20'. Plots were fertilized with AMS 65 lb/ac; UREA 35 lb/ac; MAP 30 lb/ac (33-16-0-16 NPKS). Plant heights were taken along with growth stage using the Feekes scale before harvest. Most of the plots were in the boot stage. The ends were trimmed, plot lengths were recorded and plots were harvested with a small plot forage harvester on May 20, 2022. Subsamples were taken for determination of percent moisture at harvest. Hay yield was corrected to 85 % dry matter, and silage yield was corrected to 35 % dry matter.

RESULTS

The fall of 2021 had good moisture and the winter annual forages were able to establish well. Table 1 shows dry matter yield along with calculated hay and silage yields for each line. With the exception of 'Fridge' triticale, all the top-yielding lines were winter rye. This is the fourth season we have run this type of a winter annual forage trial; rye has outperformed wheat and usually outperforms triticale check lines in all four years of these trials (Table 1 and 2). Among the rye lines tested, the OP line 'Hazlet' has consistently performed well and has been among the top yielding lines in each season. Rye forage quality declines sharply after the boot stage,

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so it is a good idea to be timely in harvesting once rye gets to that stage.

The potential for double cropping depends on availability of soil moisture. If soil moisture is adequate, soybeans have produced very well (60 bu/ac in our trials in 2017) following a rye forage crop; however, in drought years soybean yields following a rye silage crop have been reduced up to 50 % or more relative to no-rye check plots. If drought is a concern, it may be prudent either to kill the rye early to conserve soil moisture, or to double crop with forage sorghum rather than soybeans as forage sorghum is much more drought tolerant than are soybeans (see the paper on the sorghum and sorghum/sudan silage variety trial in this annual report).

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

Table 1. Visual rating of stand in Oct., and March, visual rating of vigor in March, stage and height at harvest, dry matter tonnage, and tonnage as hay and silage for 11 lines of winter annual forages evaluated in a replicated trial at the SDSU Southeast Research Farm in the 2022 season. Plots were seeded on Sept. 23, 2021 and harvested on May 20, 2022. Stand percent and vigor ratings are based on a visual evaluation of the plots on the given date.

Line	Type	Oct 22 Stand	March 31 Stand	March 31 Vigor	Feeke's Stage	Ht	Dry Matter	Hay	Silage
		(%)	(%)	(0 to 10)		(in)	(ton/ac)	(ton/ac)	(ton/ac)
KWS Aviator	HY-rye	93.3	94.5	**7.0**	**10.2**	34.3	**2.96**	**3.49**	**8.46**
Hazlet	OP-rye	94.3	95.0	**7.0**	**10.3**	34.8	**2.72**	**3.20**	**7.76**
Elbon	OP-rye	95.0	95.8	**7.5**	**10.5**	39.0	**2.70**	**3.18**	**7.73**
KWS Propower	HY-rye	89.3	96.0	**6.5**	**10.0**	29.0	**2.70**	**3.18**	**7.72**
KWS Progas	HY-rye	95.0	98.0	**6.0**	**10.1**	33.8	**2.67**	**3.14**	**7.62**
Fridge	Trit.	96.3	95.8	3.5	8.5	30.3	**2.65**	**3.12**	**7.57**
Forage FX 1001	Trit.	95.8	95.3	4.0	9.0	30.5	2.48	2.92	7.08
Tulus	Trit.	87.5	93.3	3.8	8.5	22.3	2.36	2.78	6.74
Nitrous Trit.	Trit.	86.0	88.5	4.0	8.5	24.3	2.34	2.75	6.69
Jerry	Wheat	93.3	91.5	2.8	7.5	25.3	2.29	2.69	6.53
Willow Creek	Wheat	95.5	94.8	2.8	7.0	24.3	2.11	2.48	6.03
	Mean	92.8	94.4	5.0	9.1	29.8	2.54	2.99	7.27
	CV (%)	---	---	11.7	3.7	5.0	11.3	11.3	11.3
	LSD (0.10)	---	---	0.7	0.4	1.8	0.34	0.40	0.98

Table 2. Yield data from 2019, 2020, and 2021 variety trials with winter annual forages conducted at the SDSU Southeast Research Farm in Beresford, South Dakota. All yields are reported on a dry matter basis.

LINE	Type	2019 Dry Matter
		(ton/ac)
Hazlet	OP-rye	**2.36**
Rymin	OP-rye	**2.34**
Daniello	HY-rye	**2.23**
Rymin/Icecle (1:1)	OP-rye/pea	**2.15**
Binnitto	HY-rye	**2.11**
Bono	HY-rye	**2.10**
Lon	OP-rye	**2.07**
Rymin/Icecle (3:1)	OP-rye/pea	**2.05**
Propower	HY-rye	**2.02**
Serafino	HY-rye	**2.00**
Brasetto	HY-rye	**1.99**
Progas	HY-rye	**1.95**
Tayo	HY-rye	**1.95**
Rymin/Icecle (1:3)	OP-rye/pea	1.67
Sam's DQ Mix	trit/pea/vetch	1.42
Willow Creek	winter wheat	0.64
719-Flex/Ice (1:1)	trit/pea	0.56
Fridge	triticale	0.53
719-Flex	triticale	0.47
719-Flex/Ice. (3:1)	trit/pea	0.42
Hy-Octane	triticale	0.38
Mean		1.59
CV (%)		22.5
LSD (0.05)		0.59

LINE	Type	2020 Dry Matter
		(ton/ac)
Bono	HY-rye	**4.51**
Hazlet	OP-rye	**4.23**
Propower	HY-rye	**4.06**
Elbon	OP-rye	**3.94**
Berado	HY-rye	**3.9**
Tayo	HY-rye	3.69
Brasetto	HY-rye	3.60
Progas	HY-rye	3.47
Serafino	HY-rye	3.47
Lon	OP-rye	3.39
Guardian	OP-rye	3.26
Daniello	HY-rye	3.22
Fridge	Trit.	3.10
Rymin	OP-rye	3.09
718 trical	Trit.	3.09
Nitrous	Trit.	2.95
Rymin8	OP-rye	2.61
Nitrous8	Trit.	2.57
Sy-912	wheat	2.53
HyOctane	Trit.	2.06
Mean		3.34
CV (%)		13.4
LSD(0.10)		0.77

LINE	Type	2021 Dry Matter
		(ton/ac)
Progas	HY-rye	**3.43**
Daniello	HY-rye	**3.25**
Hazlet	OP-rye	**3.19**
Rymin	OP-rye	**3.12**
Propower	HY-rye	**3.08**
Problend	HY-rye	**3.06**
Nitrous	Trit.	2.75
WillowCreek	wheat	2.10
SamsDQ	Blend	1.94
Mean		2.88
CV (%)		11.8
LSD (0.10)		0.41

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Evaluation of Alfalfa Seeding Rate and Inoculant on Plant Stand and Yield

Sara Bauder* and Peter Sexton

INTRODUCTION

Alfalfa is a very important crop to South Dakota and surrounding states. We are often in the top 10 alfalfa producing states in the nation, with 1,320,00 acres of hay and haylage harvested in 2021 alone, yielding 2,024,000 tons of alfalfa hay and haylage. Because it's not often thought of as a 'primary crop' and is not planted annually, seeding methods are sometimes less than desired. Nearby states have released alfalfa seeding rate data indicating that ideal seeding rates do not exceed 10-12 lbs/ac in most cases. In an effort to save producers money, and update old research, an alfalfa seeding rate and seeding rate x inoculant studies were carried out at the Southeast Research Farm near Beresford, SD.

METHODS

The 2022 growing season was markedly dry as the season progressed at the Southeast Research Farm. The hot, dry weather clearly affected alfalfa yields as the season progressed. This should be taken into consideration when observing this data.

Two research studies were set up to evaluate 1) how alfalfa seeding rate effects final yield and economic efficiencies; 2) whether using alfalfa inoculant can have a significant effect on yield, 3) the interactions between alfalfa inoculant use and seeding rate.

These studies were planted with a small-plot cone seeder on April 15, 2021. Vernal was used in the large seeding rate study with one-half of the plots in the study being inoculated. The small seeding rate study was planted using inoculated DB AquaMax alfalfa. Plots were managed for pests per standard best management practices; harvest area was 4'x20'. For the first growing season, no plot data was collected as very dry conditions resulted in poor growth for the seeding year. Although it remained dry through most of the 2022 growing season as well, plots produced well enough to collect data.

Whole plot yields were taken using a forage harvester (Model SMW-SCH-48; Swift Machine & Welding, Swift Current, Saskatchewan, Canada). 2022 cutting dates were as follows: cut one- June 1, cut two - June 30, cut three - August 2, and cut 4 - August 30. Subsamples of fresh material were weighed and dried at 140° F to

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determine percent moisture. All yield data are presented on a dry weight basis.

The small plot trial was designed as a randomized complete block design (RCBD) and the large seeding rate trial was designed as a split plot with seed rate as the main plot and inoculant as the sub plot. See Tables 1 and 2 for an explanation of treatments. Treatments were replicated four times in each trial.

Table 1. Large Seeding Rate Trial

Treatment #	Lbs/a of seed planted	Inoculated Seed
1	5	Yes
2	7.5	Yes
3	10	Yes
4	12.5	Yes
5	15	Yes
6	20	Yes
1	5	No
2	7.5	No
3	10	No
4	12.5	No
5	15	No
6	20	No

Table 2. Small Seeding Rate Trial

Treatment #	Lbs/a of seed planted
1	5
2	7.5
3	10
4	12.5
5	15
6	20

RESULTS AND CONCLUSIONS

Table 3. Individual Means for Large Seeding Rate trial at the SE Research Farm near Beresford, SD 2022.

Seed Rate (lbs/ac)	**Inoculation**	**CUT1**[1] (ton/ac)	**CUT2** (ton/ac)	**CUT3** (ton/ac)	**CUT4** (ton/ac)	**TOTAL** (ton/ac)	**STAND1**[2] (plt/ft2)	**STAND2** (plt/ft2)
5.0	Not Inoculated	1.61	0.54	0.24	0.14	2.53	22.8	24.6
7.5	Not Inoculated	1.90	0.61	0.29	0.15	2.95	23.4	29.4
10.0	Not Inoculated	1.95	0.51	0.32	0.10	2.88	25.3	30.3
12.5	Not Inoculated	2.14	0.57	0.24	0.14	3.09	28.6	26.2
15.0	Not Inoculated	1.95	0.36	0.08	0.03	2.42	29.6	29.7
20.0	Not Inoculated	2.20	0.58	0.19	0.09	3.06	32.3	27.1
5.0	Inoculated	1.38	0.51	0.22	0.14	2.25	16.9	27.7
7.5	Inoculated	1.86	0.52	0.27	0.13	2.77	25.9	28.8
10.0	Inoculated	1.86	0.55	0.29	0.12	2.82	29.0	28.4
12.5	Inoculated	2.17	0.53	0.20	0.10	3.00	29.4	27.0
15.0	Inoculated	2.05	0.49	0.14	0.08	2.76	31.6	27.9
20.0	Inoculated	2.06	0.43	0.11	0.04	2.64	35.8	32.2
	Mean	*1.93*	*0.52*	*0.22*	*0.10*	*2.76*	*27.5*	*28.3*
	CV (%)	*10.3*	*18.8*	*39.0*	*40.3*	*11.5*	*8.2*	*16.9*
	Seed Rate P-value	*<0.05*	*NS*	*0.10*	*NS*	*NS*	*<0.01*	*<0.05*
	Inoculant P-value	*NS*	*NS*	*NS*	*NS*	*NS*	*NS*	*NS*
	Interaction P-value	*NS*	*NS*	*NS*	*NS*	*NS*	*<0.01*	*NS*

[1]'CUT' columns represent alfalfa cuttings. Cut 1 was harvested June 1, cut two- June 30, cut 3- August 2, and cut 4- August 30.

[2]'STAND' columns indicate plants/ft^2 counted with a hoop. Stand 1 took place 6/1/22 and 8/30/22.

Table 4. Treatment Means for Large Alfalfa Seeding Rate trial at the SE Research Farm near Beresford, SD 2022.

Seed Rate (lb/ac)	**CUT1**[1] (ton/ac)	**CUT2** (ton/ac)	**CUT3** (ton/ac)	**CUT4** (ton/ac)	**TOTAL** (ton/ac)	**STAND1**[2] (plt/ft2)	**STAND2** (plt/ft2)
5.0	1.49b	0.52	0.23ab	0.14	2.39	19.8bd	26.2b
7.5	1.88a	0.56	0.28a	0.14	2.86	24.7c	29.1a
10.0	1.90a	0.53	0.31a	0.11	2.85	27.2c	29.3a
12.5	2.15a	0.55	0.22ab	0.12	3.05	29.0bc	26.6b
15.0	2.00a	0.43	0.11b	0.06	2.59	30.6b	28.8a
20.0	2.13a	0.51	0.15b	0.07	2.85	34.0a	29.7a
Mean	*1.93*	*0.52*	*0.22*	*0.10*	*2.76*	*27.5*	*28.3*
P-value	*<0.05*	*NS*	*<0.10*	*NS*	*NS*	*<0.01*	*<0.05*
LSD (0.10)	*0.30*	*NS*	*0.12*	*NS*	*NS*	*3.3*	*1.9*

[1]'CUT' columns represent alfalfa cuttings. Cut 1 was harvested June 1, cut two- June 30, cut 3- August 2, and cut 4- August 30.

[2]'STAND' columns indicate plants/ft^2 counted with a hoop. Stand 1 took place 6/1/22 and 8/30/22.

Figure 1. Alfalfa Initial and Final Stand Pooled across Inoculant Treatments for Large Alfalfa Seeding Rate trial at the SE Research Farm near Beresford, SD 2022.

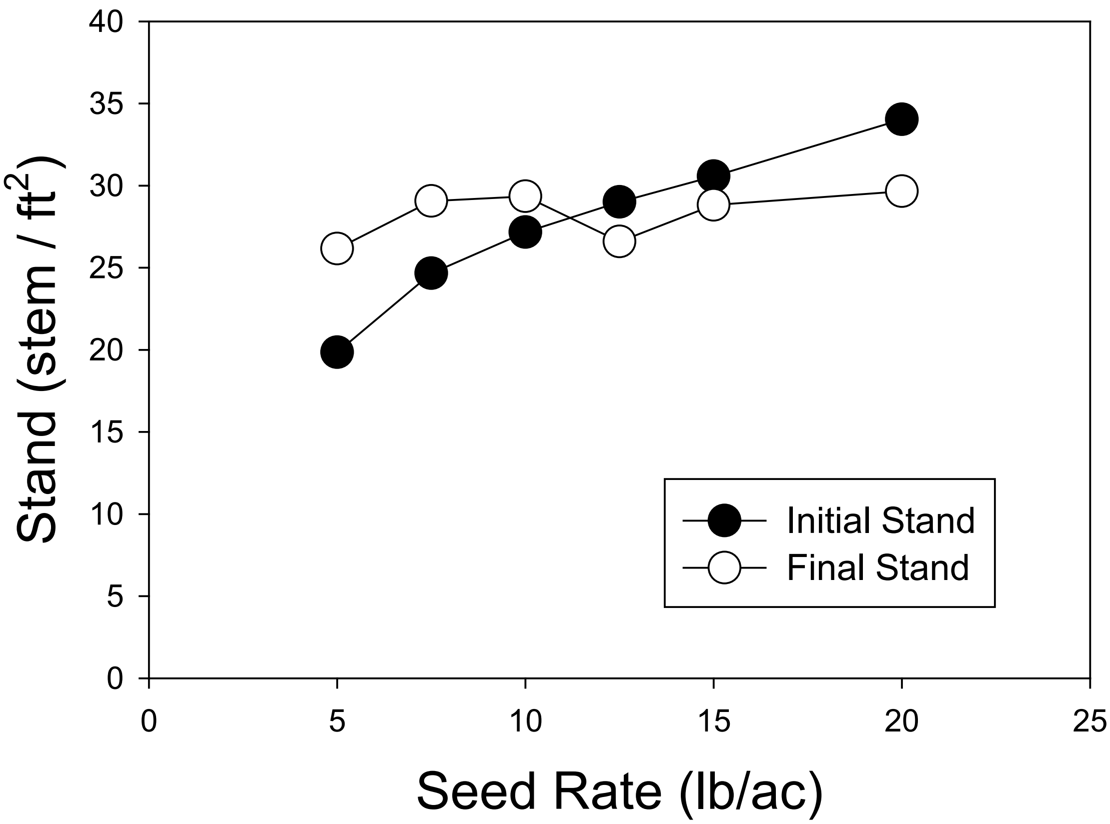


Figure 2. Initial Stand Pooled across Inoculant Treatments for Large Alfalfa Seeding Rate trial at the SE Research Farm near Beresford, SD 2022.

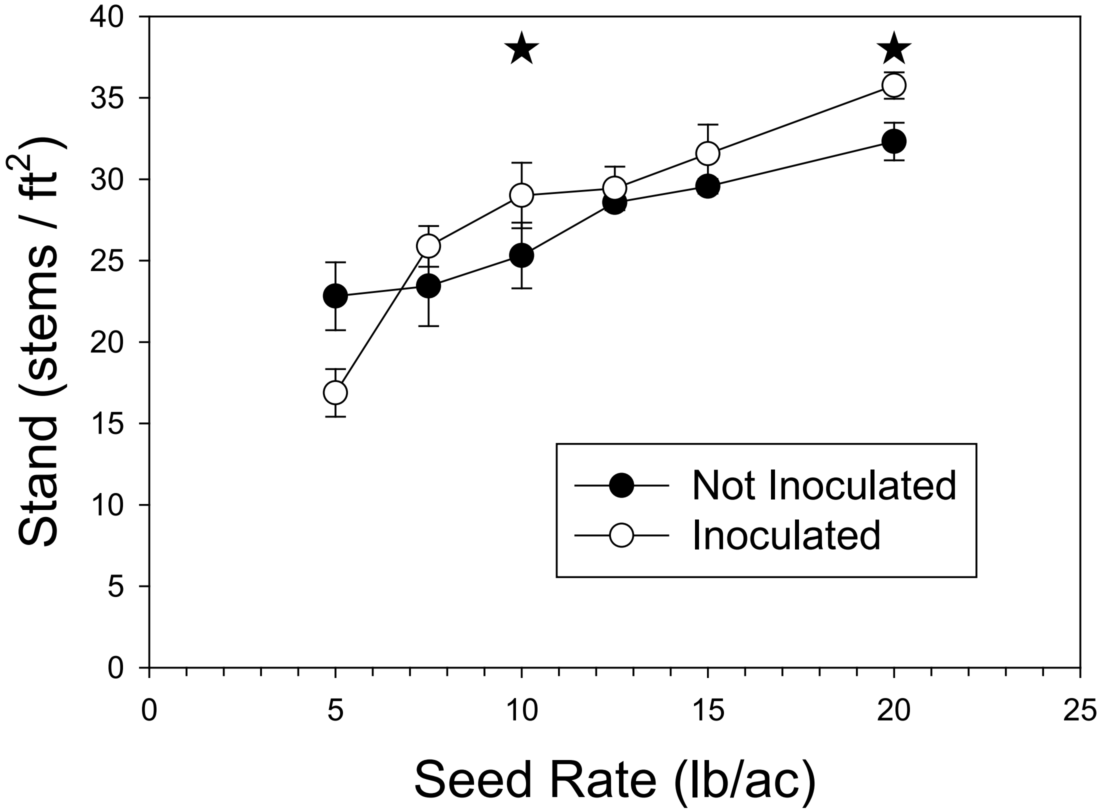
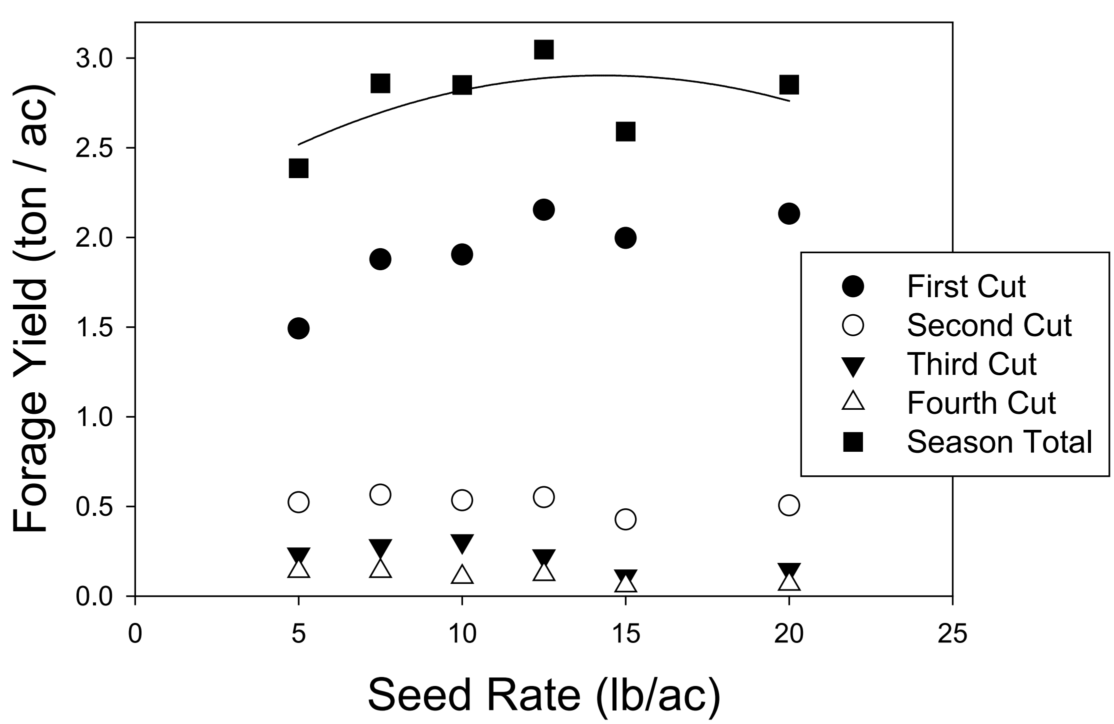


Figure 3. Alfalfa Yield Pooled across Inoculant Treatments for Large Alfalfa Seeding Rate trial at the SE Research Farm near Beresford, SD 2022.



Seed rate was a statistically significant factor in the first and third cutting of the season, as were both the initial and ending stand counts (Table 3 and 4). Stand differences are broken out in Figure 1, showing the relationship between seeding rate and its effects on initial and final stand. Seeding rate effects on yield are reflected in Figure 3, which shows the trend line peaking at about 14l b/ac seeding rate, however this was not statistically significant. When looking at Table 4, it appears that yield peak was near the 12.5 lbs/ac seeding rate with the trend line in Figure 3 suggesting that yield peak would be between 12.5 and 15 lbs/ac seeding rate. Statistically, yields were not different from the 7.5 to the 20 lbs/ac treatments in cut one, indicating that large seeding rates may not be necessary.

There was a significant interaction between seeding rate and use of inoculant for stand count #1 (Table 3), indicating greater stem counts for inoculated treatments in the initial spring count. The 10 and 20 lbs/ac seeding rates were significantly different in initial stem counts for inoculated vs. non-inoculated plots (Figure 2).

Overall, the large seeding rate trial shows a trend for greater yield with higher stands for the initial cutting, and lower yields with higher stands for later cuttings (likely due to a very dry growing season). Alfalfa is a self-thinning crop, which may be some explanation for this phenomenon. In this trial year, we can gather that the 12.5 lbs/ac seeding rate was likely ideal for this plot, and seeding rates higher than this level, are likely not worth the financial investment for this harvest year.

Table 5. Treatment Means for Large Alfalfa Seeding Rate trial at the SE Research Farm near Beresford, SD 2022.

Seed Rate (lb/ac)	CUT1[1] (ton/ac)	CUT2 (ton/ac)	CUT3 (ton/ac)	CUT4 (ton/ac)	TOTAL (ton/ac)	STAND1[2] (plt/ft2)	STAND2 (plt/ft2)
5.0	1.85b	0.76	0.45	0.24	3.30	19.9b	33.8
7.5	1.93b	0.88	0.47	0.26	3.53	23.9b	34.1
10.0	2.19a	0.72	0.48	0.21	3.60	23.3b	31.3
12.5	2.20a	0.82	0.31	0.17	3.50	29.1ab	36.1
15.0	2.28a	0.85	0.40	0.18	3.71	27.6ab	37.0
20.0	2.22a	0.82	0.35	0.39	3.78	30.2a	36.3
Mean	2.11	0.81	0.41	0.24	3.57	25.7	34.8
CV (%)	9.40	16.40	27.00	70.10	11.40	16.6	13.5
LSD (0.10)	0.25	NS	NS	NS	NS	5.3	NS

[1]'CUT' columns represent alfalfa cuttings. Cut 1 was harvested June 1, cut two- June 30, cut 3- August 2, and cut 4- August 30.

[2]'STAND' columns indicate plants/ft^2 counted with a hoop. Stand 1 took place June 1, 2022 and August 30, 2022.

The small alfalfa seeding rate trial had statistically significant seeding rate treatments for cutting 1 forage yields. Treatments 10 through 20 lbs/ac of seed were not statistically different in yield, meaning there was no real difference in yield between these seeding rates. In addition, the initial spring stand count was statistically significant with stand being statistically highest in the 12.5-20 lbs/ac seeding rate treatments; however, it can be observed that this trend leveled out and there were no significant differences in final stand counts by the end of the season.

SUMMARY OF STUDIES

Overall, both the large and small seeding rate treatments trends showed greater early yields with heavier spring stands. If one looks at the yield data alone, we can see that seeding rates of 10-20 lbs/ac did not show significantly different yields for the first cutting across both studies, telling us lower seeding rates may be just as effective as higher seeding rates. Later cuttings tended to have little difference between treatments, which is likely a drought effect. This study will be continued into the 2023 growing season.

ACKNOWLEDGEMENTS

A big thank you to the SDSU Southeast Research Farm staff for their assistance in planting, harvesting, and managing these plots!

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Improving Potassium Fertilizer Guidelines for Corn in South Dakota Using Clay Mineralogy Analysis

Andrew Ahlersmeyer*, Jason Clark, David Clay, Doug Malo, Kris Osterloh, and Shaina Westhoff

INTRODUCTION

Poorly managed potassium (K) fertilizer applications are costly. While under-applications of K fertilizer can reduce the ability of corn (*Zea mays* L.) to yield at optimal levels, over-applications of K fertilizer are just as inefficient, especially when soil test K (STK) levels are adequate. Producers rely on accurate, thoroughly tested potassium fertilizer recommendations (KFRs). To enhance KFR accuracy, scientists are exploring the inclusion of additional soil measurements into potassium fertilizer recommendation (KFR) development. In North Dakota, Breker et al. (2019) improved corn yield response prediction when partitioning sample sites based on clay mineral content. These results provide evidence that incorporating other soil test parameters, notably clay mineralogy, into KFRs may improve their accuracy. Research is needed to validate current KFRs in South Dakota. Therefore, the objectives of this project include 1) correlate STK levels to corn yield, 2) calibrate KFRs with clay mineralogy data, and 3) determine the relationships among clay mineralogy, K uptake, and fertilizer requirements.

METHODS

From 2020-2021, 15 field trials were conducted throughout South Dakota. Sites were conducted primarily on commercial operations, but also at three university research stations. Sites were chosen to encompass a broad range of soil types, climates, and management practices. The experimental design used within each site was a randomized complete block design with four replications. Six treatments (0 [control], 30, 60, 90, 120, and 150 lbs. K_2O ac.$^{-1}$) of potash fertilizer (0-0-60) were broadcast applied prior to corn emergence. Prior to treatment application, soil samples were collected within each replication at four depths: 0-4, 0-6, 6-12, and 12-24 in. Soil samples were dried and ground to pass through a 2 mm sieve, upon which they were sent to Ward Laboratories (Kearney, NE, USA) for fertility and health analysis, and Activation Laboratories (Ancaster, ON, Canada) for mineralogy analysis. Plots were harvested by hand or using a plot combine at physiological maturity. Statistical analyses

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were conducted using R. Yield data was transformed to percent of maximum yield, then correlated with STK using a linear plateau model. Quadratic plateau modeling was used to calibrate KFRs by plotting corn grain yield at responsive sites against K fertilizer treatments.

RESULTS

According to current KFRs in South Dakota, a yield response is unlikely to be observed in soils >160 ppm. In this study, the linear plateau model (Figure 1) climbed past 160 ppm and plateaued at 169 ppm, suggesting that a higher percentage of maximum yield could be achieved by raising the K critical value to 169 ppm. Of the 15 field trials conducted, only two (Figure 2) were observed to positively respond to K fertilizer treatments. To optimize corn yield, K fertilizer would need to be applied at rates of 60 and 37 lbs. K_2O ac.$^{-1}$ at sites 10 and 15, respectively. While the yield response was anticipated for site 10 (STK = 132 ppm), a yield response was not expected at site 15, where STK was exceptionally higher

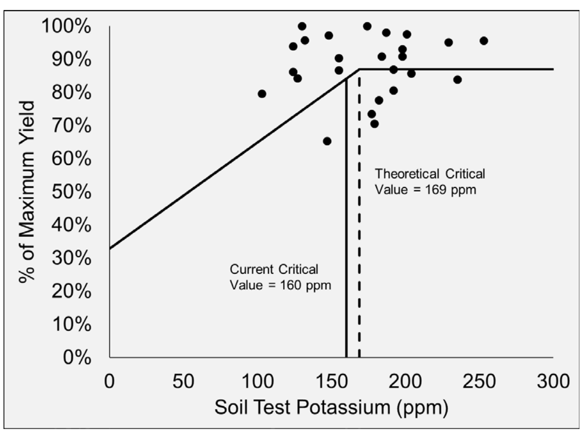

Figure 1: Linear plateau for correlation analysis.

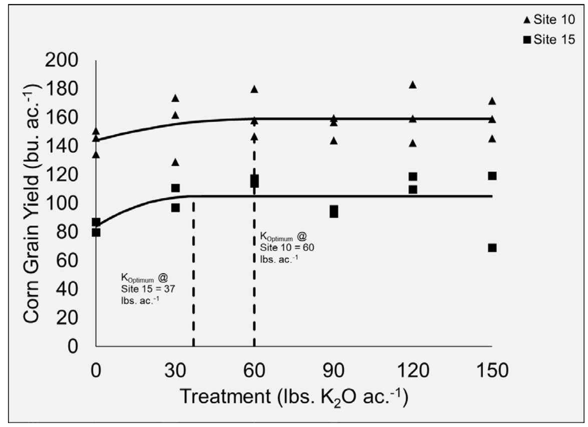

Figure 2: Quadratic plateau for calibration analysis.

than the current 160 ppm K critical level (STK = 327 ppm). Although the agronomic optimum KFR was observed, neither site required K fertilizer to yield at economic optimal levels (assuming \$0.65 lb.$^{-1}$ K and \$6.00 bu.$^{-1}$ corn price).

In our study, two sites (Table 1) showed positive yield responses to K fertilizer treatments. When comparing current and optimum KFRs, accurate predictions were made for 12 of the 15 sites. Over-applications of K fertilizer occurred at sites 9 and 12, while an under-application occurred at site 15.

It is theorized that a yield response to K fertilization may be observed, even if STK exceeds the soil test critical value, if there are more smectite than illite clays in the soil. However, none of the sites in this study (1, 2, 4, 5, 7, and 11) that had STK levels >160 ppm and S:I >1.0 showed a yield response. While the STK level at site 15 was 327 ppm, the S:I value of 0.2 was the lowest of all sites, suggesting that clay mineralogy was not responsible for the yield response at that site. While clay mineralogy could not confidently be used as a prediction tool for KFRs in the first two years of this study, five additional field trials conducted in 2022 may provide further insights for this research.

Table 1: Soil test potassium, clay mineralogy, yields, and fertilizer recommendations.

Site	K	S:I†	Mean RY_0‡	Sig. YR§	Current KFR⁋	Optimum KFR*
	ppm		%		---lbs. K_2O ac.$^{-1}$---	
1	634	1.6	83	No	0	0
2	735	1.2	92	No	0	0
3	501	0.9	100	No	0	0
4	322	4.8	96	No	0	0
5	200	4.2	96	No	0	0
6	202	0.7	96	No	0	0
7	241	1.3	99	No	0	0
8	287	0.7	100	No	0	0
9	132	1.0	99	No	60	0
10	143	6.2	91	Yes	60	60
11	436	1.5	94	No	0	0
12	155	0.8	100	No	60	0
13	161	0.3	86	No	0	0
14	170	0.9	96	No	0	0
15	327	0.2	82	Yes	0	37

† S:I, smectite:illite ratio
‡ Mean RY_0, mean relative yield from control treatment
§ Sig. YR , significant yield response (($\alpha = 0.05$)
⁋ From current SD recommendation guide *Note*: 60 lbs. K_2O is minimum recommendation when STK <160 ppm
* Obtained from quadratic plateau modeling from our field trials

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Inter-seeded Cover Crop's Influence on Corn Nitrogen Fertilizer Needs, Corn Yield, and Soil-Nitrogen – Year 4

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

INTRODUCTION

Corn production and productivity have been on a steady rise in South Dakota. Inclusion of cover crops increases diversity in corn and soybean rotations that are common in the US Midwest. The rise in cover crop use can be attributed to potential soil and water quality improvements. However, seeding costs, return on investment, lack of breeding efforts, and variety enhancement are some major concerns in cover crop adoption. Although previous research suggests that cover crops could be inter-seeded in corn as early as the V2 corn growth stage without reducing corn grain yield, the competitiveness of cover crops, like weeds, may depend on species and density. Although cover crops do not compete with the corn plant after the V5 stage, they can still influence the amount of N required to optimize corn yields. It is therefore important to understand the influence of different cover crop compositions and their effect on the needed N rates in corn, and corn and soybean yields. This study aims at understanding the effects of cover crop composition (single and multispecies) on soil biological measurements, corn N requirement, and yields in corn and soybeans.

METHODS

Corn and soybean were planted at Brookings and Beresford, SD in a corn-soybean rotation system. Treatments were laid out in a split-plot design with three cover crop treatments [1) No cover crop, 2) single grass species, and 3) grass/broadleaf mixture], and 4 - 6 N rates within each cover crop treatment for corn, ranging from 0-250 lbs. N ac^{-1} in 40-50 lb increments. Ammonium Nitrate or Urea as Super U were used as the N source. All N rate treatments were applied within 7-10 days after planting and cover crops were interseeded at V5 developmental stages in corn and soybean. In-season soil (0-6") and plant samples were collected at V6, R1, and R6 developmental stages in corn and V5, R1, and R6 developmental stages in soybean. In-season soil samples were analyzed for soil health and fertility, and a complete nutrient analysis was done on plant samples. Grain samples were collected at harvest and tested for complete nutrient analysis. Post-harvest soil samples were collected at three depths (0-12",12-24", and 24-36"). These samples were analyzed for total nitrate N content remaining in the soil after harvest.

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RESULTS

Corn yield response

Response in corn yields to N fertilization was observed in six of eight site-years (Figure 1). The non-responsiveness of the other site years can be attributed to corn lodging from high winds and drought. Results from 2019 to 2022 indicate that corn with grass cover crop required anywhere from 10 lbs. ac^{-1} (2021 Beresford & 2019 Brookings) to 70 lbs. ac^{-1} (2019 Beresford & 2022 Brookings) more N compared to when no cover crop was grown (Figure1a-f). In two of six N responsive site years (2022), including a grass/broadleaf cover crop reduced corn yield at Economical Optimum Nitrogen Rate (EONR) by about 10 bu. ac^{-1} compared to the grass or no cover crop treatments (Figure 1d,1f). Corn with grass cover crop yielded anywhere from 10 bu/ac less to 10 bu/ac more at EONR compared to the grass/broadleaf mix and no cover crop.

Soybean yield response

Regardless of the previous N rate applied, no significant difference was observed in mean soybean yields among the cover crop treatments with an exception at the Beresford site in 2021 (Figure2b). These results indicate that for soybean, interseeding grass or a grass/broadleaf mixture had little to no influence on soybean yield. Therefore, cover crops regardless of composition can be interseeded into soybean without impacting yield. In the Beresford 2021 site year, interseeded single or cover crop mixtures trended to reduce yield at the previous year’s 50 and 100 lbs. N ac^{-1} rates (Figure2b). The drought conditions during 2021 may have contributed to this trend toward reduced yields where cover crops were planted. However, the 2021 Brookings site was also under drought conditions and cover crop inclusion did not influence soybean yield. As we get more site-years of data under various moisture conditions, our understanding of interseeded cover crop's effect on soybean yield will increase.

CONCLUSIONS

Interseeding cover crops in the corn-soybean rotation can have several direct and indirect impacts on overall soil health and fertility without compromising yields. Single or multiple cover crop mixtures can be interseeded into soybean without negative impact on yield. The effect of cover crop composition on yield and N requirements of corn has been inconsistent in this study so far. Therefore, further data is required before solid conclusions about the effect of cover crop composition on N requirements and yield in corn can be determined.

ACKNOWLEDGEMENT

Authors appreciate the support of SD Agricultural Experiment Station USDA-NIFA, South Dakota Nutrient Research and Education Council.

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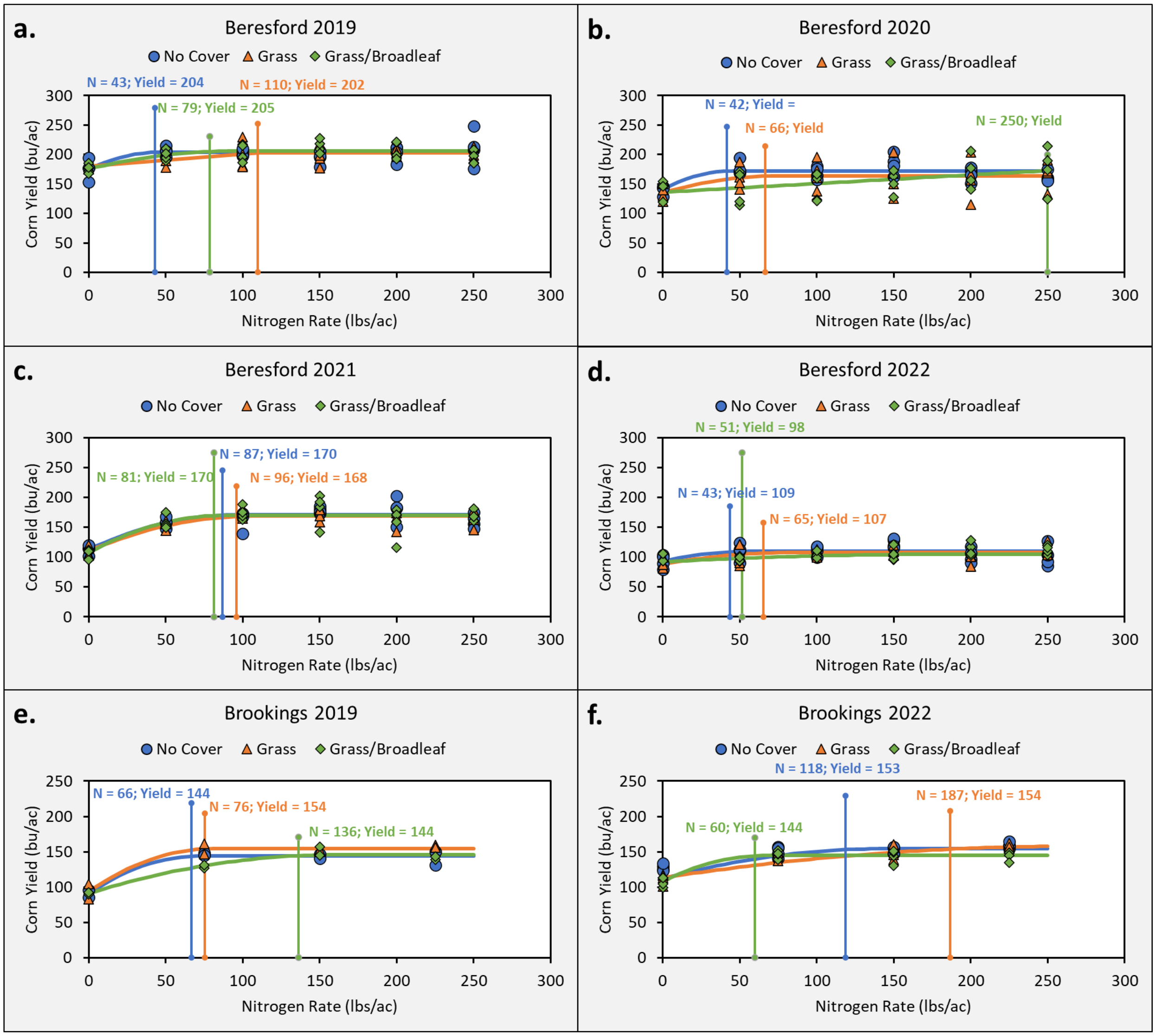

Figure 1. Corn grain yield response as a function of Nitrogen rate in 2019 through 2022.

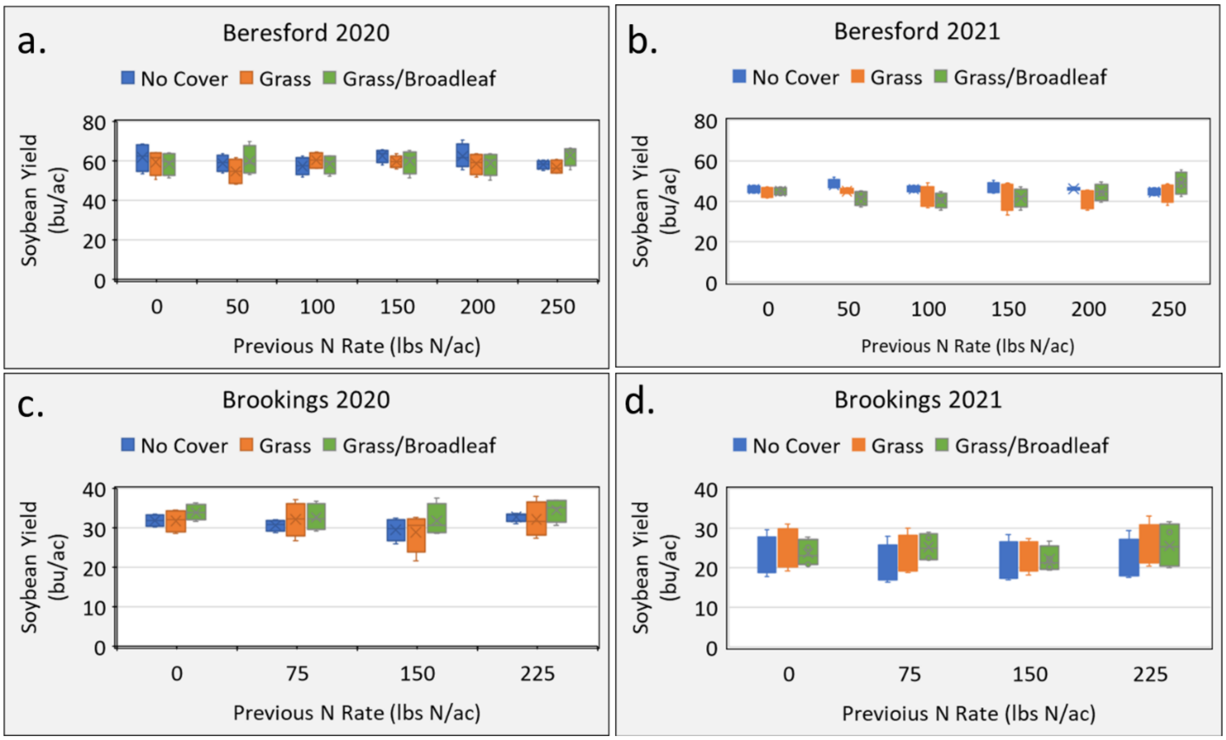

Figure 2. Soybean yield response as a function of cover crop composition and nitrogen rate in 2020 and 2021.

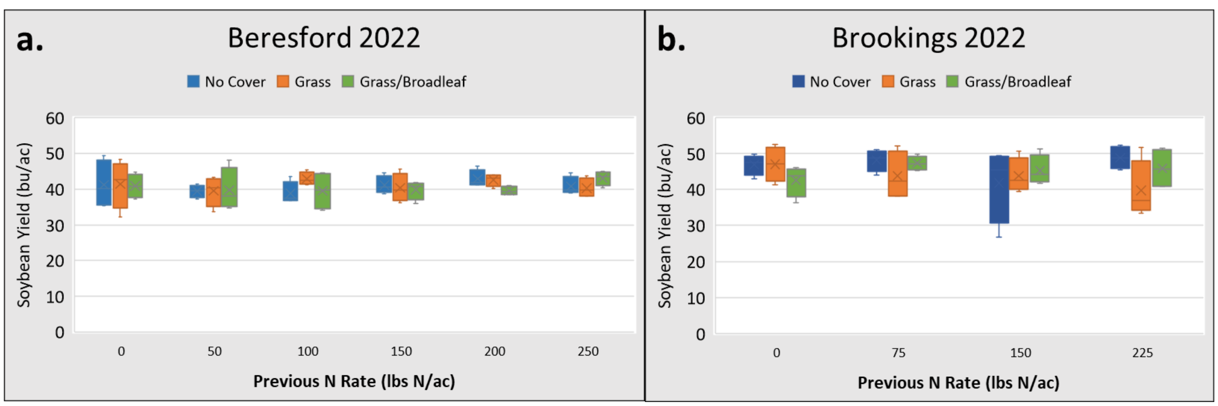

Figure 3. Soybean yield response as a function of cover crop composition and nitrogen rate in 2022.

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Investigating Fertilizer Response and Requirement in High Protein Soybean Varieties

Péter Kovács*

INTRODUCTION

Soybean meal is one of the primary uses of soybeans. In addition, soybean meal serves as the preferred raw material for the further refinement of soy protein into nutritional and functional ingredients. Improved genetics and production practices resulted in increasing soybean yield over time; however, the gain in yield has also resulted in decreasing grain protein concentration. This decreasing grain protein concentration now makes it more challenging for soybean processing and refining facilities to meet their soy protein product's quality standards. Some soybean refiners are exploring high protein soybean varieties to improve their product quality. These high protein varieties are often non-GMO varieties. Which could also provide a contracted and secured market opportunity with extra premium to South Dakota producers if they are able to meet or exceed grain quality standards for protein concentration and amino acid quality. Most field research has focused on fertilizer response and protein improvement in lower protein level soybean varieties (~33-34%). However, there is limited information whether the nutrient and fertilizer requirement of these high protein (41-42%) soybean varieties differ compared to that of conventional protein content soybean varieties. This project would compare the nutrient uptake and protein concentration response to fertilizer application in a conventional non-GMO variety, a high protein content non-GMO variety, and a GMO variety with a typical protein content (two different herbicide tolerant traits).

OBJECTIVES

The goal of the project is to investigate and compare yield and grain composition response to fertilizer application in high protein and traditional protein level soybean varieties. Specific objective is to compare conventional and high protein content soybean varieties' nutrient uptake, yield and grain quality response to added fertilizer.

METHODS

The study was conducted in 2021 and 2022.

Two planting dates were utilized, one targeting the first part of the planting window. The second planting date followed at least two weeks after the first one in late May or in early June.

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The study compared three different varieties from similar maturity groups

- commonly grown GMO variety (P21T43E)
- a non-GMO standard protein variety (P21A20)
- a non-GMO high protein content variety (Brushvale N2358)

Three different fertilizer rate combinations were applied. One of the fertilizer treatments provides 20 lbs ac^{-1} S as ammonium sulfate (AMS) (and 17.5 lbs N ac^{-1}), the other fertilizer treatment provided 20 lbs ac^{-1} S and 40 lbs ac^{-1} of N from the combination of AMS and urea, and an unfertilized control. Fertilizers were either pre-plant broadcast applied, or were applied at the R2/R3 growth stages (full bloom/first pod) utilizing a Y-Drop unit. This resulted in six different treatments for each soybean variety. The experiment followed a randomized complete block design with split-plot arrangement, where the planting date was the whole plot, and variety, fertilizer rate, and fertilizer application timing were the sub-plots.
Plant stand, grain yield and grain quality (protein and oil concentration) information was collected from the plots. Grain yield, protein and oil concentrations were adjusted to 13% moisture content.

RESULTS

In 2021, the Non-GMO standard protein variety had about 15,000 plants ac-1 higher final plant stand compared to the other varieties (Table 1). The later planted soybean yielded about 5 bu ac^{-1} more compared to the early-planted soybeans, averaged across varieties and fertilizer treatments (Table 1). The soybean variety influenced both the grain yield and the grain quality parameters in 2021 (Table 1). The high protein variety yielded about 4-5 bu ac-1 lower compared to the standard protein varieties; as expected, the high protein variety had about 3% higher grain protein concentrations compared to the other varieties averaged across planting dates, and fertilizer treatments (Table 1). Fertilizer application at the beginning of the grain fill period increased grain protein concentrations by nearly 1% (Table 1). We saw opposite trends for grain oil concentration than we observed for grain protein concentrations.

In 2022, plant establishment varied between the two planting dates. The early-planted soybean had about 20,000 plants ac^{-1} less final plant stand (Table 2). The short colder temperatures in mid-May likely impacted the soybean germination process. Soybeans with the lower plant stand likely were not able to compensate and produce more grain in addition to the prolonged drought we experienced. Yield differences among the varieties were larger in 2022 than in 2021 (Tables 1 and 2).

Preliminary conclusions are that fertilizer application did not help to improve grain yield either year or improve grain quality in 2022. Yield levels are likely not high enough where supplemental fertilizer would improve production. Higher grain protein profile was achieved with the used high protein variety; however, the observed yield gap between other varieties was larger than expected. We only utilized one high protein soybean variety; therefore, evaluating other available varieties is warranted.

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Table 1. Planting date, variety, fertilizer application timing, and fertilizer rate main effects on final plant stand, grain yield and grain quality parameters near Beresford in 2021.

	Final plant stand (plants ac^{-1})	**Grain yield (bu ac^{-1})**	**Grain protein (%)**	**Grain oil conc. (%)**
Planting Date				
PDate 1	98,100	40.8 b	35.6	18.9 a
PDate 2	96,100	45.3 a	36.3	18.8 b
Variety				
High Protein	91,600 b	39.9 c	38.7 a	18.2 c
Non-GMO Standard	107,600 a	43.8 b	35.4 b	19.0 b
GMO Standard	92,100 b	45.5 a	33.8 c	19.4 a
Fertilizer app. timing				
Planting	97,200	43.2	35.6 b	18.9 a
R3	97,000	42.9	36.4 a	18.8 b
Fertilizer Rate				
Control	99,200 a	43.1	36.0	18.9
20 lbs ac^{-1} AMS	96,900 ab	42.9	36.2	18.8
High N rate	95,100 b	43.2	35.7	18.9
***p*<F**				
Planting date	0.12	**<.0001**	*0.06*	**.03**
Variety	**<.0001**	**<.0001**	**<.001**	**<.0001**
Fertilizer app timing	0.85	0.73	0.02	0.02
Fertilizer rate	**0.04**	0.93	0.49	0.22

Table 2. Planting date, variety, fertilizer application timing, and fertilizer rate main effects on early season and final plant stand, and grain yield near Beresford in 2022.

	Early-season plant stand (plants ac^{-1})	**Final plant stand (plants ac^{-1})**	**Grain yield (bu ac^{-1})**
Planting Date			
PDate 1	77,800 b	68,300 b	35.9
PDate 2	105,200 a	89,800 a	35.8
Variety			
High Protein	89,300	76,700 b	23.4 c
Non-GMO Standard	93,500	78,500 b	32.0 b
GMO Standard	91,700	81,900 a	49.3 a
Fertilizer app. timing			
Planting	91,900	78,600	35.1
R3	91,000	79,500	34.7
Fertilizer Rate			
Control	89,300	78,200	35.1
20 lbs ac^{-1} AMS	93,100	79,600	33.5
High N rate	92,200	79,400	36.1
***p*<F**			
Planting date	**<0.0001**	**<0.0001**	0.13
Variety	0.304	**0.005**	**<0.0001**
Fertilizer app timing	0.70	0.46	0.61
Fertilizer rate	0.34	0.62	0.06
PDate x Variety	0.33	**0.005**	0.54

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Investigating the Impact of Starter Fertilizer Placement on Plant Development, Grain Yield, and Nutrient Uptake

Larousse Dorissant, Jason Clark
and Péter Kovács*

INTRODUCTION

Starter fertilizer is often associated with promoting early plant development and plant-to-plant uniformity especially for early-planted crops or in no-till growing conditions. Application of starter fertilizer and proper fertilizer placement can have a significant positive impact on corn (*Zea mays* L.) grain yield (Osborne, 2005; Vetsch et al., 2002). Approximately 60% of the producers apply starter fertilizer in South Dakota according to a recent producer survey. However, the yield impact and benefit of starter fertilizer is inconsistent (Gordon et al., 2006).

OBJECTIVES

The goal of the project is to compare the effect of starter fertilizer placement and plant development in addition to grain yield effect. Specific objectives are 1) to determine if the use of starter fertilizer increases grain yield, 2) to determine if planting date influences corn response to starter fertilizer 3) to determine the starter fertilizer placement impact on plant development and nutrient uptake.

METHODS

We compared an early planting date with a normal/late planting date response with different starter fertilizer placement and starter fertilizer combination.

The first planting date treatments were planted on May 19, 2022 while the second planting date treatments were planted on June 6, 2022 near Beresford. Two starter fertilizers were used (10-34-0 and 8-21-5 with and without additional Zn fertilizer). Starter fertilizers were placed in the following ways:

- in-furrow lower rate (IFL),
- in-furrow higher rate (IFH),
- 2 x 2, and a
- combination of in-furrow lower rate and 2 x 2 placements.
- control (did not receive starter fertilizer)

The in-furrow low-rate treatment provided approximately 9 lbs P_2O_5/ac (same amount for the two fertilizer types), the in-furrow high-rate placement treatment provided approximately 14 lbs P_2O_5/ac, while the 2 x 2 starter placement provided 23 lbs P_2O_5/ac. P0421AM hybrid was seeded at a rate of 34,000 seeds ac^{-1}. Urea was applied to balance the nitrogen fertilizer requirements

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(to 150 kg N ha^{-1}) of the corn plants regardless of the starter fertilizer treatment.

Early season plant development, nutrient uptake and grain yield were determined. Whole plant samples were taken at V6 and R6 growth stages for biomass accumulation and nutrient uptake determination. Stand count was conducted at the V4 growth stage. Growth stage of 20 consecutive individual plants were determined at V3, V8 growth stages and plant height was also measured on the same plants at V3 and V8 growth stages. Center two rows were harvested on October 19, 2022 with Kincaid 8XP Plot combine and yield was adjusted to 15.5% moisture.

RESULTS

The 2022 growing season was the second season for this study. In the first year, starter fertilizer placement did not impact grain yield or grain nutrient removal (Table 1). Early planted corn resulted in higher grain yield and more nutrient removal by grain in 2021 averaged across starter fertilizer placement and starter fertilizer types (Table 2).

Similarly to 2021, the planting date had the largest influence on the measured crop physiological parameters (Table 2). This is likely due to the minor plant development differences (growth stage) when sampling or when plant measurement occurred for the two planting dates. The use of starter fertilizer helped the plants to grow taller rather than develop faster, however the initial plant growth differences were only measurable for the combine in-furrow and 2x2 starter fertilizer placement by the V8 growth stage (Table 2). Biomass accumulation and nutrient uptake by the V6 growth stages was higher with the later planted corn (Table 2 and 3).

The later planted corn had approximately 600 plants ac^{-1} lower plant population (Table 3). Emergence may have been impacted by the onsetting drier environment.

The initial difference in plant growth disappeared by the end of the growing season as grain yield did not differ due to any of the treatments (Table 3). The prolonged drought in 2022 impacted the study as the grain yield ranged between 106 and 115 bu ac^{-1} (Table 3), restricting plant growth, pollination, and kernel development.

Preliminary findings after the first two seasons, which was impacted by the drought at various levels, are that starter fertilizer enhanced plant growth, but did not translate into grain yield differences.

The starter fertilizer’s effect on whole-season nutrient uptake, and the impact on the mid-season tissue (ear-leaf) concentration is yet to be determined.

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Table 1. Starter fertilizer placement, planting date, fertilizer type main effects on grain yield, nitrogen, phosphorus, potassium, and zinc nutrient removal by grain near Beresford in 2021.

	Grain Yield (bu/ac)	N (lbs/ac)	P (lbs/ac)	K (lbs/ac)	Zn (lbs/ac)
Starter Fertilizer Placement					
Control	158.36	130.8	25.5	44.3	22.2
IFL	164.89	127.9	24.2	42.7	21.4
IFH	155.01	123.0	23.0	40.3	20.8
2*2	163.93	131.3	26.8	45.5	24.9
Both	163.45	139.6	27.7	47.3	23.7
Planting date					
Pdate1	165.52 a	132.2	28.0a	47.1a	24.2a
Pdate2	156.76 b	128.7	22.9b	40.9b	21.0b
Starter Fertilizer Source					
10-34-0	163.45	129.3	26.6	46.1	23.1
10-34-0 + Zn	163.29	131.5	25.0	43.6	22.2
8-21-5	160.27	134.3	25.8	44.3	22.3
8-21-5+Zn	157.40	126.6	24.3	41.8	22.7

Table 2. Starter fertilizer placement, planting date, fertilizer type main effects on dry matter accumulation at V6 (6 leaf growth stage), plant growth stage and plant height at V3 and V8 growth stages near Beresford, SD in 2022.

	Dry matter accumulation at V6 (lbs./acre)	Growth stage		Plant Height (in)	
		V3	V8	V3	V8
Starter Fertilizer Placement					
Control	412.7ab	3.4	7.97	2.48c	13.5b
IFL	387.8b	3.5	7.86	2.66ab	13.2b
IFH	411.6ab	3.5	8.00	2.61abc	13.5b
2*2	403.8ab	3.5	8.01	2.55bc	13.7ab
Both	434.7a	3.5	8.14	2.72a	14.5a
Planting Date					
Pdate1	323.0b	3.9a	7.97	3.17a	13.9a
Pdate2	497.3a	3.0b	8.02	2.04b	13.4b
Fertilizer Source					
10-34-0	402.1ab	3.5	8.03	2.62	13.7
10-34-0 + Zn	404.5ab	3.4	7.94	2.53	13.5
8-21-5	436.5a	3.5	8.01	2.64	13.8
8-21-5 + Zn	397.3b	3.5	8.00	2.63	13.7

Table 3. Starter fertilizer placement, planting date, fertilizer type main effects on nitrogen, phosphorus, potassium, and zinc uptake at V6 growth stage, plant population, and on grain yield near Beresford in 2022.

	N (lbs/ac)	P (lbs/ac)	K (lbs/ac)	Zn (lbs/ac)	Plant population (plants/acre)	Grain Yield (bu/ac)
Starter Fertilizer Placement						
Control	18.0	1.6	12.5	0.020a	33,700b	117.9
IFL	17.0	1.5	12.3	0.017b	34,000ab	106.2
IFH	18.1	1.5	12.9	0.018ab	34,000ab	113.4
2*2	18.1	1.6	13.1	0.018ab	34,300a	108.1
Both	18.8	1.7	13.7	0.019ab	33,900ab	115.8
Planting date						
Pdate1	14.1b	1.3b	9.2b	0.014b	34,300a	109.4
Pdate2	21.9a	1.9a	16.6a	0.023a	33,600b	115.3
Starter Fertilizer Source						
10-34-0	17.7	1.5	12.6	0.018	34,100	114.5
10-34-0 + Zn	17.8	1.5	12.3	0.018	33,900	109.0
8-21-5	19.0	1.7	13.9	0.020	34,000	112.9
8-21-5+Zn	17.5	1.5	12.8	0.018	33,900	112.9

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Seeding Depth Impact on Grain Yield in Corn and Soybean

Péter Kovács*

INTRODUCTION

Access to soil moisture level is critical for successful and uniform seedling emergence. Adjusting the seeding depth is an important tool for farmers to provide optimum soil moisture conditions for the seed during emergence. It is likely to be more important when the planting season is dry. The top few inches of the soil experiences the largest fluctuations in soil moisture during the growing season, which may impact water availability for the plants. The dry winter and spring in South Dakota prompted us to see if a deeper planting depth would help corn and soybean access to moisture both during the emergence period, and throughout the growing season.

OBJECTIVES

The goal of the project is to compare the effect of seeding depth on crop development and grain yield both in corn and soybean.

METHODS

We initiated a simple study to compare different seeding depths' impact on crop performance. We used three different seeding depths: shallow (~1 in), normal (~2 in), and deep (~3 in) to plant corn and soybean. Treatments were assigned by a randomized complete block design with four replications. We used the DKC 51-40 hybrid in corn, and the Asgrow 20XF1 variety in soybean. The studies were planted on May 20, 2022.

Plant stands were estimated at the V4 growth stage for corn and at the V2 growth stage and shortly before harvest in the soybean. Center two soybean rows were harvested on October 6, 2022 with Kincaid 8XP plot combine and yield was adjusted to 13% moisture. The corn plots were harvested in similar fashion on October 19, 2022, and yield was adjusted to 15.5% moisture.

RESULTS

While we did not follow the emergence progress on a daily basis at the Beresford location, deeper planted plots had a day or two lag in the emergence near Brookings (no data shown).

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Plant populations did not differ statistically among the different seeding depths (Table 1), however it is interesting to note that the shallow planted soybeans had higher final stand counts compared to the shallow planted treatments (Table 1). It may suggest that the soybean is more vulnerable to deeper placed seed during emergence.

Final grain yields were similar to all seeding depths in corn and soybean (Table 1). Yields were lower due to the drought compared to previous years.

The prolonged and extreme drought severely impacted crop development. The benefit of deeper placed seed was not evident in these conditions. We are going to repeat this study in 2023 to see if seeding depth would impact grain yield in different growing conditions.

ACKNOWLEDGEMENT

The help and work of the graduate and undergraduate students of the Cropping Systems Research group is appreciated in this research. The South Dakota Ag Experiment Station and USDA-NIFA Hatch project support was appreciated during the study. The research group is thankful for Bayer Crop Science for donating seeds.

Table 1. Seeding depth effect on plant population and grain yield in corn and soybean near Beresford in 2022.

Planting Depth	----------Corn ---------		-------------------Soybean --------------------		
	Plant population (plants ac^{-1})	Grain yield (bu ac^{-1})	Early season plant stand (plants ac^{-1})	Harvest plant stand (plants ac^{-1})	Grain yield (bu ac^{-1})
Shallow (1 in)	33,300	84.5	125,900	106,000	42.1
Normal (2 in)	33,800	81.6	121,900	97,300	42.9
Deep (3 in)	33,800	83.3	118,300	94,000	42.3

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2022 Trials of Grafted Heirloom Cherry Tomatoes for High Tunnel Production

Kristine Lang* and Gretchen Kooyenga

INTRODUCTION

High tunnels have become a popular production tool for Midwest vegetable growers to extend the growing season, increase crop production, and improve the quality of the produce. However, production in this system does not come without challenges. Continuous cropping of tomatoes in the same high tunnel gives rise to recurring soilborne and foliar diseases, pest pressure, and issues related to soil fertility and salinity. Vegetable grafting of scions to vigorous rootstocks can be a tool for improving high tunnel and open field production by conferring resistance to soil-borne diseases, withstanding elevated soil salinity, and improving water use efficiency.

Two families of vegetables are being grafted on a commercial scale, Solanaceae and Cucurbitaceae. A scion is the top-portion of the graft which is selected for its horticultural properties while the rootstock is selected for desirable soil-interaction properties. The union of the scion and the rootstock takes place while the plants are in a young, vegetative growth-stage, typically between two and three weeks after seeding. Several methods exist for vegetable grafting, with splice grafting being the most widely used.

Splice grafting, also called "tube grafting", requires an angled cut of the rootstock below the cotyledons with the same angle being used on the scion. After grafting, a healing chamber is used for up to one week while the severed stems form callus tissue and grow together. A healing chamber increases humidity around the newly grafted tomato plants, reducing stress and water-loss. Reducing light levels to prevent heat stress can also be important.

Vegetable grafting first emerged in Japan and Korea to overcome soil-borne diseases and the practice has gained interest on a larger scale in the United States within the last twenty years. The phase-out of methyl bromide as a soil-management tool is one of the factors driving implementation of vegetable grafting globally and in the United States. Grafting research within the United States began in southern states, later spreading to the Pacific Northwest and Central regions.

Prior work in Iowa (Lang et al., 2020) demonstrated yield benefits of grafting a hybrid slicing tomato to DRO141TX, Estamino, and Maxifort rootstocks. However, ongoing research on unique scion

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x rootstock combinations is needed to understand interactions with specific locations.

In 2022 a high tunnel at the South Dakota State University (SDSU) Southeast Research Farm, Beresford, SD, USA, was used to trial two indeterminate cherry tomatoes grafted to three unique rootstocks to assess production and marketability for South Dakota high tunnel specialty crop producers.

MATERIALS & METHODS

This trial was a randomized complete block design with two replications that tested the effects of scion and rootstock on the plant health and yield of indeterminate heirloom cherry tomatoes. The scions tested were Indigo Cherry Drops and Pink Bumblebee. These scions were tested in combination with a non-grafted control in addition to the rootstocks DRO141TX, Estamino, and Maxifort (Table 1).

On March 22, 2022 tomatoes were seeded into a soilless potting media with scions grown in 72-cell trays and rootstocks started in 606 cell-packs. All plants were grown in the South Dakota State University Horticulture-Forestry Greenhouse. On April 7, 2022 when the seedling stems were approximately 1.5-2 mm in diameter, tomato seedlings were grafted using the splice grafting method. This required cutting the rootstock stem at a 45-degree angle below the cotyledon (seed leaf). The scion stem was cut at the same angle below the cotyledon. The two stems were joined together and held in place utilizing a silicon grafting clip. Ten of each scion x rootstock combination were grafted resulting in six grafted treatments and two non-grafted controls.

All grafted transplants were placed in 1020 trays and covered with a clear, tall 1020 humidity dome. Plants remained in a classroom in ambient temperature and light conditions, with high humidity maintained through daily misting with a spray bottle. Four days after grafting, the humidity domes were cracked open and then removed to acclimate plants prior to being returned to the greenhouse setting on April 14, 2022. The non-grafted plants remained in the classroom at ambient temperatures and were returned to the greenhouse at the same time as the grafted treatments. Plants were watered as needed during the greenhouse production period, and transplants were fertilized on May 11, 2022 at a rate of 250 ppm N with Nature's Source Professional 10-4-3 fertilizer applied via a Dosatron fertilizer injection system.

On May 5, 2022, tomatoes were planted in a high tunnel with dimensions of 20 ft wide x 45 ft long and covered with an inflated double-layer of 6 mm polyethylene film. Automated roll-up sides on the high tunnel had a set-point of 75° F at which time they would open to provide ventilation; additionally, the high tunnel had two gable vents in each the north and south peaks of the gothic frame. Each treatment plot included three plants, and plants were spaced 1.5 ft apart within row and there were 5 ft between planting rows. The grafted tomato trials were replicated, and rows were alternated with a replicated melon trial resulting in two rows of tomatoes and two rows of melons within the high tunnel.

The entire high tunnel soil surface was covered with a black, woven landscape fabric with pre-burned holes into which the tomatoes were planted; this provided weed control throughout the growing season. All tomatoes were trellised as a single-leader lower and lean system using a roller-hook and artificial twine. Tomatoes were pruned and clipped to the trellis approximately 13 times during the growing season. A drip tape system was used to deliver approximately 100 gallons of water to the two tomato rows each week; this was split into 2-3 watering events during each week and adjusted up or down based on crop stage and climate within the high tunnel. Tomatoes were fertilized at planting and again on July 25, 2022 using similar methods as described above at a rate of 250 ppm N with Nature's Source Professional 3-1-1 OMRI-approved fertilizer.

Harvest of tomato fruit began on July 7, 2022 and ended on October 12, 2022 with a total of 22 harvest events during the season. Cherry tomatoes were harvested at ripe-maturity and fruit were sorted into marketable and non-marketable categories. Non-marketable fruit included any fruit that were blemished, cracked, damaged by insects or disease, and were smaller than what is expected for an average consumer market.

In July, plants began to exhibit signs of Tomato Spotted Wilt Virus (TSWV) infection, and this was confirmed by the SDSU Extension Horticulture Specialist and the SDSU Plant Diagnostic Clinic. On July 21, 2022 plots were each assessed to count the number of plants per plot that were exhibiting disease symptoms including bronzing of foliage and a classic mosaic pattern on tomato fruit.

At the end of the season on October 14, 2022 one representative tomato plant per plot was collected for measurement of plant biomass. Tomato vines were clipped off at the soil surface, and whole plants were placed inside paper bags and transported to the SDSU Brookings campus for drying. Plant samples were dried in a forced-air oven for three days at 140°F and dry weights were recorded for each sample.

Data were analyzed with scion and rootstocks as fixed variables using PROC GLIMMIX of SAS Version 9.4. Harvest data were analyzed as the total weight and count for the growing season on a per plant basis for ease of comparison to other studies and field production contexts.

RESULTS

Yield. The scion Indigo Cherry Drops resulted in a higher per plant marketable fruit weight of 4.3 lbs./plant as compared to Pink Bumblebee with 0.7 lbs./plant ($p \leq .0001$) (Fig. 1). There was no difference in scion performance based on the rootstock used ($p = 0.55$) (Fig. 2). There were no differences in scion ($p = 0.33$) or rootstock ($p = 0.23$) effects on the weight of cull fruit per plant (Fig. 1).

The analysis of number of marketable fruits resulted in a similar scion effect ($p = 002$) with Indigo Cherry Drops yielding approx. five times more marketable fruit per plant than Pink Bumblebee (Fig. 2). There was no effect on the number of marketable fruits per plant in response to the rootstock used ($p = 0.72$) (Fig. 2). The number of cull fruit per plant was not affected by scion ($p = 0.50$) nor rootstock ($p = 0.43$) (Fig. 2).

TSWV and Plant Biomass. There were no differences in the number of plants affected by TSWV because of the scion ($p = 0.22$) or rootstock ($p = 0.80$) used (Fig. 3). The end of season tomato plant biomass data were not different between the scions used ($p = 0.12$) or among the rootstocks they were grafted to ($p = 0.14$) (Fig. 4).

DISCUSSION AND CONCLUSIONS

With only two replications and one year of data, it was difficult to tease out differences among rootstock treatments, and results are presented rather conservatively. The trial results do point to the higher-yielding IC scion, which may be an important production consideration for high tunnel producers. Interestingly, the IC had a general trend of lower plant biomass, which points to the possibility of a higher fruit to plant ratio as compared to the PB scion. The general observation of a higher proportion of PB plants with TSWV may help explain the significant decrease in yield from that cultivar. With the relatively high incidence of TSWV on tomatoes during the 2022 high tunnel production season, the research team plans to pause tomato trials for several years to decrease continuous vectoring and reintroduction of the disease.

Grafted tomatoes still carry potential benefits for South Dakota producers, but these one-year results with heirloom cherry tomatoes indicate that producers who want to add grafted plants to their production system should start with small trials versus wide-scale adoption for their own production systems. Trialing grafted and non-grafted plants in 1-2 rows using the most popular tomato cultivars would be advised. For more information on vegetable production and support, growers are encouraged to contact SDSU Extension horticulture specialists by visiting the SDSU Extension horticulture website: https://extension.sdstate.edu/garden-yard.

ACKNOWLEDGEMENTS

This study would not have been possible without the work of Ellie Fitzpatrick and Jacob Koch, SDSU Undergraduate research assistants, who aided in greenhouse management, grafting, and planting of this study. Special thanks to Brad Rops and Joslyn Fousert for leadership in rebuilding the high tunnel at the start of the season and for their watchful eye on the crop and high tunnel performance throughout the growing season. Additional thanks to Alexis Barnes, SDSU Graduate Research Assistant for assisting with data collection and entry.

Table 1. The heirloom cherry tomato scions and rootstocks with a brief description of their characteristics. Each scion and rootstock treatment were combined resulting in eight replicated trial plots for the 2022 research season.

Scions	Description
Indigo Cherry Drops	Deep purple to red flesh, 1-2 oz. fruit
Pink Bumblebee	Striped skin with pinks, yellows, and oranges, fruit less than 1 oz.
Rootstocks	
DRO141TX	Puts a higher proportion of energy into the fruit than other vegetative rootstocks, without compromising on vigor. DRO141TX has shown to carry a crop through high temperatures and a long season just as well as Maxifort.
Estamino	A strong, generative rootstock that puts a high proportion of energy into fruit. Especially useful for tomatoes in cultivation for less than six months, in unheated hoophouses, or with small-fruited varieties.
Maxifort	A vigorous, vegetative rootstock for large fruits and long-season cropping.
Non-grafted (control)	Nongrafted plants represented scions on their own roots.

Descriptions of scion and rootstock traits adapted from Johnny's Selected Seeds.

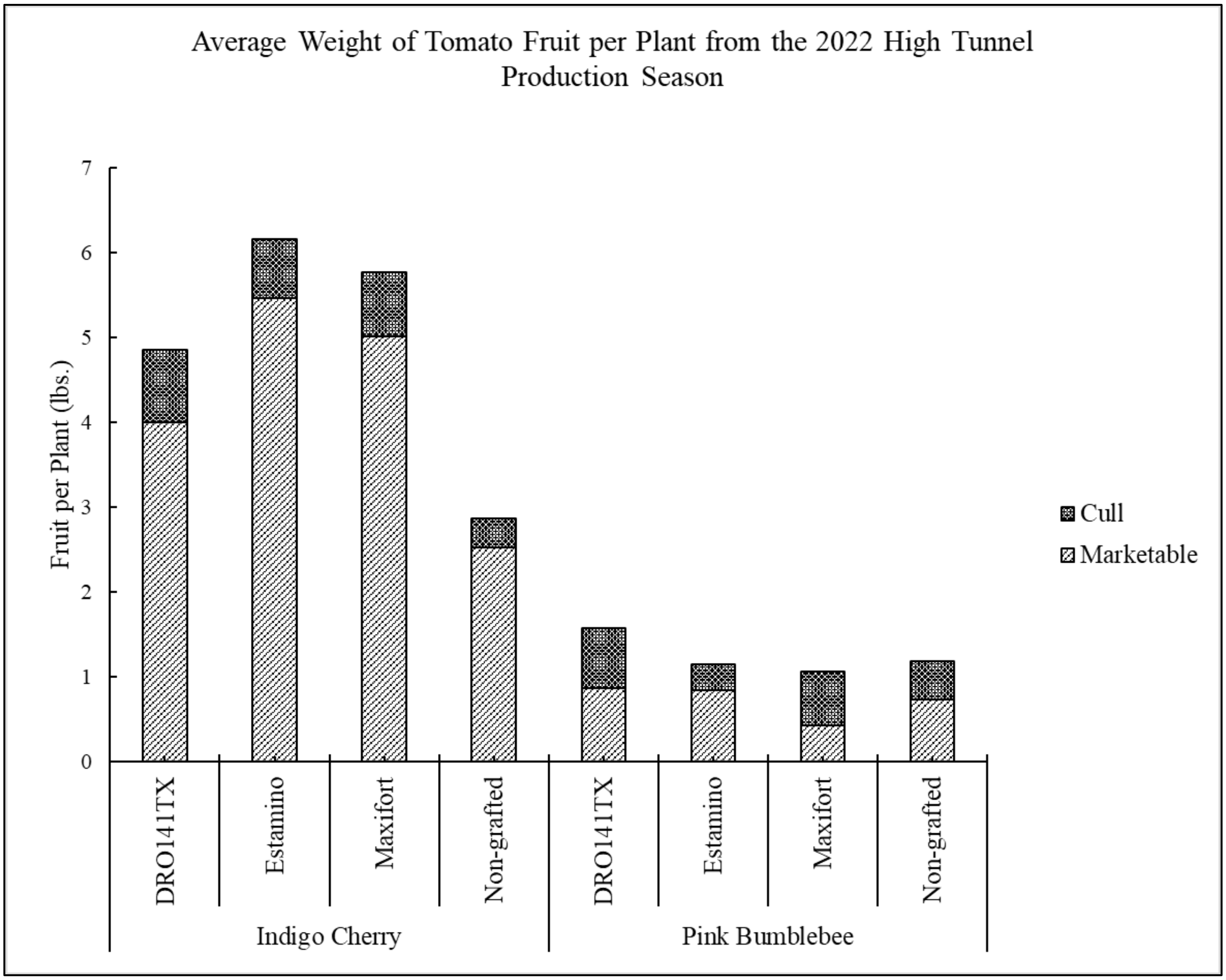

Fig. 1. The total season average weight per plant of tomato fruit harvested one to two times per week from July 7 through October 12, 2022 from a gothic-style high tunnel at the SDSU Southeast Research Farm. Indigo Cherry Drops and Pink Bumblebee were the scion cultivars which were grafted to DRO141TX, Estamino, and Maxifort rootstocks. The effect of scion was significant ($p \leq .0001$).

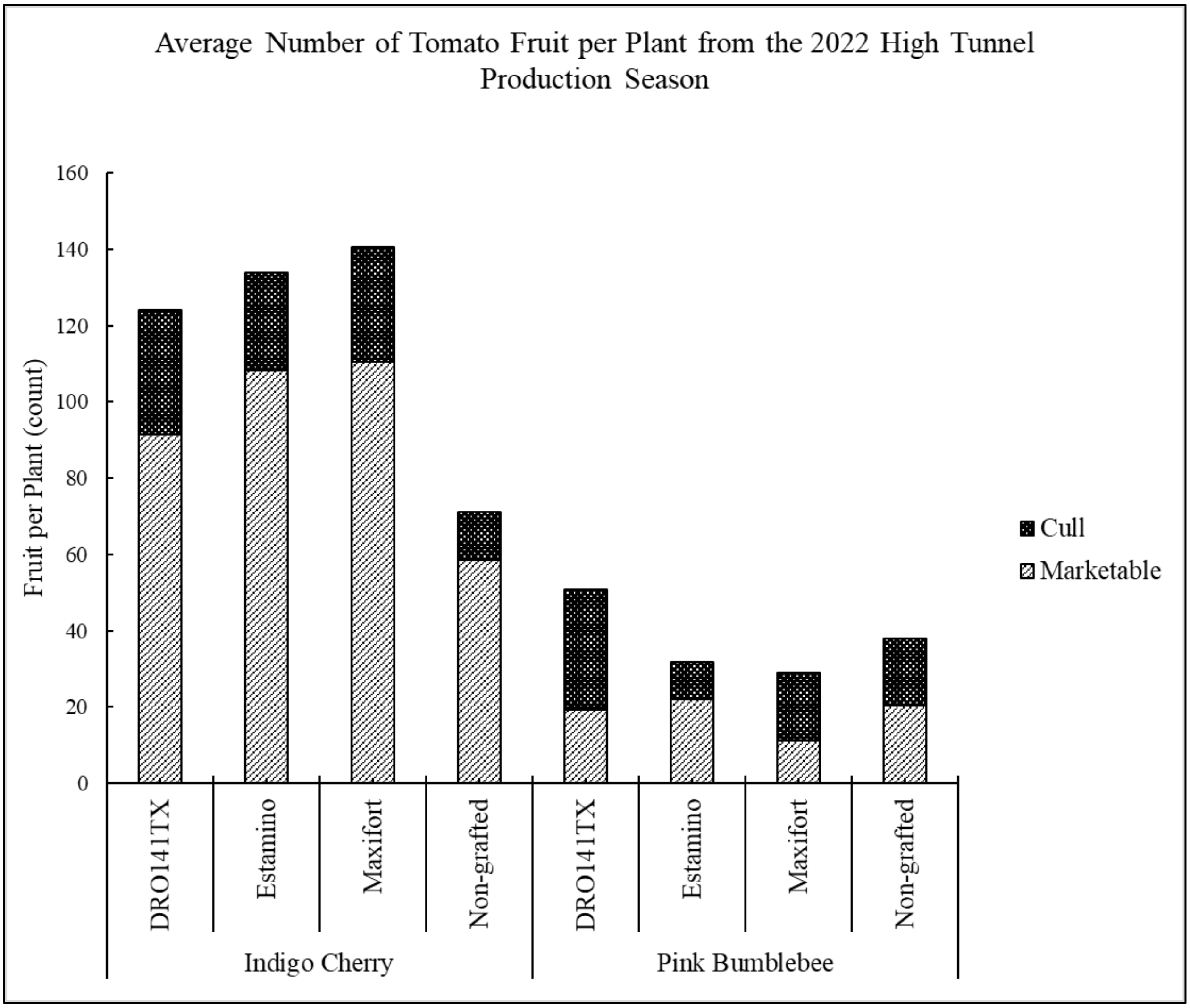

Fig. 2. The total season average count per plant of tomato fruit harvested one to two times per week from July 7 through October 12, 2022 from a gothic-style high tunnel at the SDSU Southeast Research Farm. Indigo Cherry Drops and Pink Bumblebee were the scion cultivars which were grafted to DRO141TX, Estamino, and Maxifort rootstocks. The effect of scion was significant (p = 002).

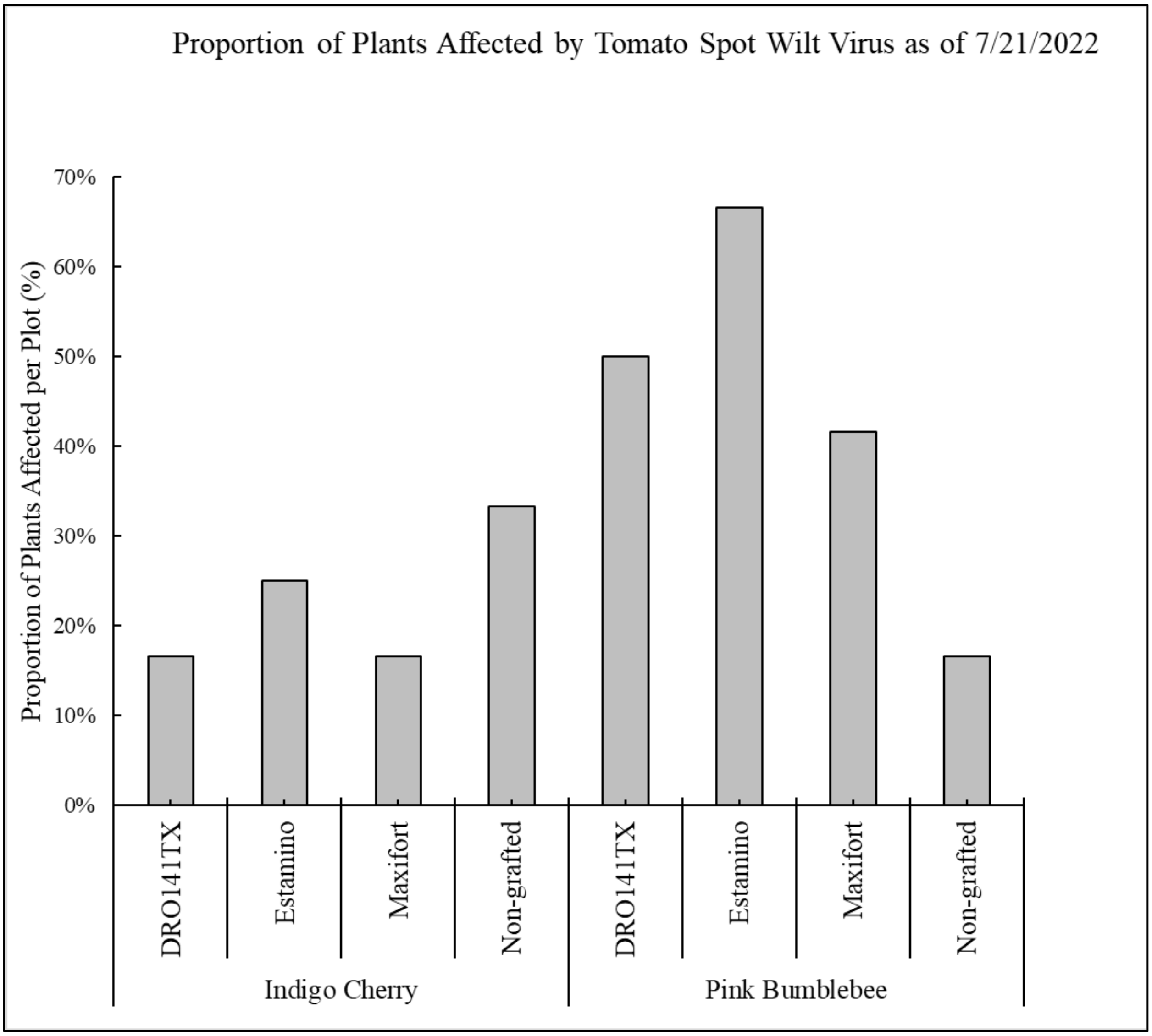

Fig. 3. The proportion of plants affected by Tomato Spotted Wilt Virus as assessed on July 21, 2022. Data were collected based on the number out of three plants per each treatment plot. Indigo Cherry Drops and Pink Bumblebee were the scion cultivars with DRO141TX, Estamino, Maxifort, and Non-grafted as the rootstock treatments. There was no effect of neither scion nor rootstock on plants exhibiting TSWV symptoms.

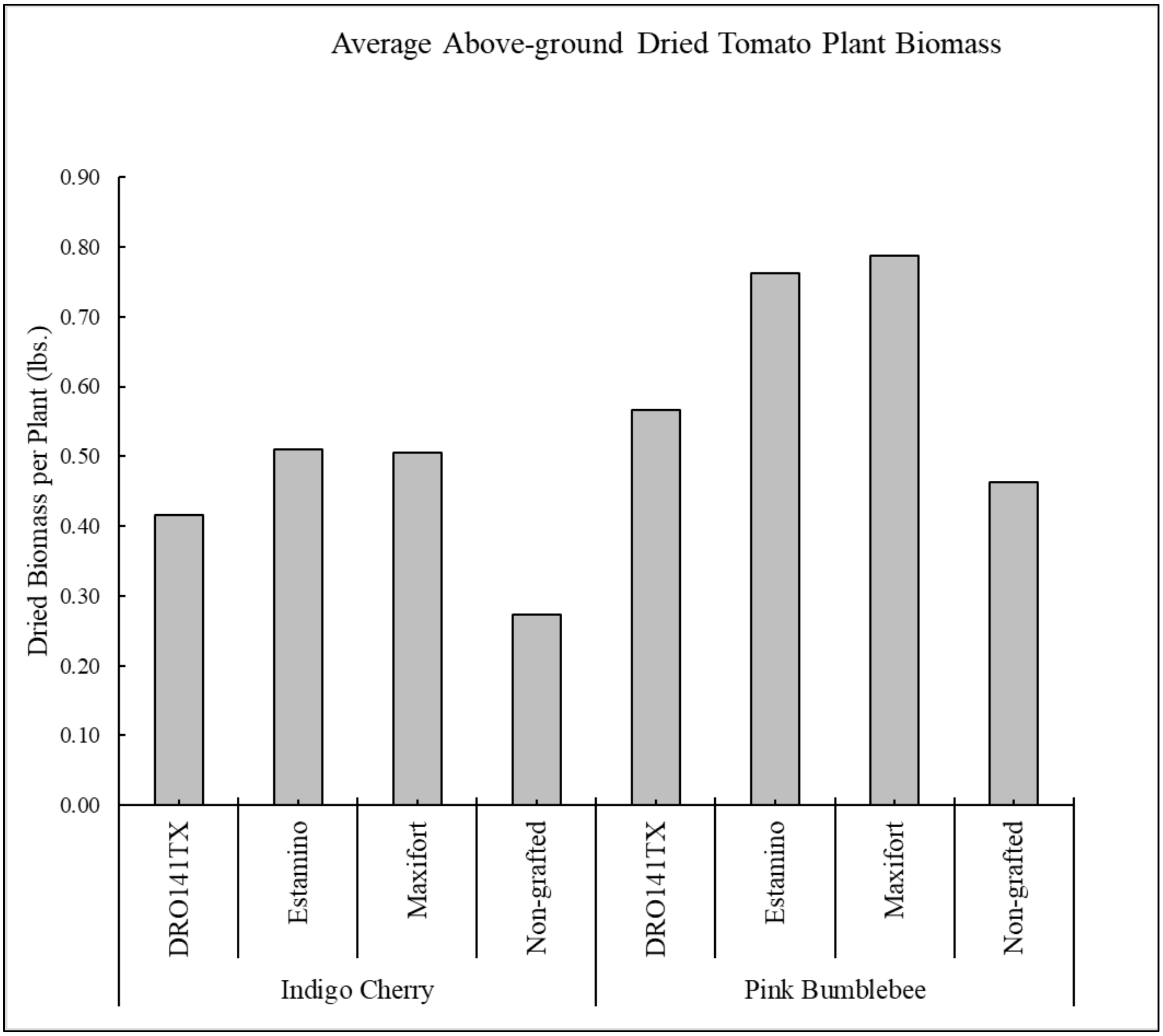

Fig. 4. The end of season dried above-ground plant biomass from grafted cherry tomatoes grown in a high tunnel at the SDSU Southeast Research Farm. Data were collected as one representative plant/plot on October 14, 2022. Indigo Cherry Drops and Pink Bumblebee were the scion cultivars with DRO141TX, Estamino, Maxifort, and Non-grafted as the rootstock treatments. There was no effect of neither scion nor rootstock on plants exhibiting TSWV symptoms.

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2022 Trials of Four Specialty Melons for Vertical Production with a High Tunnel

Kristine Lang* and Gretchen Kooyenga

INTRODUCTION

High tunnels remain a valuable crop production tool for Midwest producers. Heavy reliance on high-value solanaceous crops such as tomatoes and peppers may lead to depleted soil nutrients and soilborne disease issues. Continuing to expand the types of crops grown in high tunnels is important for economic and ecological success of South Dakota high tunnel producers. One option may be specialty melons. Typically, melons are grown in open-field settings, but recent research by Iowa State University (Bilenky and Nair, 2021) highlights the potential to grow specialty melons vertically within Midwest high tunnels. Their work demonstrated the potential for small-fruited, high-yielding melons to be profitable within a high tunnel system. Given similarities between the Iowa study location in Ames, IA, USA and the SDSU Southeast Research Farm in Beresford, SD, the goal was to replicate the previous study design for Midwest producers. This initial trial of specialty melons in South Dakota examined four cultivars; two of which performed well in Iowa and two which had not yet been trialed in a Midwest high tunnel.

MATERIALS & METHODS

This trial was a randomized complete block design with two replications of four specialty melon cultivars. The cultivars trialed were Griselet, Honey Blond, Sugar Cube, and Snow Leopard (Table 1). These cultivars were selected based on the desire to have multiple types of melons including Charentais, Muskmelon, and Honeydew types.

On April 5, 2022, melons were seeded into 50-cell trays filled with a soilless potting media. All plants were grown in the South Dakota State University Horticulture-Forestry Greenhouse. Plants were watered as needed during the greenhouse production period, and transplants were fertilized on May 11, 2022, at a rate of 250 ppm N with Nature's Source Professional 10-4-3 fertilizer applied via a Dosatron fertilizer injection system.

On May 5, 2022, melons were planted in a high tunnel with dimensions of 20 ft wide x 45 ft long and covered with an inflated double-layer of 6 mm polyethylene film. Automated roll-up sides on the high tunnel had a set-point of 75° F at which time they would open to provide ventilation;

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additionally, the high tunnel had two gable vents in each the north and south peaks of the gothic frame. Each treatment plot included four plants, and plants were spaced two feet apart within row and there were five feet between planting rows. The two replicated melon rows were alternated with a replicated tomato trial resulting in two rows of tomatoes and two rows of melons within the high tunnel. Due to low soil temperatures and cool weather the first week of May, the first planting of melon transplants did poorly, and melons were replanted on May 11, 2022. Only one plant per planting hole remained after the replant event.

The entire high tunnel soil surface was covered with a black, woven landscape fabric with pre-burned holes into which the melons were planted; this provided weed control throughout the growing season. All melons were grown vertically on metal cattle panels supported by metal t-posts. As melons grew, they were clipped to the cattle panels using plastic cucurbit trellis clips; this occurred eight times during the season. Melons were not pruned, and vines and tendrils were allowed to fill the vertical trellis throughout the growing season. A drip tape irrigation system was used to deliver approximately 100 gallons of water to the two melon rows each week; this was split into 2-3 watering events during each week and adjusted up or down based on crop stage and climate within the high tunnel. Melons were fertilized at planting and again on July 25, 2022 using similar methods as described above at a rate of 250 ppm N with Nature's Source Professional 3-1-1 OMRI-approved fertilizer. On August 25, 2022, one spray application of PyGanic was used to provide organic control of cucumber beetles which were scouted at above the economic threshold for melon production.

As melon fruit matured, some fruit became too heavy for the vines to support, and mesh produce bags were put around the fruit and tied to the cattle panel to prevent damage to the fruit or plants. The use of netted bags was especially important for G and SC melons as the vine separates from the fruit at maturity. Harvest of melon fruit began on July 26, 2022, and ended on October 12, 2022 with a total of 18 harvest events during the season. Melons were harvested at ripe-maturity and fruit were sorted into marketable and non-marketable categories. Non-marketable fruit included any fruit that were blemished, cracked, and damaged by insects or disease. Size was not used as a marketability consideration in this study as it was expected that fruit would be smaller than more popular honeydew or muskmelon varieties.

Data were analyzed with cultivar as a fixed variable using PROC GLIMMIX of SAS Version 9.4. Mean separation were based on Fisher's protected least significant differences at $p \leq 0.05$.

RESULTS AND DISCUSSION

Snow Leopard yielded more marketable fruit per plant than either Griselet or Sugar Cube, with Honey Blonde yielding similarly to the three other cultivars (p = 0.05) (Fig. 1). The number of cull fruit per plant was also highest from Snow Leopard as compared to the other cultivars (p = 0.02) (Fig. 1). Interestingly, there were no differences in the marketable (p = 0.46) or cull weight (p = 0.40) of fruit per plant or the individual fruit weight among cultivars(p = 0.12) (Figs. 2 and 3).

The number of marketable fruit per plant in the 2022 trial in South Dakota yielded results for Snow Leopard and Sugar Cube that were quite a bit higher than the results found in Iowa (Bilenky and Nair, 2021), which shows the potential for melons to perform well in this system despite a slightly shorter growing season in South Dakota. The individual fruit sizes found in the current study were similar to reported values from Iowa. These smaller sizes of fruit hold potential for marketing "single serving" or "snack size" fruit through direct market channels. Growers who are looking to add a new enterprise to their high tunnel production system may consider trialing a few varieties of smaller sized, specialty melons. This trial will be repeated in 2023 to increase the volume of data collected and improve recommendations for producers.

ACKNOWLEDGEMENTS

This study would not have been possible without the work of Ellie Fitzpatrick and Jacob Koch, SDSU Undergraduate research assistants, who aided in greenhouse management, planting, and trellis installation for this study. Special thanks to Brad Rops and Joslyn Fousert for leadership in rebuilding the high tunnel at the start of the season and for their watchful eye on the crop and high tunnel performance throughout the growing season. Additional thanks to Alexis Barnes, SDSU Graduate Research Assistant for assisting with data collection and entry.

Table 1. The 2022 specialty melon cultivars grown in a high tunnel at the SDSU Southeast Research Farm. A brief description of each melon's characteristics is included.

Melon	Description
Griselet (Charentais)	Succulent and sweet, this hybrid version of the heirloom 'Petit Gris de Rennes' looks and tastes like the French original but is protected by modern disease resistance. Unique greenish-yellow, green-sutured rind attracts attention, as does the intoxicating scent. The sweetness is accented with hints of exotic spice. Can be cut from the vigorous, healthy vines when skin yellows and rind gives slightly from your touch. High resistance to Fusarium wilt races 0–2; and intermediate resistance to Alternaria blight. 75 days to maturity.
Honey Blonde (Honeydew)	Flavorful, yellow-skinned. The attractive oval fruits avg. 3–3 1/2 lb., and have delicious orange flesh. Plants are strong and vigorous and perform well in warm or cool weather. Intermediate resistance to powdery mildew. 71 days to maturity.
Snow Leopard (Honeydew)	White skin with green variegation, white flesh. Unique, personal-size, and an excellent specialty item for farmers' markets and restaurants. Melons avg. 2 lb. with firm texture and sweet flavor. High resistance to Fusarium wilt race 0. 71 days to maturity.
Sugar Cube (Muskmelon)	Very uniform, heavily netted 2–2 1/2 lb. fruits (just a bit bigger than a softball) with deep-orange, aromatic flesh perfect for single servings. Strong disease package and long harvest window. Well-suited for northern and southern regions. High resistance to Fusarium wilt races 0–2, powdery mildew, and watermelon mosaic virus; intermediate resistance to papaya ringspot virus and zucchini yellow mosaic virus. 80 days to maturity.

Descriptions of melon traits adapted from Johnny's Selected Seeds.

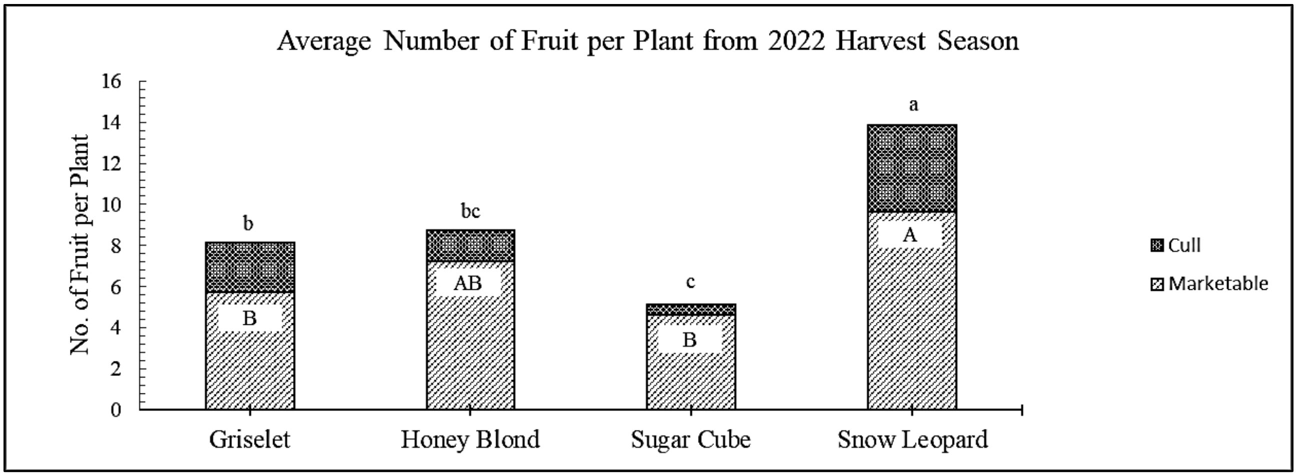

Fig. 1. The average number of fruit per plant collected from a total of 18 harvests from July 26 – October 12, 2022. Melons were grown vertically on a trellis within a high tunnel located at the SDSU Southeast Research Farm. Cultivar used affected marketable (p = 0.05) and cull (p = 0.02) fruit weight per plant. Capital and lowercase letters represent Fisher's protected least significant differences ($p \leq 0.05$) for marketable and cull response variables, respectively.

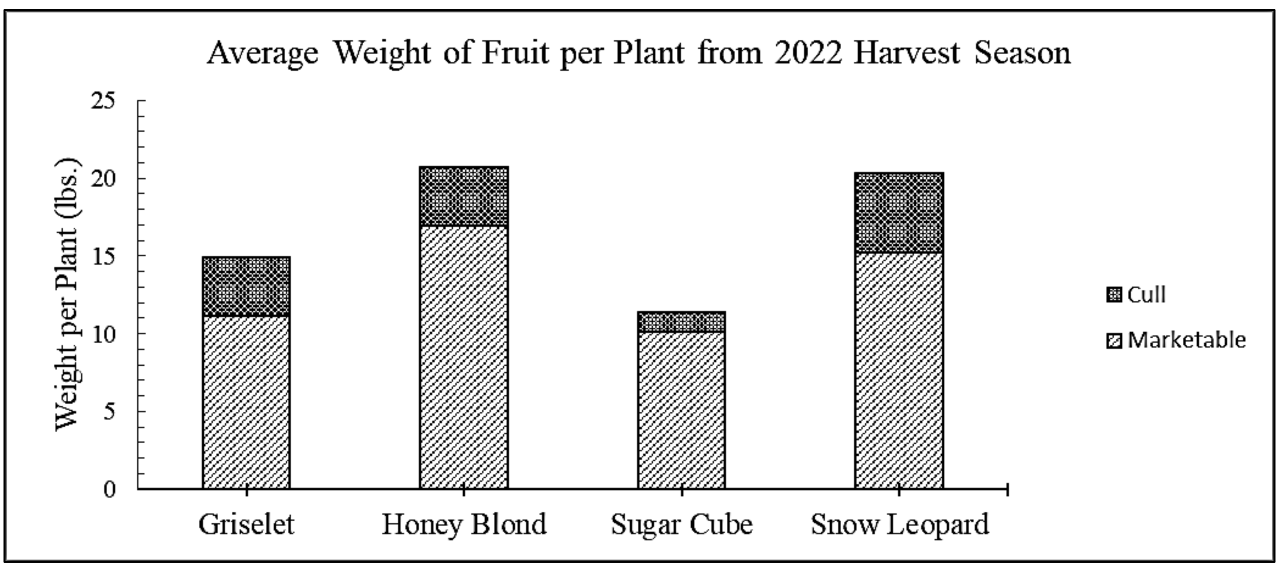

Fig. 2. The average weight of fruit per plant collected from a total of 18 harvests from July 26 – October 12, 2022. Melons were grown vertically on a trellis within a high tunnel located at the SDSU Southeast Research Farm. Cultivar did not have affect marketable (p = 0.46) nor cull (p = 0.40) fruit weight per plant.

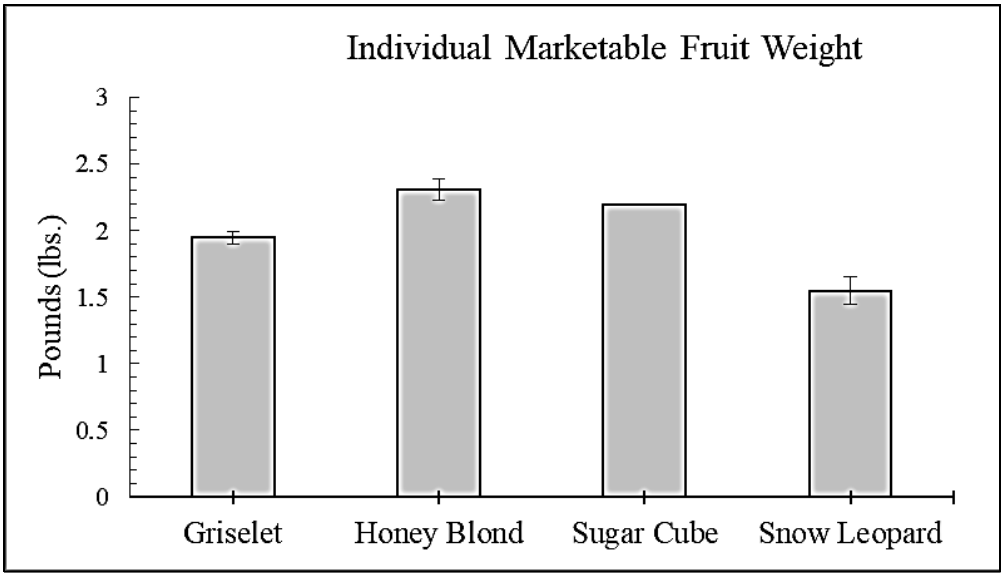

Fig. 3. The average weight (lbs.) of individual fruit from each of four melon cultivars grown on a vertical trellis within a high tunnel from May – October 2022. Cultivar did not affect individual fruit weight (p = 0.12) in the first year of this trial.

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

Evaluation of Clover Cover Crops as a Living Mulch in Winter Squash Production

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INTRODUCTION

Vegetable farmers struggle with weed suppression and soil fertility management which increases the use of black plastic mulch and organic inputs. Perennial legume cover crops provide nutrients to soil prior to vegetable planting and overwinter to establish living mulches for future growing seasons. During the growing season, clover cover crops as a living mulch may aid in weed suppression, nitrogen fixation and soil erosion prevention. Previous research has shown that clover living mulch can pose risks with light and space competition and produce low vegetable outputs.

Field research was conducted over the summer months in 2022 at the SDSU Southeast Research Farm in Beresford, South Dakota which has been experiencing drought conditions for several years. The objective of this research is to understand the relationship between three different clover species in different winter squash production systems. Vegetable cultivars chosen were 'Jester' squash (*Cucurbita maxima*) as a cash crop and acorn squash 'Honey Bear' (*Cucurbita* ***pepo*** *var.* ***turbinate*****)** as a guard row crop. Clover cultivars include 'Domino' White clover (*Trifolium repens*), 'Aberlasting' White x Kura clover (*T. repens x ambiguum*), 'Domino' Red clover (*Trifolium pratense*), and a bare ground treatment control. This study was a split plot randomized complete block design with four replications to compare the different clover species and field treatments to understand the best solution.

METHODS

Clover was seeded on April 5, 2022, at the Southeast Research Farm using a 15' John Deere no-till drill. Total field size was 400' x 120' in a randomized complete block design with each of four blocks split into four clover treatments with four different management randomized within each whole plot. No-till fabric, no-till no fabric, tilled fabric and tilled no fabric were the subplot treatments for each management style in each clover whole plot. 'Aberlasting' white x kura clover (*T. repens x ambiguum*) was seeded at 12.09 lbs./A, 'Dynamite' red clover (*T.pratense*) was seeded at 12.03 lbs/A, and 'Domino' white clover (*T. repens*) was seeded at 6.61 lbs/A. Oats were seeded at 35 lbs/A simultaneously

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with the clover to act as a nurse crop while clover seedlings established. One bare ground whole treatment plot was present per block. Initial tillage events prior to vegetable planting were necessary for tilled fabric and tilled no fabric treatments. Tilled treatments received two 30' long tillage passes using a BCS walk behind tiller.

Jester squash (*C. maxima*) was seeded in the horticulture-forestry greenhouse on April 14, 2022. On June 10, 2022, squash was transplanted into the field at the Southeast Research Farm in Beresford, South Dakota. Nine Jester squash plants were planted in each row treatment with a 9" spacing. Fabric rows consisted of 30' long pieces of fabric that were burned using a soup can and a butane burner. Squash planting was timed in each subplot treatment within two of the research blocks tested.

Drip tape irrigation was installed prior to squash planting and consisted of six hours of initial watering for root establishment, later being cut down to three hours a week in place of no rain events. Squash received three fertigation events using a Dosatron at 250 ppm for two hours two times and three hours one time, with 3-1-1 fertilizer by Natures Source Organic Plant Food. Chlorophyll content was assessed on July 27, 2022, using a SPAD meter. Squash vine borer also impacted 75% of the squash plants. This was noted on August 8, 2022, and reparations were taken care of by August 12, 2022, using pocketknives to cut near the borer entrance hole and tweezers were used to extract the borer from the squash. Dense wet soil was applied to the extracted area as a "cast" to signal regrowth and cell development in the squash. August 9, 2022, squash samples were sent to Ward Labs for nutrient analysis due to suspected low amounts of nitrogen and yellowing leaf color.

Data collection for clover establishment was taken four times randomly over the course of the season. A 25x25 centimeter quadrat was randomly tossed three times within the whole clover plot alleyways (between crop rows) and two times in each in-row clover x management subplot (within row) to analyze the relationship between weeds and clover species. The tallest clover, weed and oat in each quadrat were measured from the base of the stem to the tallest leaf point to understand the competition relationship. All oats, clovers and weeds present in the quadrat were cut at the base of the stem and kept in a brown paper sample bag for biomass drying. Samples were then dried for approximately three days at 140 degrees Fahrenheit in a gas conventional dryer. Dried samples were weighed to the nearest 0.1 grams using a small food scale to determine plant biomass height and weight relationship. After data collection was taken, clover and weeds were mowed in the whole plot walkways and hand cultivated in the bare ground treatments; time spent for these events was recorded. Mowing height was set at 3" from the ground with two passes along each row for height consistency. One event on August 29, 2022, required the need to weed eat the whole plot walkways of the squash due to weeds outcompeting clover and a mower would not cut through the biomass. Timed weeding events occurred for in-row (subplot) weed management events and consisted of hand pulling and using hand cultivation tools where appropriate.

One harvest event took place on September 16, 2022, at which every squash fruit was harvested and graded into different categories. Categories include marketable (U.S. 1) free of imperfections and a diameter of 4" and above. Non-marketable consisted of undersized fruit or fruit damaged by insect or rodent pests. Squash was graded visually, counted, and weighed at the time of harvest and was later composted or donated based on the condition of the fruit.

At the end of the season, three jester (C. *maxima*) squash plants were trimmed at the base of the stem in each subplot, dried for four days at 140 degrees Fahrenheit using a conventional gas dryer. Dried squash biomass was weighed to the nearest 0.5 grams using a metric scale. All data was analyzed using PROC GLIMMIX of SAS in a randomized complete split block design.

RESULTS AND DISCUSSION

Whole plot biomass accumulation. Plant height differed significantly between treatments (Table 1). Oats outcompeted weeds and clover in all treatments, White x Kura clover had the biggest impact. Weed height outcompeted clover height in all treatments, which was not surprising given the drought tolerant weeds present. Plant biomass also differed significantly between treatments. Bare ground had the greatest number of weeds at 1090.8 lbs./A, while white x kura clover had the lowest biomass at 260.8 lbs./A. Weed and oat biomass outweighed all clover biomass in all treatments (Table 1).

Plant height was significantly higher in red clover compared to white clover treatments (Table 2). Weed height still outcompeted all clover treatments in September but did decrease in the bare ground treatment. Red and white clover both increased in height compared to July, and white x kura saw a 24% decrease in height. Plant biomass was significant in the treatments and saw an 80% decrease in weed biomass in the bare ground plots compared to July. White x kura clover had the largest difference between clover and weed biomass at a ratio of 1:23 lbs./A, which is a 96% difference (Table 2).

In-row biomass accumulation. Oat and Clover height differed significantly for the in-row plots, while weed height had no effect on the clover treatments (Table 3). Weed height was consistently high in every treatment in comparison to the clovers, while oats were considerably higher than both weeds and clover. Oat and clover biomass differed significantly compared to weed biomass, which was only significant in the bare ground treatments. Weed biomass in red clover, white clover, and white x kura clover were not affected based on management. Weed biomass was significantly higher in the bare ground treatments in comparison to red, white, and white x kura clover (Table 3).

Plant height differed significantly between treatments. (Table 4). Red and white clover outcompeted weed height in NT and NTF plots while white x kura clover was out competed by weed height, most likely from the ongoing droughts in South Dakota. Plant biomass was significant overall besides bare ground treatments. Weed biomass was greater in NT plots for white clover and red clover, with clover biomass being the greatest in red clover plots (Table 4).

Yield. There were no significant differences between clover treatment effects on Jester squash yield (Table 5). However, the bare ground treatment had significantly greater amounts of marketable fruit and marketable weight compared to the clover treatments. No-till plots had 48% less marketable squash compared to the other management treatments, and the marketable weight was the lowest outcome of the treatments. Cull number and weight of fruit were about the same for all treatments.

These results show that bare ground treatments had the highest yield outcome; all clover treatments had similar detrimental effects on squash yield.

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Table 1. Weed and oat and clover living mulch average biomass and plant height collected from alleyways between planting 'Jester' Delicata squash rows on July 6, 2022 at the Southeast Research Farm, Beresford, SD.[z]

	Plant Height (inches)				Plant Biomass (lbs/acre)		
Clover Treatment	**Oats**	**Clover**	**Weeds**		**Oats**	**Clover**	**Weeds**
Bare Ground	0.0 b[w]	0.0 b	8.6 a		0.0 b	0.0 b	1090.8 a
Red	11.9 a	2.6 a	4.1 b		493.2 a	147.0 a	420.9 b
White	10.6 a	2.0 a	4.2 b		320.1 a	42.7 ab	497.9 b
White x Kura	13.7 a	2.1 a	2.9 b		557.2 a	86.5 ab	260.8 b

[w]Values within the same column and treatment followed by the same letter are not statistically different according to Fisher's protected least significant difference ($P \leq 0.05$). Data are presented as management (M) within clover (C) treatments due to multiple response variables with M x C

Table 2. Weed and oat and clover living mulch average biomass and plant height collected from alleyways between planting 'Jester' Delicata squash rows on September 23, 2022 at the Southeast Research Farm, Beresford, SD.[z]

	Plant Height (inches)		Plant Biomass (lbs/acre)	
Clover Treatment	**Clover**	**Weeds**	**Clover**	**Weeds**
Bare Ground	0.0 b[w]	4.8	0.0 b	221.7 b
Red	5.1 a	6.4	366.3 a	802.7 ab
White	3.9 b	6.1	273.9 a	863.1 a
White x Kura	1.6 c	6.3	54.5 b	1255.6 a

[w]Values within the same column and treatment followed by the same letter are not statistically different according to Fisher's protected least significant difference ($P \leq 0.05$). Data are presented as management (M) within clover (C) treatments due to multiple response variables with M x C interactions.

Table 3. In-row weed and oat and clover living mulch average biomass and plant height collected on July 6, 2022 at the Southeast Research Farm, Beresford, SD.[z]

	Plant Height (inches)			Plant Biomass (lbs/acre)		
Clover Treatment	**Oats**	**Clover**	**Weeds**	**Oats**	**Clover**	**Weeds**
Bare Ground						
T[y]	0.0[w]	0.0	9.2	0.0	0.0	560.2 a
NT	0.0	0.0	9.1	0.0	0.0	524.6 a
TF	0.0	0.0	6.5	0.0	0.0	316.6 ab
NTF	0.0	0.0	4.9	0.0	0.0	112.03 b
Red Clover						
T	0.0 b	0.0 b	5.1	0.0 b	0.0 b	183.2
NT	12.3 a	5.0 a	5.6	202.7 a	305.9 a	277.4
TF	0.0 b	0.0 b	6.1	0.0 b	0.0 b	124.5
NTF	11.8 a	3.8 a	4.2	136.9 ab	51.6 b	136.9
White Clover						
T	0.0 c	0.0 c	4.7	0.0 b	0.0 b	259.7
NT	13.3 a	4.7 a	6.2	186.7 a	328.9 a	248.9
TF	0.0 c	0.0 c	5.6	0.0 b	0.0 b	183.2
NTF	9.7 b	2.5 b	3.3	106.7 ab	28.5 b	232.9
White x Kura Clover						
T	0.0 b	0.0 b	3.9	0.0	0.0 c	136.9
NT	11.2 a	4.2 a	5.5	382.4	138.7 a	275.6
TF	0.0 b	0.0 b	5.6	0.0	0.0 c	136.9
NTF	11.9 a	2.8 a	4.5	174.3	53.3 b	167.2

[z]Planting rows were 30 inches wide and each plot was planted with nine 'Jester' Delicata Squash spaced three feet apart within the row.

[y]Management treatments were tillage (T), no-till (NT), tillage + fabric (TF), and no-till + fabric (NTF).

[w]Values within the same column and treatment followed by the same letter are not statistically different according to Fisher's protected least significant difference ($P \leq 0.05$). Data are presented as management (M) within clover (C) treatments due to multiple response variables with M x C interactions.

Table 4. In-row weed and clover living mulch average biomass and plant height collected on September 23, 2022 at the Southeast Research Farm, Beresford, SD.[z]

	Plant Height (inches)		Plant Biomass (lbs/acre)	
Clover Treatment	**Clover**	**Weeds**	**Clover**	**Weeds**
Bare Ground				
T[y]	0.0[w]	11.9	0.0	846.5
NT	0.0	9.9	0.0	529.9
TF	0.0	0.0	0.0	0.0
NTF	0.0	4.3	0.0	55.1
Red Clover				
T	0.0 b	11.0 a	0.0 b	238.3 b a
NT	14.7 a	11.3 a	2651.6 a	433.9 a
TF	0.0 b	0.0 b	0.0 b	0.0 b
NTF	2.8 b	2.2 b	83.6 b	33.8 b
White Clover				
T	0.0 b	4.9 b	0.0 b	97.8 b
NT	7.9 a	7.0 a	1275.1 a	186.7 a
TF	0.0 b	0.0 c	0.0 b	0.0 c
NTF	2.5 b	0.0 c	53.3 b	0.0 c
White x Kura Clover				
T	0.0 b	4.1 b	0.0 b	131.6 b a
NT	5.4 a	9.8 a	716.7 a	298.8 a
TF	0.0 b	0.4 b	0.0 b	23.1 b
NTF	3.8 a	1.2 b	245.4 b	5.3 b

[z]Planting rows were 30 inches wide and each plot was planted with nine 'Jester' Delicata Squash spaced three feet apart within the row.

[y]Management treatments were tillage (T), no-till (NT), tillage + fabric (TF), and no-till + fabric (NTF).

[w]Values within the same column and treatment followed by the same letter are not statistically different according to Fisher's protected least significant difference ($P \leq 0.05$). Data are presented as management (M) within clover (C) treatments due to multiple response variables with M x C interactions.

Table 5. Average fruit per plant of 'Jester' Delicata squash grown in 2022 at the Southeast Research Farm, Beresford, SD. Data includes marketable and cull fruit count and weight.

Treatment	**Mark. No.**	**Mark. Wt. (lbs.)**	**Cull No.**	**Cull Wt. (lbs.)**
Clover (C)[z]				
BG	7.3 a[y]	6.4 a	0.5	0.1
RC	1.4 b	0.5 b	0.5	0.1
WC	1.2 b	0.5 b	0.5	0.1
KC	1.7 b	0.7 b	0.5	0.1
p-value[x]	<.0001	0.003	0.93	0.91
Management (M)[w]				
T	3.3 a	3.5	0.4	0.1
NT	1.7 b	1.1	0.5	0.1
TF	3.3 a	1.8	0.5	0.1
NTF	3.3 a	1.9	0.6	0.1
p-value	0.004	0.28	0.55	0.31
C x M				
p-value	0.74	0.47	0.66	0.36

[z]Clover treatments were: bare ground (BG), red clover (RC), white clover, (WC), and white x kura clover (KC)

[y]Values within the same column and treatment followed by the same letter are not statistically different according to Fisher's protected least significant difference ($P \le 0.05$).

[x]*p-values* based on F test.

[w]Management treatments were tillage (T), no-till (NT), tillage + fabric (TF), and no-till + fabric (NTF)

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SDSU Oat Breeding

Melanie Caffe* and Nick Hall

In 2022, area planted with oats in South Dakota (260,000 acres) was up 21% from 2021 (USDA, NASS). Less than a third (29%) of the oat area in the state was harvested for grain. With 6 million bushels of oats produced in 2022, South Dakota ranked third behind North Dakota (13.5 million bushels) and Minnesota (8.3 million bushels). However, average oat grain yield was higher in South Dakota (80 bu/ac) than North Dakota (71 bu/ac) and Minnesota (59 bu/ac).

While most of the oat planted in South Dakota is used as forage, domestic use of milling oats continues to increase. The demand for milling oats relative to total supply has been rising from 6% in 1994-95 to 27% in 2020-21 (Oatinfomation). It is essential that South Dakota producers have access to high yielding oat varieties with good milling quality to take advantage of this continuously growing market. The objective of the SDSU oat breeding program is to develop new oat varieties with improved agronomic characteristics (i.e., grain and forage yield, lodging resistance, disease resistance), and with characteristics that are essential to the milling industry.

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 this area of the state. In 2022, close to 1,500 test plots were seeded at SERF. Those included:

- An organic oat variety trial to compare the performance of 30 oat cultivars and breeding lines under organic management.
- The South Dakota Crop Performance Testing Oat Variety Trial (SD CPT OVT) to evaluate the performance of 27 oat cultivars for grain production.
- A forage trial to evaluate the forage yield and quality of 23 advanced breeding lines and 12 released cultivars.
- Three regional nurseries: Uniform Early Oat Performance Nursery (28 entries), Uniform Mid-season Oat Performance Nursery (35 entries), Mid-West Cooperative Nursery (30 entries), each evaluating experimental breeding lines from multiple mid-west oat breeding programs.
- SDSU breeding trials including the Advanced Yield Trial (40 entries listed in Table 1), the Preliminary Yield Trial

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(234 entries) and an early generation nursery (137 entries).

The organic trial was seeded on April 21st while the rest of the trials were drilled on April 22nd, 2022. Data collected on each test plot included heading date, plant height, lodging severity, grain yield, and test weight. Milling and nutritional quality evaluations were also collected on harvested samples. Table 1 provides a summary of the agronomic performance of SDSU experimental lines at SERF and across all locations (Brookings, Dakota Lake Research Farm (DLRF), Miller, SERF, South Shore, Volga, and Winner).

Table 1. Agronomic performance of entries in the Advanced Yield Trial at SERF and across all locations in 2022.

Entry	Yield bu/ac		Test weight lb/bu		Heading Julian date	Height Inches
	SERF	**All**	**SERF**	**All**	**All**	**All**
SD200882	**87.4**	102.4	**33.1**	35.4	176.5	33.0
SD200223	**87.3**	112.7	**31.6**	34.6	174.3	35.1
SD201228	**84.1**	108.6	**31.0**	34.6	174.8	33.2
SD200198	**81.4**	116.5	**31.9**	**36.9**	173.9	37.2
SD201373	**81.1**	106.8	29.9	34.8	174.8	36.7
SD200048	**79.8**	110.4	**33.1**	**36.7**	176.8	38.0
MN Pearl	**79.0**	96.2	**33.0**	33.9	177.8	35.8
SD200049	**78.5**	98.2	**31.6**	**36.2**	176.0	35.8
SD200587	**77.3**	102.1	**34.2**	**36.9**	176.9	36.3
SD201374	**77.0**	117.3	**31.3**	34.4	176.7	38.5
SD200608	**76.9**	106.6	29.5	**36.2**	175.7	36.4
SD201470	**76.7**	**125.5**	29.0	33.8	178.3	35.4
Hayden	**76.6**	107.2	**31.1**	35.2	176.8	35.9
SD200611	76.4	101.5	**34.3**	34.8	177.3	34.5
SD201365	76.2	108.0	**35.5**	35.8	177.4	34.7
SD200074	75.0	101.0	**35.5**	**37.0**	176.8	36.7
SD201026	74.9	107.0	**31.9**	**36.5**	176.5	37.4
SD201355	74.5	111.0	28.8	34.5	177.8	34.9
SD201379	73.6	108.5	28.8	35.6	173.6	36.7
SD200078	72.6	107.0	30.4	35.8	176.4	36.8
SD200109	72.5	101.7	30.5	34.3	174.6	36.7
SD201234	71.9	107.4	29.8	35.1	177.9	34.2
SD201650	69.2	104.7	30.1	35.4	176.0	35.3
SD200625	68.0	113.8	28.4	35.5	176.7	32.9
Deon	67.7	102.3	**32.9**	35.6	178.3	36.9
SD Buffalo	66.0	102.3	**31.5**	34.9	174.8	35.5
SD201263	65.8	107.8	29.2	36.1	173.8	34.7

Table 1. Continued

SD200768	65.8	100.8	30.7	**36.4**	174.7	35.4
SD200345	64.7	102.4	30.4	36.1	172.8	35.6
SD201631	64.0	110.6	30.3	35.5	175.0	33.2
SD200326	62.3	108.2	**33.8**	**36.6**	172.3	32.6
SD200877	61.9	97.0	28.2	35.3	176.4	35.4
Rushmore	58.7	93.1	**32.5**	36.1	175.3	35.5
SD201637	58.4	103.3	22.8	33.3	176.5	34.0
Warrior	58.4	102.6	27.9	34.2	175.7	34.0
SD200265	54.6	103.2	**31.0**	35.8	172.8	32.9
SD201182	54.5	106.2	**31.0**	35.9	176.1	34.9
SD201090	53.7	99.1	25.2	34.1	175.5	33.9
SD201033	50.8	102.3	22.6	34.0	175.7	35.9
SD200226	48.0	99.5	**30.9**	35.2	171.3	32.3
Average	**70.1**	**105.6**	**30.6**	**35.4**	**175.7**	**35.3**
CV (%)	**9.1**	**9.3**	**9.0**	**3.9**	**0.5**	**5.1**
LSD (0.05)	**10.8**	**6.0**	**4.7**	**0.8**	**0.7**	**1.2**

The 2022 growing season at SERF was characterized by a lack of moisture. The average yield (70.1 bu/ac) was lower than the average of all locations (105.6 bu/ac). No crown rust was observed at this site. Grain yield at SERF ranged from 87.4 bu/ac for experimental line SD200882 to 48.0 bu/ac for experimental line SD200226. Test weight at SERF ranged from 35.5 lb/bu for SD201365 and SD200074 to 22.6 lb/bu for SD201033. Several experimental lines performed equal or better than the check for yield and test weight. Agronomic and milling quality performance at SERF and across the state will help identify promising breeding lines.

Oat varieties differ for their agronomic and milling characteristics. Choosing a variety that is suited for the intended market and adapted to the area can have a significant impact on the revenue per acre. Summary of agronomic and milling quality performance from the SD CPT OVT can be found at [Oat Variety Trial Results (sdstate.edu)](). The relative performance among varieties for grain yield can be affected by the environment, it is recommended to consider data from multiple years when selecting a variety.

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Impacts of Crop Rotation and Cover Crops on Soil Physical Properties, Carbon Stocks, and Microbial Community in Southeast SD

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PROJECT INTRODUCTION

Crop rotations and cover crops are two conservation practices that have been shown to have beneficial impacts on soil health. Previous research has shown that more diversified rotation systems tend to have greater benefits under a similar tillage system. However, there are inconsistencies because rotation involves growing crops with varying residue quality and quantity that have different influences on soil physical and hydrological properties, deep soil carbon stocks, and the microbial communities. Thus, the objective of this study was to determine how crop rotations managed with or without cover crops, under no-till, influence (a) soil pore characteristics and porosity using X-ray computed tomography (b) soil hydrologic properties such as soil water retention, saturated hydraulic conductivity (Ksat), (c) soil organic carbon (SOC) and total nitrogen (TN) in deep soil layers, and (d) soil carbon fractions and distribution as influenced by microbial communities.

METHODS

The rotation treatments consisted of corn (*Zea mays* L.)-soybean [*Glycine max* L. (Merr.)]-oat (*Avena sativa* L.)- winter wheat (*Triticum aestivum* L.) (CSOR, rye replaced winter wheat since 2021), and corn-soybean (CS). Half of the plot received cover crops (CC) in each rotation, and the other half received no cover crops (NCC). The treatments were arranged in a complete randomized block split-plot design, with rotations as whole plots and cover crops as split plots. This experiment has been established since 1991.

In October 2021 and May 2022, soils were collected from 0-7.5 cm to analyze soil microbial communities, enzyme activities, and aggregate distribution and SOC concentration in aggregates.

In November 2021, soil cores were collected from 0-80 cm and divided into six depths (0-7.5, 7.5-15, 15-30, 30-45, 45- 60, and 60-80 cm) for analyzing total SOC and N, and SOC distribution in labile and stable fractions.

In May 2022, undisturbed cores were collected at 0-40 cm (segmented into 0-10, 10-20, 20-30, and 30-40 cm) from each plot to assess the influences of crop rotation and cover cropping practices on soil pore

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structures and physical properties. Soil cores were transported to the University of Missouri Veterinary Center at Columbia, MO, for CT scanning to assess total porosity (macroporosity plus coarse mesoporosity), macroporosity, and coarse mesoporosity. After that, soil cores will be used to determine soil water retention, plant available water (PAW), Ksat, bulk density (ρ_b), and thermal conductivity (λ).

PROGRESS AND PRELIMINARY FINDINGS

Analysis on soils collected on October and November 2021 showed that under both corn and soybean phases, plots under cover crops (CC) had significantly higher microbial biomass carbon and nitrogen (MBC and MBN) than those under no cover crops (NCC). No significant effect was found for either rotation or the interaction between rotation and cover crops (Figure 1). Under corn phase, total and bacterial PLFA (phospholipid fatty acids) concentrations ($P < 0.05$) were statistically higher in both CSOR and CC plots than in CS and NCC plots, respectively, while fungal PLFA was significantly higher only in CC plots (Figure 2). Only rotation was found to significantly affect cold water extractable carbon (CWECN) (with CSOR> CS) at 0-7.5 cm depth, but no effect on hot water extractable carbon (HWECN) was detected in either rotation or cover crop at any given depth (Figure 3, 4, 5, and 6). These results highlight that greater crop diversification and cover-cropping integration can positively influence the microbial community structure under no-till management.

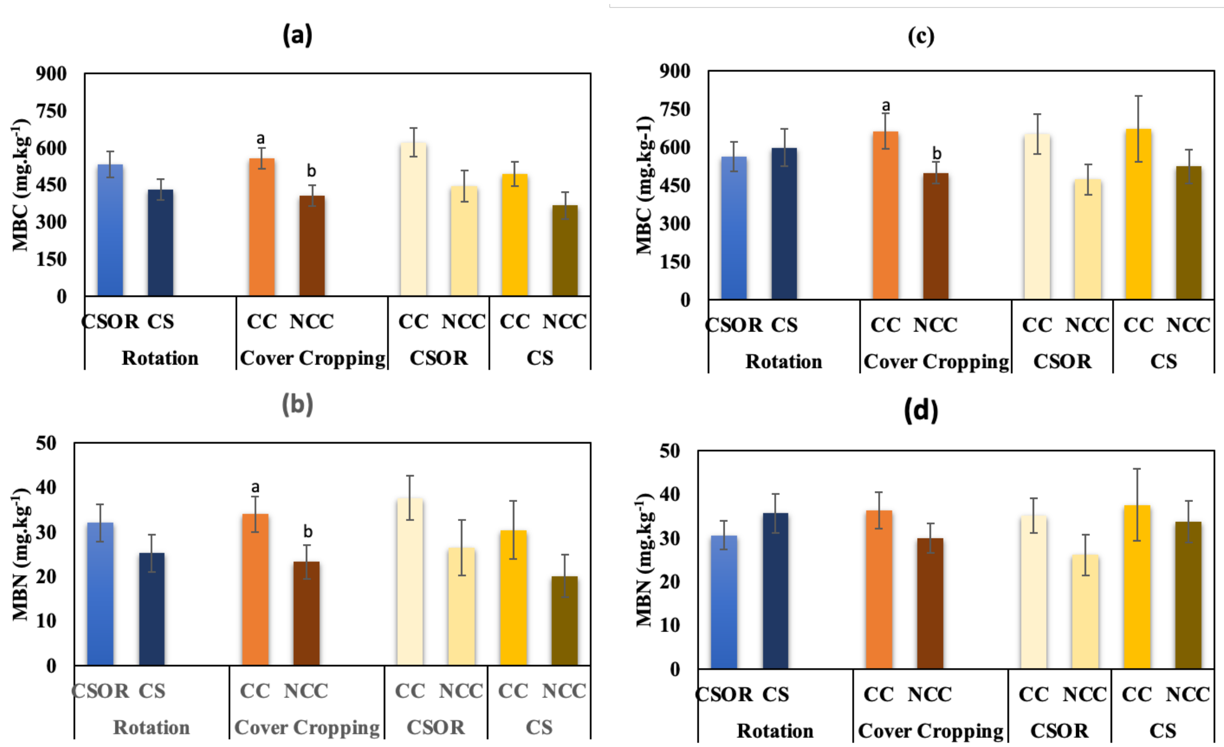

Figure 1: Microbial biomass carbon and nitrogen concentration (mean± standard error) at 0-7.5 cm depth under corn (a and b) and soybean (c and d). Different letters on a given figure and within a given factor (Rotation, cover cropping, Rotation by Cover cropping) are significantly different at P≤ 0.05, according to Fisher's LSD.

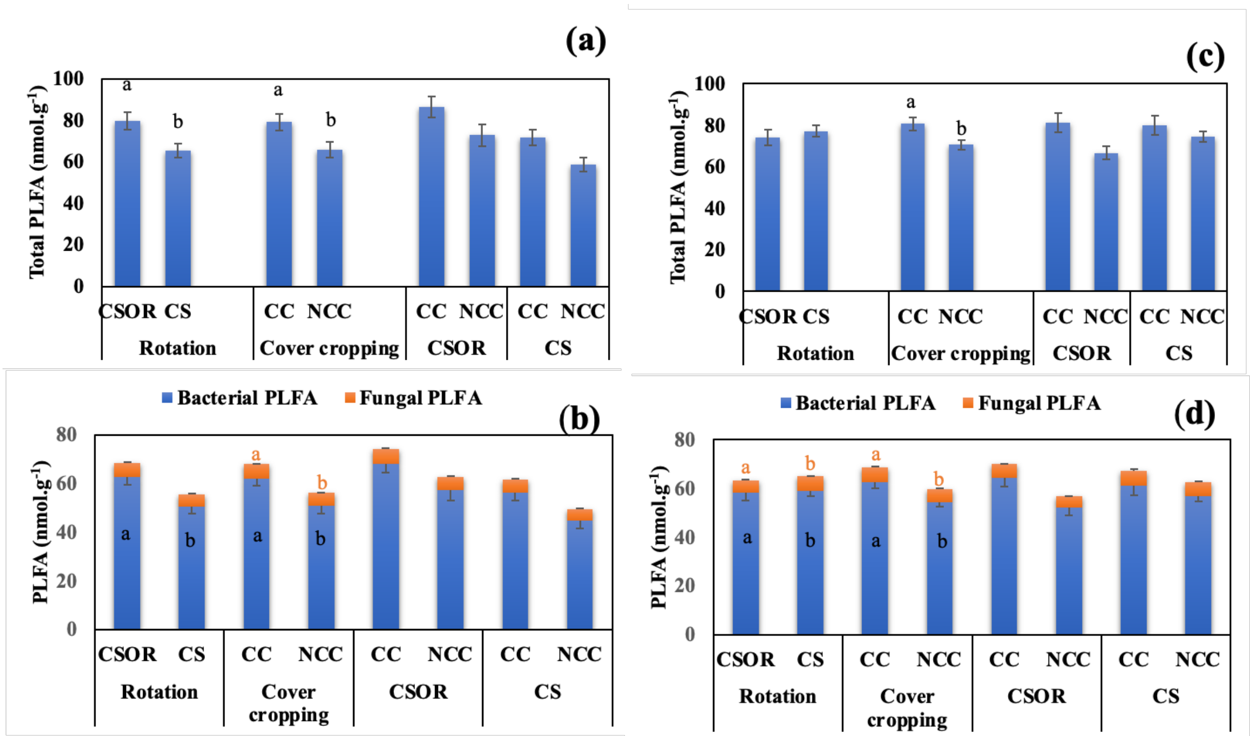

Figure 2: *Total, fungal, and bacterial phospholipid fatty acids (mean± standard error) at 0-7.5 cm depth under corn (a and b) and soybean (c and d). Different letters on a given figure and within a given factor (Rotation, cover cropping, Rotation by Cover cropping) are significantly different at P≤ 0.05, according to Fisher's LSD.*

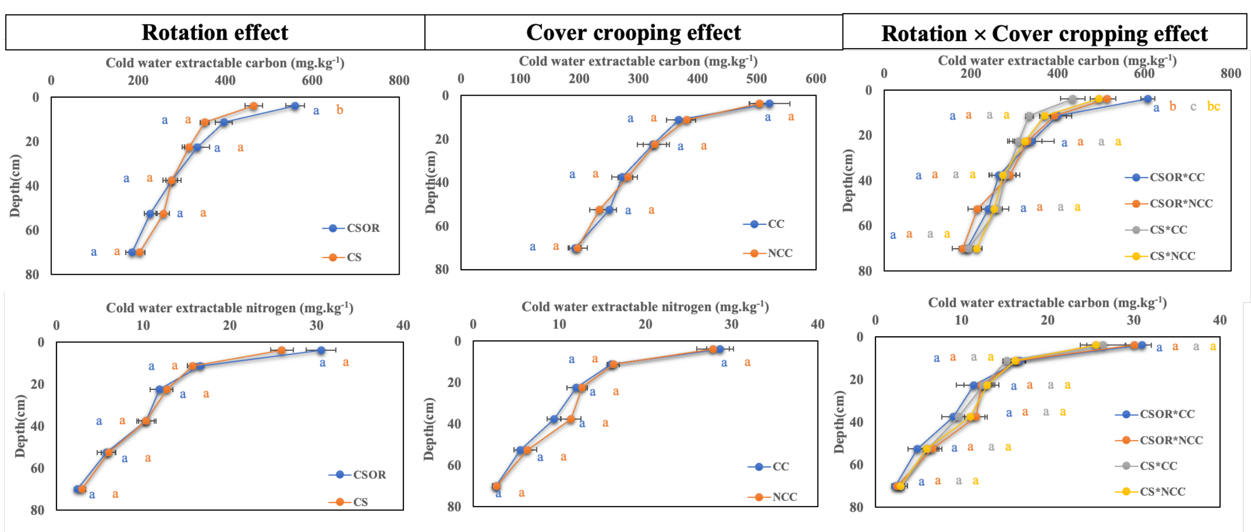

Figure 3*: Cold-water extractable carbon and nitrogen (CWEN) at six different depths under corn phase. different letters within a given depth for a given factor (Rotation, cover cropping, Rotation by Cover cropping) are significantly different at P≤ 0.05, according to Fisher's LSD.*

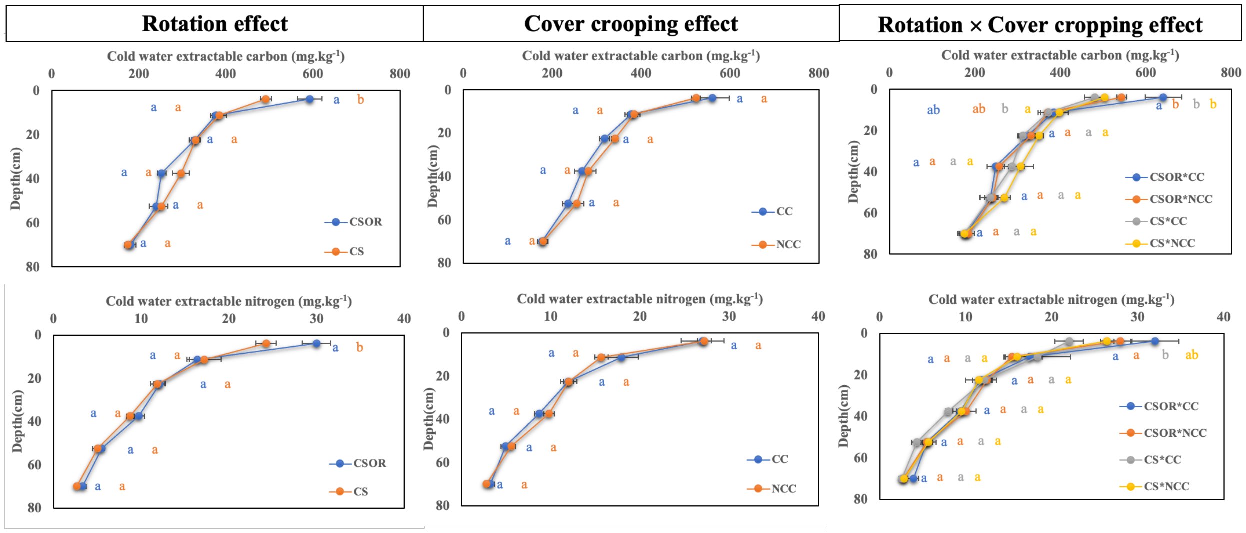

Figure 4: *Cold water extractable carbon and nitrogen (CWEN) at six different depths under soybean phase. different letters within a given depth for a given factor (Rotation, cover cropping, Rotation by Cover cropping) are significantly different at P≤ 0.05, according to Fisher's LSD.*

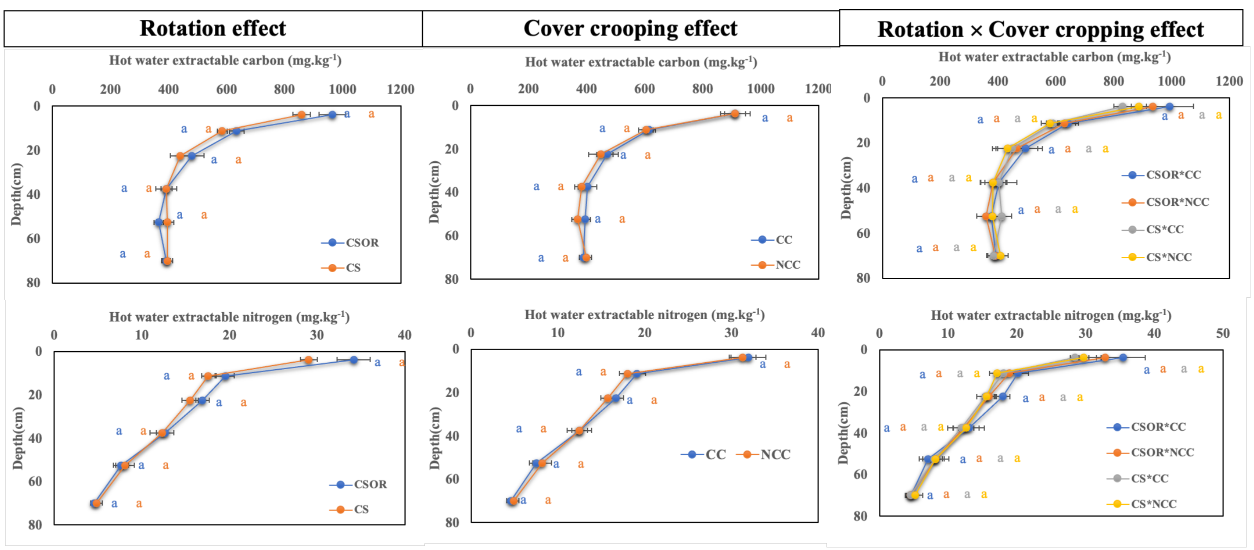

Figure 5*: Hot water extractable carbon and nitrogen (HWECN) at six different depths under corn phase. different letters within a given depth for a given factor (Rotation, cover cropping, Rotation by Cover cropping) are significantly different at P≤ 0.05, according to Fisher's LSD.*

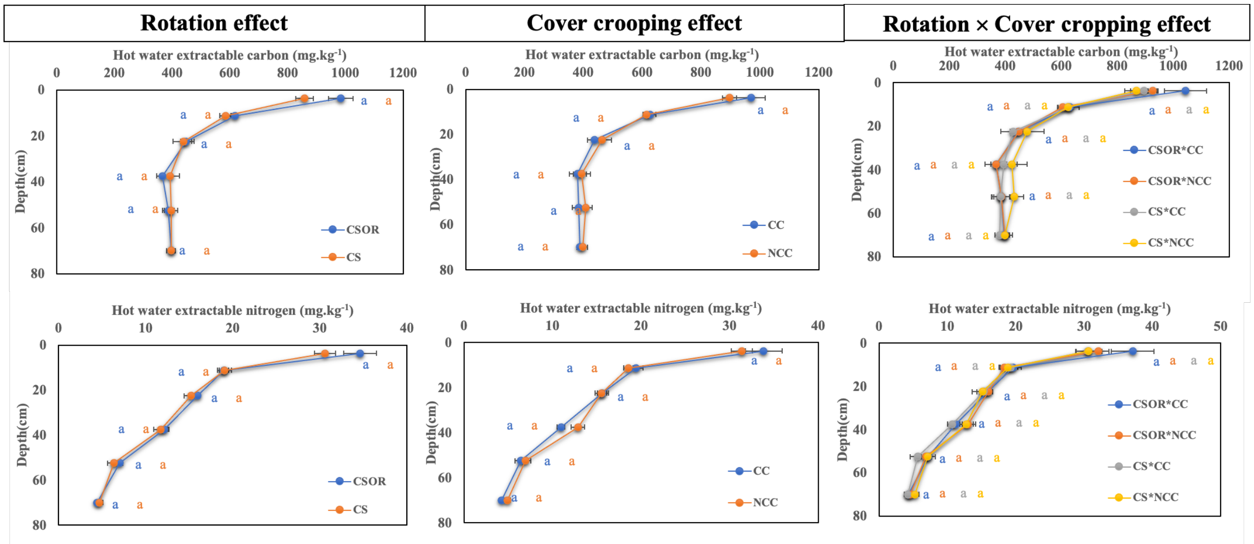

Figure 6: *Hot water extractable carbon and nitrogen (HWECN) at six different depths under corn phase. different letters within a given depth for a given factor (Rotation, cover cropping, Rotation by Cover cropping) are significantly different at P≤ 0.05, according to Fisher's LSD.*

Analysis on soils collected in November 2021 for soil organic carbon content and other soil labile organic carbon fractions has not been completed yet.

Initial processing has been completed for soils collected in May 2022 as well as scanning. However, Processing on the scanned data has started but has not been done yet.

Plan for the year 2023

Data analysis and manuscript writing will be completed in 2023 for the results obtained from Fall 2021 sampling.

Lab analysis on aggregate and carbon stocks and distribution will be completed on soils collected in October/November 2021.

Analysis on deep soil intact cores (0-40 cm) collected in May 2022 for analyzing soil physical properties will be continued and completed this year.

SOUTHEAST RESEARCH FARM ANNUAL REPORT
South Dakota State University
2022 Progress Report
Agricultural Experiment Station
Plant Science Department
South Dakota State University, Brookings, SD 57007
Southeast Research Farm, Beresford, SD 57004

Soil Health Under Cover Crops and Livestock Integration in SD Row Cropping Systems

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PROJECT INTRODUCTION

To improve soil health, wise selection of agroecosystem management is critical. Among different sustainable management strategies, cover cropping is an effective technique to improve soil fertility and quality. Integrating livestock in the cropping system, on the other hand, is also a useful method for enhancing overall ecosystem functions. Soil health management practices like cover cropping, Integrated Crop Livestock System (ICLS) are known to improve the soil carbon. Thus, the objective of this study is to understand the impacts of livestock and cover crop integration on soil health and carbon dynamics.

METHODS

The experiment was conducted in the research site at SDSU Southeast Research Farm, (SERF) Beresford, SD. For soil physical properties analysis, four treatments:

- 1) corn-soybean-oat rotation without cover crop or livestock integration (CNT),
- 2) corn-soybean-oat rotation with cover crops (CC),
- 3) corn-soybean-oat rotation with cover crops as well as livestock integration (ICLS)
- 4) Grazed pasture (GP) was replicated four times.

Intact soil cores were collected in summer of 2018, from four depths (0-10), (10-20), (20-30) and (30-40) cm. Soil X-ray CT scanning was done for determining the soil pore characteristics followed by water retention, bulk density, saturated hydraulic and thermal conductivities for determining hydro-physical properties.

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Treatments for bio-chemical properties included corn-soybean-oat rotation without cover crop or livestock integration (CNT), corn-soybean-oat rotation with cover crops (CC), and corn-soybean-oat rotation with cover crops as well as livestock integration (ICLS). The total of nine treatments (3 treatments*3crop phases) were replicated four times. Two samplings were done, the first one in Oct 2021 and the second in May 2022, from surface depth of 0-10 cm. Some soil bio-chemical parameters like soil moisture, pH, microbial biomass carbon/ nitrogen, water extractable C/N, phospho-lipid fatty acid and POXC were analyzed.

For soil physical properties, only first two depths were analyzed (0-10 and 10-20 cm). At both depths, total porosity was higher in GP than CNT. Similarly, the hydro-physical properties like water retention, saturated hydraulic conductivities were higher in CC and GP treatments than the CNT. CNT treatment showed higher bulk density (BD) and lower thermal conductivity than the rest of the treatments. Our study showed that the cover cropping had higher potential of improving soil hydro-physical properties while GP seems to be outperforming the crop rotation systems in sustaining soil health.

Gravimetric moisture was found significantly higher in October sampling than May sampling whereas no significant difference was observed in soil pH. ICLS and CC did better than CNT in terms of improving soil bio-chemical properties like MBC/N, PLFA, WEC/N and POXC. When the sampling times were compared, most of the soil health parameters were found significantly higher in October than May sampling. Hence, ICLS and CC improved bio-chemical properties and moisture was suggested to be promising in improving soil health.

Progress, Preliminary Findings, and Plan for 2023

Soil-Physics

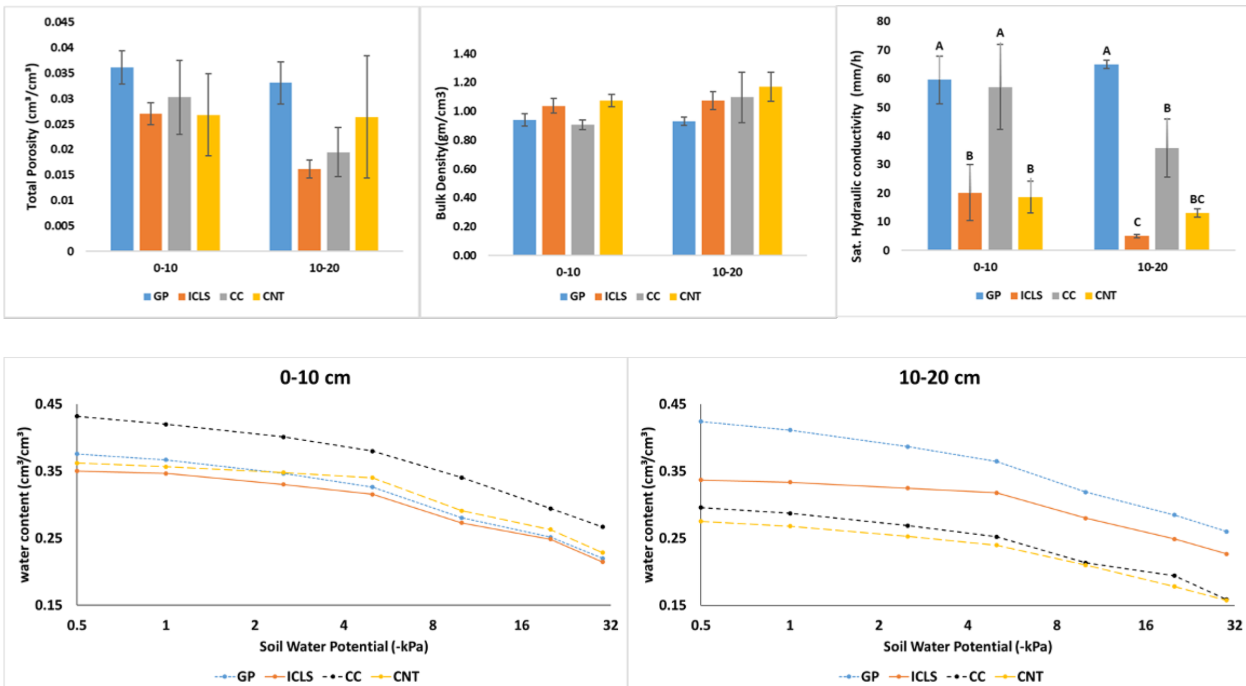

Figure 1. Effect of different treatments GP, ICLS, CC and CNT on soil physical properties

Soil Biochemistry

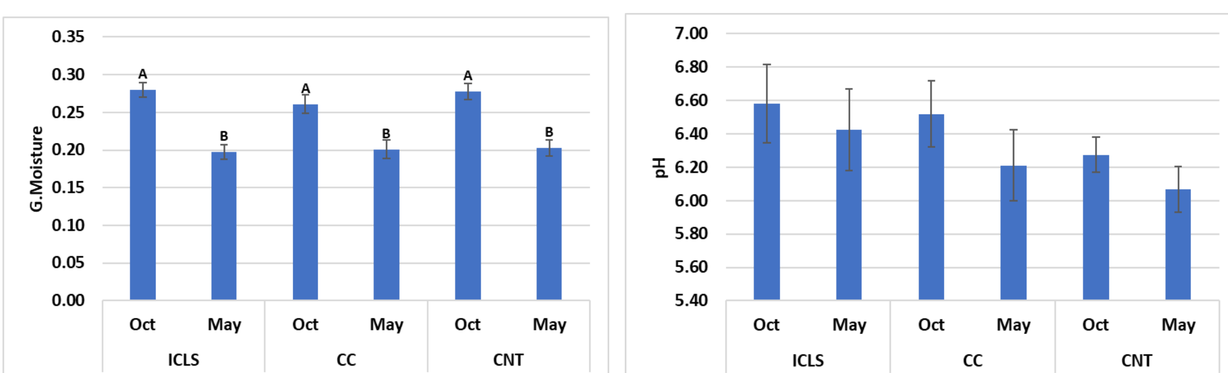

Figure 2. Interaction effect of treatments (Integrated Crop Livestock System (ICLS), cover crops (CC) and rotation (CNT)) and sampling times on gravimetric moisture content and soil pH

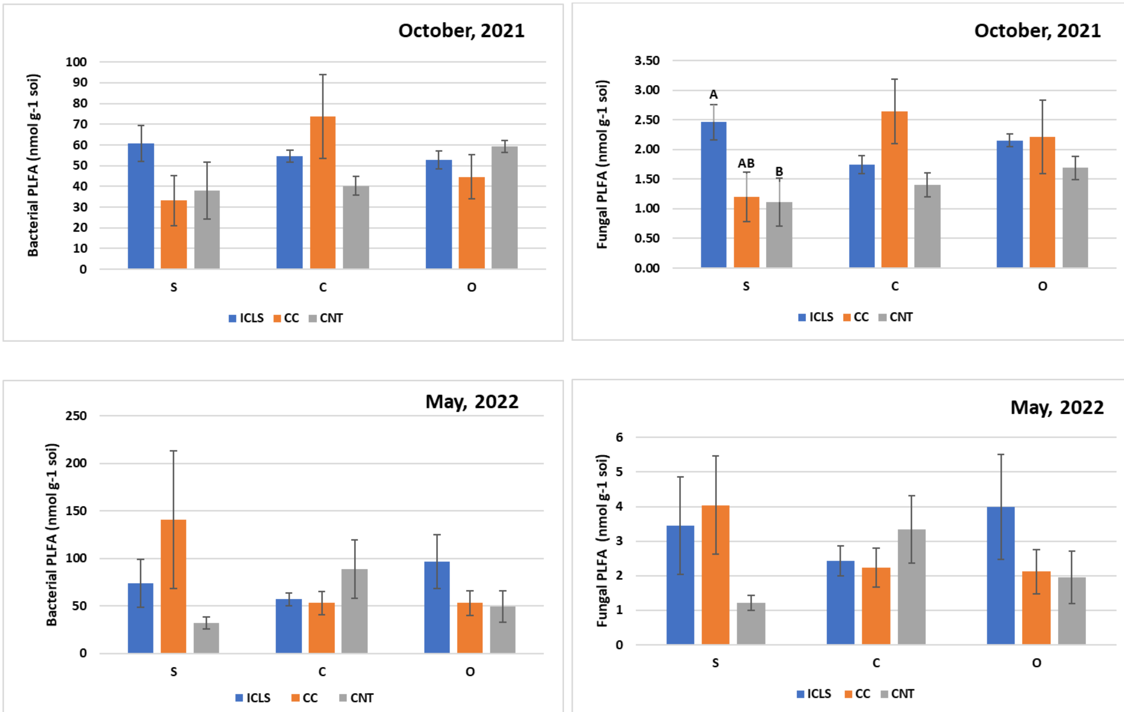

Figure 3. Effect of treatments (Integrated Crop Livestock System (ICLS), cover crops (CC) and rotation (CNT)) on total bacterial PLFA and Fungal PLFA at different crop phases (Soybean (S), Corn (C) and Oat (O)) and sampling times

<u>Plan for 2023</u>

1. The rest of the lab analysis related to physical, chemical, and biological parameters will be carried out along with their statistical analysis.

- **SOIL PHYSICAL ANALYSIS**

➢ Analysis of lower depths soil

➢ Plant Available Water

- **SOIL BIO-CHEMICAL ANALYSIS**

➢ Electrical conductivity

➢ Potentially Mineralizable Nitrogen/Carbon

➢ Wet Aggregate Analysis

➢ Total organic C/N analysis

➢ Sodium Absorption Ratio

2. Writing papers regarding the findings

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

WEED CONTROL DEMONSTRATIONS and EVALUATION TESTS for 2022

Southeast South Dakota Research Center
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 Center. The station is one of the major sites for corn, soybean and sorghum weed control studies. Tests at the station focus on common waterhemp, velvetleaf, marestail, dandelion and foxtail.

2022 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. The year started out with just enough moisture to activate herbicides and germinate crops. The extreme drought during the growing season limited second weed flushes after herbicide application and reduced yields.

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.

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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. Preemergence Treatments in Corn
3. Weed Control with Maverick in Corn
4. Maverick in Corn for Pre Weed Control
5. Trivolt Programs
6. Roundup Ready Soybean Demonstration
7. Dicamba Soybean Demonstration
8. Enlist Soybean Demonstration
9. Liberty Soybean Demonstration
10. LLGT27 Soybean Demonstration
11. Preview 2.1SC Programs in Soybeans
12. Enlist Weed Control Programs in E3 Soybeans
13. Tendovo Crop Tolerance and Efficacy in Conventional Till Soybeans
14. Dicamba Paired Soil Residual
15. Engenia Pre Weed Control in Soybeans
16. Reviton with Tank-Mix Partners for Burndown

ACKNOWLEDGEMENTS

We greatly appreciate the cooperation and assistance provided by the station personnel.

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

Program input and partial support for field programs is also acknowledged.

South Dakota Soybean Research and Promotion Council
Crop Protection Industries

2022
CORN HERBICIDE DEMONSTRATION
Southeast Research Farm

Treatment	Rate/A	6/6/22 Vele	6/6/22 Cowh	6/22/22 Vele	6/22/22 Cowh	7/11/22 Grft	7/11/22 Vele	7/11/22 Cowh	10/20/22 Yield bu/A
Check	---	0	0	0	0	0	0	0	4
Pre									
Balance Flexx + Harness Xtra 6L	4 oz + 1.8 qt	95	98	88	99	97	91	92	39
Pre & Post									
Surestart II + Atrazine & Resicore + Durango DMA + Amsol	2 pt + 1 pt & 1.5 qt + 1 qt + 2.5%	73	97	98	99	99	99	99	66
Bicep Lite II Mag & Halex GT + Aatrex + NIS + AMS	1 qt & 3.6 pt + 1 pt + 0.25% + 1.7 lb	25	90	98	99	98	99	97	69
Calibra & Acuron GT + Aatrex + NIS + AMS	1.4 qt & 3.75 pt + 0.5 pt + 0.25% + 1.7 lb	65	85	98	99	99	99	99	67
Acuron & Acuron + RU Powermax + AMS	1.25 qt & 1.25 qt + 32 oz + 1.7 lb	78	90	97	99	99	99	98	59
Verdict + Atrazine & Status + Zidua SC + Atrazine + RU Powermax + COC + AMS	10 oz + 16 oz & 4 oz + 2.5 oz + 16 oz + 32 oz + 1% + 2.5 lb	78	95	98	99	99	99	98	61
Resicore + Atrazine & Durango DMA + Incinerate + Amsol	2 qt + 1 pt & 1 qt + 3 oz + 2.5%	94	98	99	99	99	99	99	52
Harness & RU Powermax + Atrazine + AMS	1.75 pt & 32 oz + 1 pt + 2.5 lb	44	97	96	99	99	99	96	57
Harness & Impact Core + Impact + Atrazine + MSO + AMS	1.75 pt & 20 oz + 0.75 oz + 1 pt + 0.5% + 2.5 lb	44	97	95	99	96	99	96	56
Harness & Sinate + Atrazine + MSO + AMS	1.75 pt & 28 oz + 1 pt + 1% + 3 lb	48	97	98	99	98	96	97	61
Harness Xtra 6L & Laudis + RU Powermax 3 + Amsol + Superb HC	1.8 qt & 3 oz + 30 oz + 2.5% + 0.5%	48	97	96	99	99	99	98	63
TriVolt + Atrazine & Laudis + Atrazine + RU Pmax 3 + Amsol + Superb HC	12 oz + 1 pt & 3 oz + 1 pt + 30 oz + 2.5% + 0.5%	78	96	98	99	99	99	99	58
Fearless & Katagon + Atrazine + Destiny HC	1.25 pt & 3.2 oz + 1 pt + 1%	29	95	91	98	97	97	94	55
Pre & Epost									
Harness & Shieldex + Atrazine + AMS + COC	1.75 pt & 1.35 oz + 1 qt + 1.7 lb + 1%	45	97	99	99	99	99	99	50
Restraint + Atrazine & Shieldex + Atrazine + AMS + COC	36 oz + 1 qt & 1.35 oz + 1 qt + 1.7 lb + 1%	58	97	99	99	97	99	99	51
Epost									
Harness Max + Atrazine + RU Powermax 3 + Amsol	55 oz + 1 pt + 30 oz + 2.5%	--	--	99	99	99	99	99	59
Anthem Maxx + Callisto + Atrazine + RU Powermax	3 oz + 3 oz + 1 pt + 1 qt	--	--	99	99	99	99	98	56
Armezon Pro + Atrazine + RU Powermax + COC + AMS	18 oz + 16 oz + 32 oz + 1% + 2.5 lb	--	--	99	99	99	99	95	66
LSD (0.05)		8	2	2	0.5	2	2	2	16

2022
CORN HERBICIDE DEMONSTRATION
Southeast Research Farm

RCB: 4 reps
Variety: DKC 51-38 RIB
Planting Date: 5/10/22
Pre: 5/10/22
Epost: 6/8/22 Corn V3, 7-10 in.
Post: 6/15/22 Corn V4-5, 18-20 in; Vele 2-10 in; Cowh 4-11 in.

Precipitation: (inches)
Pre: 1st week 0.44   2nd week 0.07

Soil: Silty Clay; 4.6% OM; 6.8 pH

Vele=Velvetleaf
Cowh=Common waterhemp
Grft=Green foxtail

Comments: The objective of the study was to evaluate program treatments for weed control in corn. Moderate green foxtail, velvetleaf and heavy common waterhemp pressure. Preemergence treatments were activated by 0.44 inches of rainfall the first week after planting with limited precipitation the next two weeks. Some differences in early velvetleaf control noted. Most treatments had excellent season long weed control. Extreme drought severely reduced yield.

2022
PREEMERGENCE TREATMENTS IN CORN
Southeast Research Farm

Treatment	Rate/A	6/6/22 Grft	6/6/22 Vele	6/6/22 Cowh	6/28/22 Grft	6/28/22 Vele	6/28/22 Cowh
Check	---	0	0	0	0	0	0
Pre							
Harness Xtra 6L	2.3 qt	86	63	97	80	46	95
Bicep Lite II Mag	1.5 qt	75	49	96	69	50	92
Zidua SC + Atrazine	5 oz + 1 qt	75	70	96	69	63	92
Outlook + Atrazine	15 oz + 1 qt	83	61	97	78	53	93
Verdict + Atrazine	13 oz + 1 qt	83	79	96	78	81	93
Resicore + Atrazine	2 qt + 1 qt	84	93	97	78	95	96
Surestart II + Atrazine	2 pt + 1 qt	79	73	97	78	53	94
Balance Flexx + Atrazine	4 oz + 1 qt	80	88	97	76	90	94
Balance Flexx + Harness Xtra 6L	4 oz + 1.8 qt	86	88	97	83	91	95
Acuron	2.5 qt	78	88	97	74	91	96
Corvus + Atrazine	4.5 oz + 1 qt	76	89	96	80	90	95
TriVolt + Atrazine	20 oz + 1 qt	85	89	97	85	94	96
Maverick + Atrazine	16 oz + 1 qt	45	81	97	45	91	96
LSD (0.05)		7	6	1	5	6	1

RCB: 4 reps
Variety: DKC 51-38 RIB
Planting Date: 5/10/22
Pre: 5/10/22

Precipitation: (inches)
Pre: 1st week 0.44 2nd week 0.07

Soil: Silty Clay; 4.4% OM; 6.8 pH

Grft=Green foxtail
Vele=Velvetleaf
Cowh=Common waterhemp

Comments: The purpose of the study was to evaluate preemergence corn herbicide treatments for weed control and residual activity. Moderate velvetleaf and common waterhemp and heavy green foxtail pressure. Preemergence treatments were activated by 0.44 inches of rainfall the first week after planting with limited precipitation the next two weeks. There were many differences for green foxtail and velvetleaf control and all treatments had good waterhemp control.

2022
WEED CONTROL WITH MAVERICK IN CORN
Southeast Research Farm

Treatment	Rate/A	5/26/22	6/6/22		6/22/22			7/5/22			10/20/22
		VCRR	Vele	Cowh	Grft	Vele	Cowh	Grft	Vele	Cowh	Yield bu/A
Check	---	0	0	0	0	0	0	0	0	0	7
Epost											
RU Powermax + Induce + AMS	32 oz + 0.25% + 3 lb	0	--	--	99	99	86	95	98	80	42
Acuron + RU Powermax + Induce + AMS	48 oz + 32 oz + 0.25% + 3 lb	0	--	--	99	99	99	98	99	99	59
Halex GT + Induce + AMS	64 oz + 0.25% + 3 lb	0	--	--	99	98	95	98	99	91	65
Armezon Pro + RU Powermax + Induce + AMS	24 oz + 32 oz + 0.25% + 3 lb	0	--	--	99	99	96	98	99	93	69
Resicore + RU Powermax + Induce + AMS	44 oz + 32 oz + 0.25% + 3 lb	0	--	--	99	98	96	98	99	95	62
Maverick + RU Powermax + Induce + AMS	14 oz + 32 oz + 0.25% + 3 lb	0	--	--	99	99	97	98	99	94	64
Maverick + Aatrex + RU Powermax + Induce + AMS	14 oz + 16 oz + 32 oz + 0.25% + 3 lb	0	--	--	99	99	99	99	99	98	75
Pre & Post											
Acuron & Acuron + RU Powermax + Induce + AMS	48 oz & 48 oz + 32 oz + 0.25% + 3 lb	0	87	93	92	98	89	98	99	97	70
Maverick & Maverick + RU Powermax + Induce + AMS	18 oz & 14 oz + 32 oz + 0.25% + 3 lb	0	91	96	94	99	91	98	99	95	63
Maverick + Aatrex & Maverick + Aatrex + RU Powermax + Induce + AMS	18 oz + 16 oz & 14 oz + 16 oz + 32 oz + 0.25% + 3 lb	0	88	94	92	99	95	98	99	97	72
Perpetuo + Aatrex & Maverick + RU Powermax + Induce + AMS	8 oz + 32 oz & 14 oz + 32 oz + 0.25% + 3 lb	0	72	86	96	92	83	98	99	92	63
LSD (0.05)		--	3	3	3	1	4	1	0	6	12

RCB: 4 reps
Variety: DKC 51-38 RIB
Planting Date: 5/10/22
Pre: 5/10/22
Epost: 6/8/22 Corn V3, 7-10 in; Vele 1-5 in; Cowh 1-5 in; Grft 3-5 lf, 1-5 in.
Post: 6/17/22 Corn V5, 23 in.

Precipitation: (inches)
Pre: 1st week 0.44 2nd week 0.07

Soil: Silty Clay; 4.4% OM; 6.8 pH

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

Comments: The objective of the study was to evaluate Maverick programs for weed control in corn. Moderate velvetleaf and heavy green foxtail and common waterhemp pressure. Preemergence treatments were activated by 0.44 inches of rainfall the first week after planting with limited precipitation the next two weeks. All treatments had good foxtail and velvetleaf control. Roundup alone only provided 80% waterhemp control. Extreme drought severely reduced yield.

2022
MAVERICK IN CORN FOR PRE WEED CONTROL
Southeast Research Farm

Treatment	Rate/A	5/26/22 VCRR	6/6/22 Vele	6/6/22 Cowh	6/22/22 Vele	6/22/22 Cowh	7/5/22 Grft	7/5/22 Vele	7/5/22 Cowh	10/20/22 Yield bu/A
Check	---	0	0	0	0	0	0	0	0	4
Post										
RU Powermax 3 + Induce + AMS	21.8 oz + 0.25% + 3 lb	0	--	--	--	--	95	56	33	11
Pre & Post										
Acuron &	3 qt &	0	87	98	93	90	96	99	88	44
RU Powermax 3 + Induce + AMS	21.8 oz + 0.25% + 3 lb									
Bicep Lite II Mag &	1.5 qt &	0	31	97	18	86	94	40	70	33
RU Powermax 3 + Induce + AMS	21.8 oz + 0.25% + 3 lb									
Resicore &	88 oz &	0	92	98	92	97	97	96	92	46
RU Powermax 3 + Induce + AMS	21.8 oz + 0.25% + 3 lb									
Maverick &	1 qt &	0	92	98	91	89	95	94	90	47
RU Powermax 3 + Induce + AMS	21.8 oz + 0.25% + 3 lb									
Maverick + Aatrex &	1 qt + 24 oz &	0	92	98	92	97	97	96	92	52
RU Powermax 3 + Induce + AMS	21.8 oz + 0.25% + 3 lb									
Trivolt &	21 oz &	0	77	98	83	80	95	89	84	40
RU Powermax 3 + Induce + AMS	21.8 oz + 0.25% + 3 lb									
LSD (0.05)		--	4	0.5	3	4	1	9	12	15

RCB: 4 reps
Variety: DKC 51-38 RIB
Planting Date: 5/10/22
Pre: 5/10/22
Post: 6/26/22 Corn 34 in; Vele 3-8 in; Cowh 4-11 in; Grft 4-12 in.

Precipitation: (inches)
Pre: 1st week 0.44   2nd week 0.07

Soil: Silty Clay; 4.4% OM; 6.8 pH

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

Comments: The objective of the study was to evaluate preemergence treatments followed by glyphosate for weed control in corn. Moderate green foxtail, velvetleaf and heavy common waterhemp pressure. Preemergence treatments were activated by 0.44 inches of rainfall the first week after planting with limited precipitation the next two weeks. Three treatments gave greater than 90% preemergence velvetleaf and waterhemp control. Roundup alone only provided 30% waterhemp control. Extreme drought severely reduced yield.

2022
TRIVOLT PROGRAMS
Southeast Research Farm

Treatment	Rate/A	5/26/22 VCRR	6/2/22 Vele	6/2/22 Cowh	6/2/22 VCRR	6/28/22 Grft	6/28/22 Vele	6/28/22 Cowh	7/15/22 Grft	7/15/22 Vele	7/15/22 Cowh
Check	---	0	0	0	0	0	0	0	0	0	0
Pre											
Trivolt + Atrazine	20 oz + 1 qt	0	55	80	0	91	90	87	95	94	90
Acuron	3 qt	0	65	81	0	91	97	95	92	96	90
Resicore + Atrazine	3 qt + 1 qt	0	74	87	0	93	98	96	94	97	95
Pre & Post											
Trivolt + Atrazine & DiFlexx Duo + Atrazine + RU Powermax 3 + Class Act Ridion	12 oz + 1 pt & 24 oz + 1 pt + 30 oz + 1%	0	48	70	0	99	99	98	99	99	97
Trivolt + Atrazine & Laudis + Atrazine + RU Powermax 3 + Amsol	12 oz + 1 pt & 3 oz + 1 pt + 30 oz + 2.5%	0	43	70	0	99	99	98	99	99	97
Trivolt + Atrazine & Capreno + Atrazine + Amsol	12 oz + 1 pt & 3 oz + 1 pt + 2.5%	0	46	70	0	96	99	94	96	99	93
Trivolt + Atrazine & Capreno + Atrazine + RU Powermax 3 + Amsol	12 oz + 1 pt & 3 oz + 1 pt + 30 oz + 2.5%	0	45	69	0	98	99	97	98	99	96
Trivolt + Atrazine & Harness Max + Atrazine + RU Powermax 3 + Amsol	12 oz + 1 pt & 40 oz + 1 pt + 30 oz + 2.5%	0	44	70	0	99	99	98	99	99	98
Harness + Atrazine & Laudis + Atrazine + RU Powermax 3 + Amsol	1.75 pt + 1 pt & 3 oz + 1 pt + 30 oz + 2.5%	0	40	73	0	99	99	99	99	99	97
LSD (0.05)		--	7	2	--	2	1	2	2	2	3

RCB: 4 reps
Variety: DKC 51-38 RIB
Planting Date: 5/10/22
Pre: 5/10/22
Post: 6/15/22 Corn V4-5, 18-20 in; Grft 3-7 in.

Soil: Silty Clay; 4.4% OM; 6.8 pH

Precipitation: (inches)
Pre: 1st week 0.44   2nd week 0.07

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

Comments: The objective of the study was to evaluate Trivolt programs for weed control in corn. Moderate green foxtail, velvetleaf and heavy common waterhemp pressure. Preemergence treatments were activated by 0.44 inches of rainfall the first week after planting with limited precipitation the next two weeks. All pre followed by post programs provided good weed control.

2022
ROUNDUP READY SOYBEAN DEMONSTRATION
Southeast Research Farm

Treatment	Rate/A	6/22/22 Grft	6/22/22 Vele	6/22/22 Cowh	7/11/22 Grft	7/11/22 Vele	7/11/22 Cowh	9/30/22 Grft	9/30/22 Cowh	9/30/22 Vele	10/3/22 Yield bu/A
Check	---	0	0	0	0	0	0	0	0	0	3
PPI & Post											
Treflan + Dimetric 3L & RU Powermax 3 + Amsol + Flexstar	1.5 pt + 10.67 oz & 30 oz + 2 qt + 1 pt	86	87	92	99	97	94	99	89	97	21
Prowl H2O + Dimetric 3L & RU Pmax 3 + Amsol + Avalanche Ultra	3 pt + 10.67 oz & 30 oz + 2 qt + 1.5 pt	86	83	91	99	92	93	99	89	96	22
Pre & Post											
Sonic & Flexstar + Select Max + COC	5 oz & 1 pt + 12 oz + 0.25%	66	89	93	87	90	92	88	87	83	13
Authority MTZ & Avalanche Ultra + Section Three + NIS	14 oz & 1.5 pt + 5.33 oz + 0.25%	55	74	91	75	61	92	73	85	58	9
Authority Supreme & Cobra + Select Max + NIS	8 oz & 12.8 oz + 12 oz + 0.25%	64	85	89	79	73	90	82	83	77	15
Sonic & EverpreX + Durango DMA + Amsol	4.5 oz & 1 pt + 1 qt + 2.5%	58	88	88	99	99	93	99	88	99	21
Broadaxe XC + Dimetric 3L & Flexstar GT + Dual Magnum + AMS + MSO	28 oz + 10 oz & 56 oz + 1 pt + 3.4 lb + 1%	66	81	90	99	93	93	99	93	94	21
Authority MTZ & Anthem Maxx + COC + RU Powermax 3 + AMS	14 oz & 3 oz + 1 pt + 30 oz + 1.7 lb	58	81	88	99	99	93	99	88	99	20
Zidua Pro & RU Powermax 3 + Outlook + Amsol	6 oz & 30 oz + 10 oz + 2 qt	78	89	90	99	97	89	99	82	98	21
Fierce EZ & RU Powermax 3 + Perpetuo + Induce + AMS	6 oz & 30 oz + 6 oz + 0.25% + 3 lb	63	75	86	99	98	90	99	83	99	20
Fierce MTZ & RU Powermax 3 + Perpetuo + Induce + AMS	16 oz & 30 oz + 6 oz + 0.25% + 3 lb	58	53	86	99	98	90	99	83	99	20
Tendovo & Flexstar GT + AMS	2.35 qt & 3.5 pt + 3.4 lb	82	79	93	99	97	93	99	93	99	22
LSD (0.05)		11	12	4	3	7	2	4	5	11	3

RCB: 4 reps
Variety: AG20XF1
Planting Date: 5/18/22
PPI/Pre: 5/18/22
Post: 6/28/22 Soy 4-5 tri, 9-12 in; Grft 5-10 in; Vele 3-9 in; Cowh 3-9 in.

Precipitation: (inches)
Pre: 1st week 0.26 2nd week 0.75

Soil: Clay; 4.3% OM; 7.2 pH

Grft=Green foxtail
Vele=Velvetleaf
Cowh=Common waterhemp

Comments: The objective of the study was to evaluate program treatments for weed control in soybeans. Moderate green foxtail, velvetleaf and heavy common waterhemp pressure. There was enough moisture early in the season for soybean germination and herbicide activation. There were many differences for preemergence green foxtail and velvetleaf control, and many treatments had good waterhemp control. Treatments with poor late season weed control had reduced yields. Extreme drought severely reduced overall yield.

2022
DICAMBA SOYBEAN DEMONSTRATION
Southeast Research Farm

Treatment	Rate/A	6/22/22 Grft	6/22/22 Vele	6/22/22 Cowh	7/11/22 Grft	7/11/22 Vele	7/11/22 Cowh	9/30/22 Grft	9/30/22 Cowh	9/30/22 Vele	10/3/22 Yield bu/A
Check	---	0	0	0	0	0	0	0	0	0	3
Pre & Post											
Broadaxe XC + Tricor DF & RU Powermax + Volt Edge + Class Act Ridion + OnTarget	28 oz + 5 oz & 56.5 oz + 27 oz + 26 oz + 0.5% + 0.5%	76	76	86	98	99	93	98	94	99	23
Tavium + Tricor DF + Volt Edge + OnTarget & Flexstar GT + Dual Magnum + MSO + AMS	56.5 oz + 5 oz + 26 oz + 0.5% & 3.5 pt + 1 pt + 0.5% + 1.7 lb	86	94	93	99	99	95	99	95	98	21
Boundary & RU Powermax + Tavium + Volt Edge + Class Act Ridion + OnTarget	2 pt & 27 oz + 56.5 oz + 26 oz + 0.5% + 0.5%	55	41	86	99	99	91	97	94	99	21
Tendovo & Tavium + RU Powermax + Volt Edge + Class Act Ridion + OnTarget	1.75 pt & 56.5 oz + 27 oz + 26 oz + 0.5% + 0.5%	60	87	88	98	97	92	97	93	99	22
Engenia + Pursuit + Zidua SC + Sentris & Liberty + RU Pmax 3 + Outlook + AMS	12.8 oz + 3 oz + 3.25 oz + 8 oz & 32 oz + 30 oz + 10 oz + 3 lb	91	96	95	99	99	97	99	97	99	25
Engenia + Sharpen + Zidua SC + Sentris & Engenia + RU Powermax 3 + Outlook + Sentris + Class Act Ridion + OnTarget	12.8 oz + 1 oz + 3.25 oz + 8 oz & 12.8 oz + 30 oz + 10 oz + 8 oz + 0.5% + 0.5%	87	93	95	99	99	97	99	98	99	23
Fierce EZ & RU Pmax 3 + Xtendimax + Perpetuo + Intact + Induce + Volt Edge	6 oz & 30 oz + 22 oz + 6 oz + 0.5% + 0.25% + 26 oz	35	50	87	99	99	95	97	93	98	17
Fierce MTZ & RU Pmax 3 + Xtendimax + Perpetuo + Intact + Induce + Volt Edge	1 pt & 30 oz + 22 oz + 6 oz + 0.5% + 0.25% + 26 oz	38	59	85	99	98	92	98	92	98	17
Warrant + Mauler & Liberty + Xtendimax + Volt Edge + Intact + Class Act Ridion	48 oz + 8 oz & 32 oz + 22 oz + 26 oz + 0.5% + 1%	55	58	90	97	97	96	75	95	96	20
Warrant + Mauler & RU Powermax 3 + Xtendimax + Volt Edge + Intact + Class Act Ridion	48 oz + 8 oz & 30 oz + 22 oz + 26 oz + 0.5% + 1%	58	58	86	99	98	94	98	94	99	25
LSD (0.05)		13	9	4	1	1	3	3	2	2	5

2022
DICAMBA SOYBEAN DEMONSTRATION
Southeast Research Farm

RCB: 4 reps
Variety: AG20XF1
Planting Date: 5/18/22
Pre: 5/18/22
Post: 6/28/22 Soy 4-5 tri, 9-12 in; Grft 5-10 in; Vele 3-9 in; Cowh 3-9 in.

Precipitation: (inches)
Pre: 1st week 0.26 2nd week 0.75

Soil: Clay; 4.3% OM; 7.2 pH

Grft=Green foxtail
Vele=Velvetleaf
Cowh=Common waterhemp

Comments: The objective of the study was to evaluate combination treatments with dicamba for weed control in XtendFlex soybeans. Moderate green foxtail, velvetleaf and heavy common waterhemp pressure. There was enough moisture early in the season for soybean germination and herbicide activation. There were some differences for early evaluations of preemergence weed control. Most treatments had good weed control after the follow up postemergence application. Extreme drought severely reduced yield.

2022
ENLIST SOYBEAN DEMONSTRATION
Southeast Research Farm

		6/22/22			7/11/22			9/30/22			10/3/22
Treatment	**Rate/A**	**Grft**	**Vele**	**Cowh**	**Grft**	**Vele**	**Cowh**	**Grft**	**Cowh**	**Vele**	**Yield bu/A**
Check	---	0	0	0	0	0	0	0	0	0	2
Pre & Post											
Sonic & Enlist One + Durango DMA + Amsol	5 oz & 32 oz + 32 oz + 2.5%	69	91	91	99	99	98	99	99	99	23
Sonic & Enlist One + Liberty + Amsol	5 oz & 2 pt + 2 pt + 2.5%	73	92	90	99	99	98	96	98	98	24
Verdict + Outlook & Liberty + Enlist One + Zidua SC + AMS	5 oz + 8 oz & 32 oz + 32 oz + 2.5 oz + 3 lb	50	75	89	98	97	98	94	98	98	23
Fierce EZ & Enlist One + RU Powermax 3 + Perpetuo + AMS + Induce	6 oz & 1 pt + 30 oz + 6 oz + 1.5 lb + 0.25%	30	53	83	99	98	95	98	92	99	19
Fierce EZ + Firstrate & Enlist One + RU Powermax 3 + Perpetuo + AMS + Induce	6 oz + 0.6 oz & 1 pt + 30 oz + 6 oz + 1.5 lb + 0.25%	38	86	82	99	98	97	99	98	99	24
LSD (0.05)		6	7	6	1	3	2	2	3	3	3

RCB: 4 reps
Variety: Impact NK S20-E3
Planting Date: 5/18/22
Pre: 5/18/22
Post: 6/26/22 Soy 5-6 tri, 7-11 in; Grft 4-7 in; Vele 3-7 in; Cowh 3-10 in.

Precipitation: (inches)
Pre: 1st week 0.26 2nd week 0.75

Soil: Clay; 4.3% OM; 7.0 pH

Grft=Green foxtail
Vele=Velvetleaf
Cowh=Common waterhemp

Comments: The objective of the study was to evaluate combination treatments with Enlist for weed control in Enlist E3 soybeans. Moderate green foxtail, velvetleaf and heavy common waterhemp pressure. There was enough moisture early in the season for soybean germination and herbicide activation. Several treatments provided good early season velvetleaf and waterhemp control. All treatments had good weed control after the follow up postemergence application. Extreme drought severely reduced yield.

2022
LIBERTY SOYBEAN DEMONSTRATION
Southeast Research Farm

		6/22/22			7/11/22			9/30/22				10/3/22
Treatment	**Rate/A**	**Grft**	**Vele**	**Cowh**	**Grft**	**Vele**	**Cowh**	**Grft**	**Vele**	**Cowh**	**Colq**	**Yield bu/A**
Check	---	0	0	0	0	0	0	0	0	0	0	1
Pre & Post												
Authority MTZ & Cheetah + AMS	14 oz & 32 oz + 3 lb	53	58	91	98	80	93	91	61	92	92	17
Dimetric Charged & Total SL + AMS	15 oz & 32 oz + 1.5 lb	58	68	88	97	81	89	94	58	82	83	18
Moccasin MTZ & Interline + AMS	3.56 pt & 32 oz + 3 lb	69	69	93	98	83	92	96	70	87	86	18
Fierce EZ & Liberty + Perpetuo + Select Max + Induce + AMS	6 oz & 32 oz + 6 oz + 9 oz + 0.25% + 3 lb	45	48	74	98	88	91	94	63	81	78	21
Fierce EZ + Firstrate & Liberty + Perpetuo + Select Max + Induce + AMS	6 oz + 0.6 oz & 32 oz + 6 oz + 9 oz + 0.25% + 3 lb	70	93	87	98	98	95	97	98	91	90	22
Zidua Pro & Liberty + RU Powermax 3 + Outlook + AMS	4.5 oz & 32 oz + 30 oz + 10 oz + 3 lb	81	94	89	99	97	93	99	98	87	97	24
LSD (0.05)		7	10	5	1	4	3	2	12	7	6	5

RCB: 4 reps
Variety: NK S20-E3
Planting Date: 5/18/22
Pre: 5/18/22
Post: 6/26/22 Soy 5-6 tri, 7-11 in; Grft 4-7 in; Vele 3-7 in; Cowh 3-10 in.

Precipitation: (inches)
Pre: 1st week 0.26   2nd week 0.75

Soil: Clay; 4.3% OM; 7.0 pH

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

Comments: The objective of the study was to evaluate combination treatments with Liberty for weed control in Enlist E3 soybeans. Moderate green foxtail, velvetleaf and heavy common waterhemp pressure. There was enough moisture early in the season for soybean germination and herbicide activation. There were differences for early season preemergence weed control. Only a few treatments had good late season weed control. Extreme drought severely reduced yield.

2022
LLGT27 SOYBEAN DEMONSTRATION
Southeast Research Farm

		6/22/22			7/11/22			9/30/22		10/3/22
Treatment	**Rate/A**	**Grft**	**Vele**	**Cowh**	**Grft**	**Vele**	**Cowh**	**Grft**	**Cowh**	**Yield bu/A**
Check	---	0	0	0	0	0	0	0	0	2
Epost										
RU Powermax + AMS	30 oz + 1.7 lb	99	99	93	99	99	77	92	48	15
Liberty + AMS	32 oz + 1.7 lb	98	99	99	96	97	90	88	84	15
Liberty + RU Powermax 3 + AMS	32 oz + 30 oz + 1.7 lb	99	99	97	99	99	91	90	79	19
Pre & Post										
Alite 27 + Dimetric 3L & RU Powermax 3 + AMS	3 oz + 10.67 oz & 30 oz + 1.7 lb	94	96	95	99	99	94	99	92	19
Alite 27 + Dimetric 3L & Liberty + AMS	3 oz + 10.67 oz & 32 oz + 1.7 lb	93	96	97	98	95	96	99	95	22
Alite 27 + Outlook & Liberty + AMS	3 oz + 10 oz & 32 oz + 1.7 lb	94	95	98	99	97	97	99	96	21
Alite 27 + Zidua SC & Liberty + RU Powermax 3 + Outlook + AMS	2 oz + 2.5 oz & 32 oz + 30 oz + 10 oz + 3 lb	92	98	94	99	99	95	99	92	19
LSD (0.05)		2	2	2	1	2	3	5	4	4

RCB: 4 reps
Variety: NK S20-LLGT27
Planting Date: 5/18/22
Pre: 5/18/22
Epost: 6/15/22 Soy 1-2 tri, 3-5 in; Grft 2-7 in; Vele 0.5-2 in; Cowh 0.5-2 in.
Post: 6/26/22 Soy 5-6 tri, 7-11 in; Grft 4-7 in; Vele 3-7 in; Cowh 3-10 in.

Precipitation: (inches)
Pre: 1st week 0.26 2nd week 0.75

Soil: Clay; 4.3% OM; 7.0 pH

Grft=Green foxtail
Vele=Velvetleaf
Cowh=Common waterhemp

Comments: The objective of the study was to evaluate combination treatments with Alite 27 for weed control in LLGT27 soybeans. Moderate green foxtail, velvetleaf and heavy common waterhemp pressure. There was enough moisture early in the season for soybean germination and herbicide activation. Alite 27 combinations provided good preemergence weed control. Poor weed control with Liberty or Roundup alone significantly reduced yield. Extreme drought severely reduced overall yield.

2022
TENDOVO CROP TOLERANCE AND EFFICACY IN CONVENTIONAL TILL SOYBEANS
Southeast Research Farm

Treatment	Rate/A	6/15/22 Grft	6/15/22 Vele	6/15/22 Cowh	6/28/22 Grft	6/28/22 Vele	6/28/22 Cowh	7/19/22 Grft	7/19/22 Cowh	7/19/22 Vele	10/3/22 Yield bu/A
Check	---	0	0	0	0	0	0	0	0	0	3
Pre & Post											
Tendovo & Tavium + RU Powermax 3 + Volt-Edge + Intact + Class Act Ridion	2.1 qt & 3.53 pt + 30 oz + 20 oz + 0.5% + 1%	91	97	97	85	92	87	98	96	98	27
Tendovo & Tavium + RU Powermax 3 + Volt-Edge + Intact + Class Act Ridion	2.35 qt & 3.53 pt + 30 oz + 20 oz + 0.5% + 1%	90	98	98	87	94	90	98	97	98	26
Boundary & Tavium + RU Powermax 3 + Volt-Edge + Intact + Class Act Ridion	2.4 pt & 3.53 pt + 30 oz + 20 oz + 0.5% + 1%	87	97	96	77	76	86	98	96	97	26
Broadaxe XC & Tavium + RU Powermax 3 + Volt-Edge + Intact + Class Act Ridion	32 oz & 3.53 pt + 30 oz + 20 oz + 0.5% + 1%	88	94	97	85	76	93	98	97	98	24
Sonic & Tavium + RU Powermax 3 + Volt-Edge + Intact + Class Act Ridion	8 oz & 3.53 pt + 30 oz + 20 oz + 0.5% + 1%	87	97	97	84	94	92	98	98	98	22
Fierce MTZ & Tavium + RU Powermax 3 + Volt-Edge + Intact + Class Act Ridion	1.5 pt & 3.53 pt + 30 oz + 20 oz + 0.5% + 1%	58	95	97	57	88	88	98	96	99	18
Zidua Pro & Tavium + RU Powermax 3 + Volt-Edge + Intact + Class Act Ridion	6 oz & 3.53 pt + 30 oz + 20 oz + 0.5% + 1%	93	98	97	90	91	88	98	96	99	23
Authority Edge & Tavium + RU Powermax 3 + Volt-Edge + Intact + Class Act Ridion	11 oz & 3.53 pt + 30 oz + 20 oz + 0.5% + 1%	86	97	98	81	88	89	98	98	99	20
LSD (0.05)		6	2	2	8	7	3	1	2	2	5

RCB: 4 reps
Variety: AG 20XF1
Planting Date: 5/18/22
Pre: 5/18/22
Post: 6/28/22 Soy 4-5 tri, 9-12 in; Grft 5-10 in; Vele 3-9 in; Cowh 3-9 in.

Precipitation: (inches)
Pre: 1st week 0.26 2nd week 0.75

Soil: Clay; 4.3% OM; 7.2 pH

Grft=Green foxtail
Vele=Velvetleaf
Cowh=Common waterhemp

Comments: The objective of the study was to evaluate several preemergence treatments followed by Tavium and glyphosate for weed control in soybeans. Moderate green foxtail, velvetleaf and heavy common waterhemp pressure. There was enough moisture early in the season for soybean germination and herbicide activation. Many treatments provided good early season preemergence weed control and had excellent control after the post application. Extreme drought severely reduced yield.

2022
PREVIEW 2.1SC PROGRAMS IN SOYBEANS
Southeast Research Farm

		6/22/22			7/11/22			7/27/22			10/3/22
Treatment	**Rate/A**	**Grft**	**Vele**	**Cowh**	**Grft**	**Vele**	**Cowh**	**Grft**	**Cowh**	**Vele**	**Yield bu/A**
Check	---	0	0	0	0	0	0	0	0	0	5
Pre & Epost											
Preview 2.1SC & Interline + Amsol	21 oz & 32 oz + 5%	91	84	93	98	94	97	98	97	92	28
Preview 2.1SC + Moccasin & Interline + Amsol	21 oz + 1.25 pt & 32 oz + 5%	91	81	93	99	92	97	98	97	88	26
Preview 2.1SC & Intermoc + Amsol	21 oz & 64 oz + 5%	90	78	91	99	81	95	98	97	71	21
Preview 2.1SC + Moccasin & Intermoc + Amsol	21 oz + 1.25 pt & 64 oz + 5%	90	86	93	99	87	96	98	98	71	25
Preview 2.1SC + Firstrate & Intermoc + Amsol	21 oz + 0.6 oz & 64 oz + 5%	93	91	94	98	96	98	98	96	93	30
Tripzin ZC & Intermoc + Amsol	43 oz & 64 oz + 5%	87	78	94	98	88	96	98	97	75	23
Moccasin MTZ & Intermoc + Amsol	42 oz & 64 oz + 5%	89	76	93	99	82	96	98	97	76	23
Zidua Pro & Dual Magnum + Liberty + Amsol	6 oz & 1.33 pt + 29 oz + 5%	93	93	90	99	97	97	97	98	95	29
Boundary & Dual Magnum + Liberty + Amsol	32 oz & 1.33 pt + 29 oz + 5%	90	60	95	99	90	96	98	98	81	27
LSD (0.05)		2	10	2	1	8	2	1	2	11	4

RCB: 4 reps
Variety: NK S20-E3
Planting Date: 5/20/22
Pre: 5/22/22
Epost: 6/26/22 Soy 3 tri, 6-8 in; Grft 5-10 in; Vele 3-6 in; Cowh 2-9 in.

Precipitation: (inches)
Pre: 1st week 0.29 2nd week 0.89

Soil: Silty Clay Loam; 4.5% OM; 6.6 pH

Grft=Green foxtail
Vele=Velvetleaf
Cowh=Common waterhemp

Comments: The objective of the study was to evaluate several preemergence treatments followed by glufosinate for weed control in soybeans. Moderate green foxtail, waterhemp and heavy velvetleaf weed pressure. There was enough moisture early in the season for soybean germination and herbicide activation. All treatments had good late season control of green foxtail and common waterhemp. Poor velvetleaf control in some treatments reduced yield. Extreme drought severely reduced overall yield.

2022
ENLIST WEED CONTROL PROGRAMS IN E3 SOYBEANS
Southeast Research Farm

Treatment	Rate/A	7/5/22			7/11/22			7/19/22		
		Grft	Vele	Cowh	Grft	Vele	Cowh	Grft	Vele	Cowh
Pre & Epost										
Kyber & Enlist One + Liberty + EverpreX + Amsol	1 pt & 2 pt + 2 pt + 1 pt + 2.5%	96	89	95	98	92	98	98	88	98
Kyber & Enlist One + Durango DMA + EverpreX + Amsol	1 pt & 2 pt + 32 oz + 1 pt + 2.5%	97	93	95	98	99	96	99	98	96
Kyber & Durango DMA + Liberty + EverpreX + Amsol	1 pt & 32 oz + 2 pt + 1 pt + 2.5%	98	88	96	98	88	93	99	86	86
Pre & Epost & Post										
Kyber & Enlist One + Liberty + EverpreX + Amsol & Enlist One + Liberty + Amsol	1 pt & 2 pt + 2 pt + 1 pt + 2.5% & 2 pt + 2 pt + 2.5%	97	89	96	98	92	98	99	99	99
Kyber & Enlist One + Durango DMA + EverpreX + Amsol & Enlist One + Liberty + Amsol	1 pt & 2 pt + 32 oz + 1 pt + 2.5% & 2 pt + 2 pt + 2.5%	97	95	96	98	99	94	99	99	99
Kyber & Enlist One + Liberty + EverpreX + Amsol & Enlist One + Durango DMA + Amsol	1 pt & 2 pt + 2 pt + 1 pt + 2.5% & 2 pt + 32 oz + 2.5%	95	90	97	99	93	98	99	99	99
Check	---	0	0	0	0	0	0	0	0	0
LSD (0.05)		1	4	1	0.5	4	3	0.5	3	2

RCB: 4 reps
Variety: Hoegemeyer 2123E
Planting Date: 5/20/22
Pre: 5/22/22
Epost: 6/26/22 Soy 3 tri, 6-8 in; Grft 5-10 in; Vele 3-6 in; Cowh 2-9 in.
Post: 7/12/22 Soy 14-16 in, bloom; Grft 6-8 in; Vele 6-8 in; Cowh 4-6 in.

Precipitation: (inches)
Pre: 1st week 0.29   2nd week 0.89

Soil: Silty Clay Loam; 4.5% OM; 6.6 pH

Grft=Green foxtail
Vele=Velvetleaf
Cowh=Common waterhemp

Comments: The objective of the study was to evaluate Kyber preemergence followed by combination post treatments for weed control in Enlist E3 soybeans. Moderate green foxtail, waterhemp and velvetleaf weed pressure. There was enough moisture early in the season for soybean germination and herbicide activation. Most treatments provided good late season weed control.

2022
DICAMBA PAIRED SOIL RESIDUAL
Southeast Research Farm

Treatment	Rate/A	6/2/22 VCRR	6/6/22 VCRR Stunt	6/22/22 Grft	6/22/22 Vele	6/22/22 Cowh
Check	---	0	0	0	0	0
Pre						
Warrant + Mauler	48 oz + 8 oz	0	0	65	45	88
Warrant	48 oz	0	0	66	20	89
Warrant Ultra	50 oz	0	0	81	20	92
Fierce EZ	6 oz	0	20	45	63	83
Valor EZ	2 oz	0	16	48	71	78
Authority MTZ	10 oz	0	0	63	83	90
Warrant + Mauler + Xtendimax + Vaporgrip	48 oz + 8 oz + 22 oz + 20 oz	0	0	91	91	94
Warrant + Xtendimax + Vaporgrip	48 oz + 22 oz + 20 oz	0	0	89	92	95
Warrant Ultra + Intact + Xtendimax + Vaporgrip	50 oz + 0.5% + 22 oz + 20 oz	0	0	91	92	96
Fierce EZ + Xtendimax + Vaporgrip + Intact	6 oz + 22 oz + 20 oz + 0.5%	0	20	93	95	92
Valor EZ + Xtendimax + Vaporgrip	2 oz + 22 oz + 20 oz	0	14	90	94	92
Authority MTZ + Xtendimax + Vaporgrip	10 oz + 22 oz + 20 oz	0	0	85	93	95
Xtendimax + Vaporgrip	22 oz + 20 oz	0	0	53	83	91
LSD (0.05)		--	3	8	8	4

RCB: 4 reps
Variety: AG 20XF1
Planting Date: 5/18/22
Pre: 5/18/22

Precipitation: (inches)
Pre: 1st week 0.26 2nd week 0.75

Soil: Clay; 4.5% OM; 6.7 pH

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

Comments: The objective of the study was to evaluate several preemergence treatments alone and tankmixed with Xtendimax for weed control in soybeans. Moderate green foxtail, velvetleaf and heavy common waterhemp pressure. There was enough moisture early in the season for soybean germination and herbicide activation. The addition Xtendimax preemergence significantly increased weed control. Velvetleaf had the greatest increase in control.

2022
ENGENIA PRE WEED CONTROL IN SOYBEANS
Southeast Research Farm

		6/15/22			6/28/22		
Treatment	**Rate/A**	**Grft**	**Vele**	**Cowh**	**Grft**	**Vele**	**Cowh**
Check	---	0	0	0	0	0	0
Pre							
Engenia + Sentris	12.8 oz + 8 oz	76	90	94	56	80	80
Zidua SC	3.25 oz	45	63	48	48	43	43
Engenia + Zidua SC + Sentris	12.8 oz + 3.25 oz + 8 oz	91	97	98	79	85	88
Zidua Pro	6 oz	84	90	94	77	80	71
Engenia + Zidua Pro + Sentris	12.8 oz + 6 oz + 8 oz	90	98	97	87	90	89
Authority Edge	8 oz	63	85	86	51	63	65
Engenia + Authority Edge + Sentris	12.8 oz + 8 oz + 8 oz	88	94	98	82	89	91
Engenia Prime	16 oz	88	98	98	86	90	89
LSD (0.05)		9	4	9	8	6	10

RCB: 4 reps
Variety: AG 20XF1
Planting Date: 5/18/22
Pre: 5/18/22

Precipitation: (inches)
Pre: 1st week 0.26 2nd week 0.75

Soil: Clay; 4.3% OM; 7.2 pH

Grft=Green foxtail
Vele=Velvetleaf
Cowh=Common waterhemp

Comments: The objective of the study was to evaluate some preemergence treatments alone and tankmixed with Engenia for weed control in soybeans. Moderate green foxtail, velvetleaf and heavy common waterhemp pressure. There was enough moisture early in the season for soybean germination and herbicide activation. The addition Engenia preemergence significantly increased weed control. Engenia alone had good activity on velvetleaf and waterhemp.

2022
REVITON TANK-MIX PARTNERS FOR BURNDOWN
Southeast Research Farm

Treatment	Rate/A	6/2/22 Dali	6/2/22 Prle	6/6/22 Dali	6/6/22 Prle	6/15/22 Dali	6/15/22 Prle
Check	---	0	0	0	0	0	0
Burndn							
Reviton + Destiny HC	2 oz + 1%	91	96	67	97	57	90
Reviton + RU Powermax + AMS + Destiny HC	1 oz + 22 oz + 1.7 lb + 1%	96	99	97	99	98	98
Reviton + Liberty + AMS + Destiny HC	1 oz + 32 oz + 1.7 lb + 1%	95	99	96	99	89	99
Reviton + RU Pmax + Rancor + AMS + Destiny HC	2 oz + 22 oz + 1 pt + 1.7 lb + 1%	96	99	94	99	96	99
Reviton + Arrow + AMS + Destiny HC	2 oz + 6 oz + 1.7 lb + 1%	95	99	88	99	77	82
Reviton + Lo-Vol 4 2,4-D + AMS + Destiny HC	1 oz + 1 pt + 1.7 lb + 1%	96	99	97	99	95	99
Reviton + RU Powermax + Lo-Vol 4 2,4-D + AMS + Destiny HC	1 oz + 22 oz + 1 pt + 1.7 lb + 1%	96	99	95	99	90	99
Reviton + RU Powermax + Helmet + Rancor + AMS + Destiny HC	1 oz + 22 oz + 1.82 pt + 13.5 oz + 1.7 lb + 1%	96	99	93	99	82	98
LSD (0.05)		1	1	5	1	7	2

RCB: 3 reps
Variety: AG 20XF1
Planting Date: 6/2/22
Burndn: 5/27/22 Dali 6-12 in; Prle 5-8 in rosette

Soil: Clay; 3.0% OM; 7.8 pH

Precipitation: (inches)
Burndn: 1st week 0.73 2nd week 0.38

Dali=Dandelion
Prle=Prickly lettuce

Comments: The objective of the study was to evaluate combination treatments with Reviton for burndown weed control in no-till soybeans. Several treatments provided good control of dandelion and prickly lettuce.

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Southeast Research Farm, Beresford, SD 57004

Evaluating Corn Silage Quality Losses by Chop Length and Packing Density

Sara Bauder*, Kiernan Brandt, Ben Beckman, Dr. Warren Rusche

Over 500,000 acres of corn silage were harvested in South Dakota during 2021 yielding 6,000,000 tons total, making the state one of the top producers of the feedstuff in the nation. Our neighbors in Nebraska harvested 260,000 acres of corn silage yielding a total of 5,070,000 tons total in 2021, a smaller, yet very significant amount. With so many producers using corn silage as a main feedstuff in grower livestock diets and for breeding stock, it's important that we continue to evaluate maximizing yields as well as best cutting, packing, and storage processes.

The objectives of this study were to 1) evaluate corn silage quality and losses based upon 3 different common chop lengths, 2) evaluate corn silage quality and losses based upon three different packing densities, 3) evaluate the interaction between packing density and chop length as it relates to corn silage quality and losses. This project is specifically designed to provide data that is applicable to farmers in South Dakota and Nebraska that will assist with improving quality and quantity at feeding time.

METHODS

The silage for this project was cut and packed on August 25 and 26, 2021 at the Southeast Research farm near Beresford, SD. After running a microwave test, average dry matter was 39% (61% moisture) was found. Each chop length was cut separately and covered until all five replications involving that length were completed. Then, the next chop length treatment was cut and covered, and so on. Chop length was changed using sprocket adjustments on the silage chopper until the acceptable chop length was achieved for each treatment. Chop length and density treatments can be viewed in Table 1.

In order to make the project feasible, mini silos were used to simulate bunker silos or silage piles. The silos consisted of a 3 foot length with a 7.75 inch inside diameter PVC sewer and drain pipe. The bottom end of each pipe was sealed using a rubber end-cap clamped on with a hose clamp, creating a tight seal.

Before packing, each silo was weighted empty. Then, each silo replication was filled in 6 layers with different weights of silage per the density required by the treatment. Total silage weight for each treatment was calculated using desired as-fed density multiplied by tube volume multiplied by silage dry matter. Silage was packed into the tubes in layers by placing known weights of

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material in the tube, and compressing silage to a known depth using a specially designed steel plunger with down pressure applied by a skid steer loader bucket.

Each tube was sealed using an oxygen barrier covered with a traditional silage tarp. A large rubber band and rubber clamp was used to seal each tube. The mini silos were stored upright, under roof in a cold storage shed for the remainder of the experiment. Initial composite samples of each chop length were taken and sent in for quality analysis at the time the tubes were sealed.

On December 13, 2021 (~110 days after cutting), the silage tubes were weighed and sampled for losses and quality analysis. Tubes appeared to be unaffected by any wildlife or other issues and all seals appeared to have stayed intact. Each silage tube was opened and the top foot was removed, mixed, and sub sampled. Then, the bottom two feet were removed from each tube, mixed, and sub sampled in the same manner. Silage was immediately bagged, cooled and shipped for quality analysis.

All quality analysis was performed by Rock River Laboratory in Watertown, WI using a comprehensive nutrition analysis by near infrared reflectance spectroscopy (NIRS).

Percent losses in DM were calculated by determining the difference in dry matter per silo between filling date and sampling date, expressed as a percentage of initial dry matter. Initial dry matter content was 39.2, 41.99, and 46.13 percent for 0.25. 0.5, and 0.75 treatments respectively. Final dry matters were the average of the two locations within each silo. Data were analyzed as a 3 × 3 factorial using R version 4.2.2. Silo was the experimental unit with location within silo treated as a block for silage composition. Means were separated using TukeyHSD with significance determined using an $\alpha \leq 0.05$.

Table 1. Explanation of Treatments for a Silage Packing Density and Chop Length Study near Beresford, SD, 2021.

Treatment	Chop Length (inches)	Density (lbs. dry matter/ft^3)
1	1/4	12 (L)
2	1/4	15 (M)
3	1/4	17 (H)
4	1/2	12 (L)
5	1/2	15 (M)
6	1/2	17 (H)
7	3/4	12 (L)
8	3/4	15 (M)
9	3/4	17 (H)

RESULTS AND CONCLUSIONS

Note that although 12 (L), 15 (M), and 18 (H) lbs. dry matter per cubic foot was the goal for the density treatments in this trial, 18 lbs/ft^3 was not physically feasible so the highest density treatment was dropped to 17lbsft^3.

Dry Matter Losses

Although packed and cut over the same two days, the silage used for the 0.75 treatment was drier than recommended at harvest compared to the other two treatments, therefore, the results of this experiment should be interpreted with caution as the dry matter losses observed may have been caused by harvest moisture content rather than cutting length or density. Dry matter losses observed in this experiment are shown in Table 2. Length of cut affected dry matter losses during storage in this experiment ($P \leq 0.001$). Silage that was harvested at a theoretical length of cut of 0.75" had greater DM losses compared to either 0.25 or 0.50". Packing density did not affect dry matter losses in this experiment. There was an interaction between chop length and packing density ($P < 0.05$) where greater packing density numerically lowered DM losses with the 0.50" chopping length but packing to the highest density resulted in numerically the greatest DM loss for both 0.25 and 0.75".

Table 2. Effect of length of cut and packing density of percentage dry matter lost during storage.[1,2]

	---------------------------------Length of cut---------------------------------		
Density	0.25	0.50	0.75
L (12 lbs. DM/ ft^3)	8.7[a]	13.3[a]	22.1[b]
M (15 lbs. DM/ ft^3)	7.9[a]	12.6[a]	21.4[b]
H (17 lbs. DM/ ft^3)	9.3[a]	9.9[a]	25.6[b]

[1]Calculated using initial filled weight and harvest dry matter concentration and net final weight and final dry matter concentration, expressed as a percentage of initial dry matter content.

[2]Standard error of the mean = 1.21

[a,b]Row means with different superscripts differ ($P \leq 0.05$)

Silage composition

The effects of packing density, chop length, and sampling location for nutrient composition are shown in Table 3. There were no interactions between packing density and length of cut for nutrient composition observed in this experiment ($P > 0.05$). Length of cut did affect CP percentage ($P < 0.05$); however, the largest magnitude of the largest difference between treatments (0.1%) suggests that these observations do not materially affect feed value. Packing density and sampling location did not affect CP concentration ($P = 0.16$). There also were no effects on TDN content from either length of cut, packing density, or sampling location ($P > 0.11$).

On the other hand, pH of the silage after storage was affected by all three factors examined. Post-storage pH was lowest for the high-density treatment, the greatest for the medium packing density, with the lowest packing density treatment intermediate (3.86, 3.87, and 3.84 for L, M, and H, respectively).

Cutting silage at the 0.75" length resulted in lower pH after storage than either 0.25 or 0.5", and silage sampled at the lower portion of the silo had reduced pH compared to silage sampled near the top of the silo. All of these differences were small in magnitude, and it appears to be unlikely that they would appreciably alter final feeding value.

Table 3. Effects of packing density, chop length, and sampling location on silage nutrient composition.

	-------Packing Density-------			-------Length of cut-------			--Sampling location---		
	L	M	H	0.25	0.50	0.75	Top	Bottom	SEM[1]
CP	5.54	5.58	5.55	5.64	5.52	5.51	5.52	5.59	0.0406
TDN	69.16	69.01	68.78	69.27	68.78	68.89	68.97	68.99	0.172
pH	3.86[a,b]	3.87[a]	3.84[b,c]	3.87[a]	3.86[a]	3.83[b]	3.88[a]	3.83[b]	0.006

[1]Standard error of the mean.

[a,b,c]Means within a factor (Packing Density, Length of Cut, Sampling Location) with different superscripts differ ($P \leq 0.05$).

SUMMARY

Under the conditions of this experiment, chopping silage at 0.5" or less reduced DM losses compared to a longer theoretical cut length; however, it is difficult to determine whether the effects seen are caused by the length of cut or by crop moisture conditions at harvest. Packing density had little effect on storage losses, and harvest practices had little effect on nutrient composition or silage characteristics after storage. Although this study did not reflect large changes in feed quality based upon packing density and chop length, we suspect that piled, tarped feed, under the same conditions, may likely show more extreme differences. This experiment should be repeated with some minor changes in order to identify the lower thresholds of the evaluated parameters to determine where producers may be at risk of a noticeable decline in feed value as affected by packing density and chop length.

ACKNOWLEDGEMENTS

The quality analysis and educational publications that will arise from this study have been made possible by a grant from Nebraska Sustainable Agriculture Research and Education (SARE). Plastic covering and oxygen barrier film was donated by Connor AgriScience (SealPro brand). Additional assistance and equipment to make this project possible was provided by the Southeast Research Farm staff at Beresford, SD. Expertise and assistance with methods construction was provided by Dr. Micheal Brouk, Professor and Extension Specialist at Kansas State University. Statistical analysis and interpretation was completed by Dr. Warren Rusche. Thank you to all of our contributors!

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Evaluating Corn Silage Quality Losses Based upon Covering Type

Sara Bauder*, Kiernan Brandt, Ben Beckman, Dr. Warren Rusche

Over 500,000 acres of corn silage were harvested in South Dakota during 2021 yielding 6,000,000 tons total, making the state one of the top producers of the feedstuff in the nation. Our neighbors in Nebraska harvested 260,000 acres of corn silage yielding a total of 5,070,000 tons total in 2021, a smaller, yet very significant amount. With so many producers using corn silage as a main feedstuff in grower livestock diets and for breeding stock, it is important that we continue to evaluate maximizing yields as well as best cutting, packing, and storage processes.
The objectives of this study were:

1) To investigate the value of using corn silage inoculants across common storage scenarios.
2) To investigate the value of using different types of plastic coverings, oxygen barriers, and liquid silage coverings and how they affect quality loss and tonnage loss when piled or packed in bunkers.
3) To investigate the value of interactions between using corn silage inoculant and coverings.

Many beef producers use corn silage piles and bunkers in their production systems. Although these storage methods can be very beneficial, if corn silage is not chopped, packed, handled, and stored properly, considerable spoilage and quality losses may be observed.

Although this type of research has been completed in other states, there has been very little new research emphasis on corn silage harvest and storage techniques in this area for many years. There are still many beef producers in the region who do not value the use of inoculant, perhaps unaware of its purpose. Uncovered silage piles are also still quite common to southeastern South Dakota and northeastern Nebraska. According to Kansas State University research, an uncovered pile or bunker can lose up to 75% dry matter in the top 10 inches, yet the practice remains. In addition, liquid products such as condensed distillers solubles (CDS) have been proposed by manufacturers and producers as an alternative to silage tarp. Research on CDS to cover silage is limited and knowledge regarding any interactions between alternative covers and inoculants is lacking. The treatments also include the use of a lighter (4 mil) and heavier (6-8 mil)

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plastic material in combination with an oxygen barrier. It has become evident in recent years that lighter materials are easier to apply, lighter for removal and recycling, more environmentally friendly, and shown to be as strong as or stronger than heavier plastics in some machine testing.

METHODS

Silage was chopped at the Southeast Research Farm near Beresford, SD on August 31, 2022 using a 1/2" chop length (cutter available for research does not have a processor). Average dry matter at packing was 34%. Capped mini-silos were be used to simulate bunker silos or silage piles. The silos consist of industrial PVC drainpipe; each silo is 3' in length with a 7.75" inside diameter. The bottom end of each silo was sealed using a rubber end cap clamped on with a hose clamp. This method has been validated previously and demonstrates excellent sealing ability.

Before packing, each empty silo weight was recorded. If the treatment required it, dry inoculant (heterofermentative) was thoroughly mixed by hand at a rate consistent with product directions with each 'known weight' layer of silage before packing. To achieve a goal of 17lbs DM/ft^3, silage was packed in 6 layers by placing known weights of material in each tube and compressing to a known depth using a specially designed steel plunger with down pressure applied by a skid steer loader bucket. Density was calculated using [desired as-fed density X tube volume X silage dry matter].

Each tube was covered using the proper treatment method (see Table 1); five replications of each treatment were packed. If a plastic covering was used, a rubber-band and steel clamp secured the covering(s). After all packing and sealing was complete, each silo weight was recorded. Silos were stored upright, outdoors.

104 days after packing, silage tubes were weighed, opened, and sampled for dry matter loss and quality analysis. Tubes appeared to be unaffected by any wildlife or other issues and all seals appeared to have stayed intact. Upon opening, the top foot of silage was removed, mixed, and sub-sampled, simulating silage near the top of the pile that may be more susceptible to spoilage. The remaining two feet were mixed and sub-sampled separately. Samples were immediately bagged, cooled, and shipped for quality analysis to Dr. Marisol Berti's research lab at NDSU. Due to a winter storm, the samples remained in shipping for one week- we cannot guarantee that quality was not lost in transit, but due to very cold temperatures during this period, we can assume it is likely that samples were not heavily damaged.

The experiment was conducted with a 2 × 5 factorial treatment structure. The factors will be inoculant usage with five different types of covering as shown in Table 1. Data will be analyzed using a model appropriate for a factorial treatment structure. If the effects of treatment are significant ($P \leq 0.05$), means will be separated using Fisher's LSD test.

RESULTS

Samples for this are being analyzed at the time of writing this report. Upon data completion, data will be analyzed using statistical software and conclusions will be reported.

ACKNOWLEDGEMENTS

The materials, shipping, and educational publications that will arise from this study have been made possible by a grant from the Midwest Forage Association (MFA). Sample analysis was donated at a very reduced cost by Dr. Marisol Berti and her lab technicians at NDSU. The soluble distiller solubles product was donated by POET at Hudson, SD. Plastic covering and oxygen barrier film was donated by Connor AgriScience (SealPro brand). Inoculant was provided by Klein Farms (Baltic, SD). Additional assistance and equipment to make this project possible was provided by the Southeast Research Farm staff at Beresford, SD. Thank you to all of our contributors!

Table 1. Explanation of Treatment for a Silage Inoculant and Cover study near Beresford, SD, 2022.

Treatment[1]	Inoculant Applied[2]	Type of Covering
1	No	Uncovered
2	Yes	Uncovered
3	No	Heavy Plastic Cover[3]
4	Yes	Heavy Plastic Cover
5	No	Heavy Plastic Cover + Oxygen Barrier[4]
6	Yes	Heavy Plastic Cover + Oxygen Barrier
7	No	Liquid ‘Cover’[5]
8	Yes	Liquid ‘Cover’

[1]Five replications of each treatment
[2]Anchor for Silage by Agnition was used (not less than 22,680,000,000,000 cfu*/lb lactic acid bacteria
[3]6-8 mil plastic thickness
[4]Sealpro® oxygen barrier
[5]Comprised of condensed distillers solubles (CDS)

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Effect of Processing Method of Hybrid Rye on Growth Performance, Efficiency of Dietary Net Energy Utilization, and Carcass Characteristics of Yearling Steers Fed a Finishing Diet

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INTRODUCTION

Previous studies we conducted at the SDSU Southeast Research Farm evaluating hybrid rye established that rye grain could be substituted for dry-rolled corn (DRC) in feedlot diets (Rusche et al., 2020). In that study, substituting rye for one-third of DRC in the diet resulted in performance, feed efficiency, and carcass characteristics nearly equivalent to when DRC was the sole grain source. This research provided assurance that cattle feeding could be a viable market, reducing the risk of incorporating hybrid rye into existing crop rotations.

The original study did highlight some challenges with adopting this feedstuff. We discovered that processing rye grain using the same roller mill as we used for corn was ineffective because of the size and shape of the rye kernels. We also discovered that replacing two-thirds or all the corn with rye depressed feed intake. We were able to eliminate this decrease in feed intake by feeding the rye grain whole; however, this resulted in poorer performance and feed efficiency (Buckhaus et al., 2021).

Purchasing or updating roller mills may not be feasible in every situation, particularly if rye grain is not a permanent component of the diet. Hammer mills (grinder mixers) are widely available and could be an alternative, provided that this method does not result in such small particle size that could cause acidosis. Feeding whole rye may be an acceptable alternative if the price discount between rye and corn is sufficiently wide to counter efficiency losses. The objective of this experiment was to compare differing processing methods when rye grain replaced approximately one-third of the corn.

EXPERIMENTAL PROCEDURES

All procedures were approved by SDSU Institutional Animal Care and Use Committee (IACUC, approval # 2202-010E).

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Experimental design and treatments

Four treatments were used in a 147-d randomized complete block design experiment. Those four treatments were a control diet containing 60% DRC (CON), and three treatments where rye was processed using three different methods [un-processed (UP); dry-rolled (DR); or hammer-milled (HM)] fed at 17% of diet DM along with 43% DRC. The DR rye was rolled similarly to rye fed in our initial studies (Rusche et al., 2020) with a processing index of 78.7. The HM rye was processed through a tractor PTO driven grinder-mixer with a 3/8" screen operated at 2000 rpm. The hybrid rye for this experiment had an initial ergot alkaloid concentration of 1 ppm on a DM basis, less than the maximum allowable ergot alkaloid concentration of 2 ppm for cattle diets (Coufal-Majewski et al., 2016).

Animals, initial processing, and study initiation

Predominately Angus steers (n = 192) with an initial bodyweight (BW) of 904 ± 46.1 lbs. were used in this study. Steers were purchased from two sources in eastern SD and transported to the Southeast Research Farm. Shortly after arrival they were individually weighed, identified with a unique individual ear tag, vaccinated against respiratory pathogens: infectious bovine rhinotracheitis (IBR), bovine viral diarrhea (BVD) types 1 and 2, parainfluenza-3 virus (PI3), and bovine respiratory syncytial virus (BRSV) (Bovi-Shield Gold 5, Zoetis, Parsippany, NJ) and clostridial species (Ultrabac 7/Somubac, Zoetis), and administered pour-on moxidectin (Cydectin, Bayer, Shawnee Mission, KS). Steers were allotted to one of 24 pens (n = 8 steers pen; 6 pens per treatment) and the study was initiated on March 10, 2022. Steers were adapted to their final diet over a 21-d period using three step-up diets with rye included as UP, DR, and HM beginning on d 1. Steers were administered a steroidal implant (200 mg trenbolone acetate and 28 mg estradiol benzoate; Synovex Plus, Zoetis) on d 28.

Diets and intake management

Steers were fed once daily. The final diets fed from d 20 to 117 are presented in Table 1. Rye silage replaced corn silage and grass hay for the last 14 d because of feed supply (Table 2). Bunks were managed to be slick at 0800h most mornings. Feed intake and diet formulations were summarized weekly. 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. One steer from DR was removed from the study for reasons unrelated to dietary treatment, thus all data are reported on a deads and removals excluded basis.

Cattle management and data collection

Steers were weighed at the time of study initiation, d 28, 56, 84, 119, and the morning of study termination on d 147. Body weights were measured before the morning feeding with a 4% pencil shrink applied to initial and final BW. Average daily gain (ADG) was determined as the difference between final and initial shrunk BW divided by days on feed (147). Dry matter intake (DMI) was tabulated at weekly intervals and summarized by interim period. Feed conversion ratio (G:F) was calculated using ADG divided by DMI.

Steers were shipped to Tyson Fresh Meats in Dakota City, NE after final BW determination and harvested the next day.

Prevalence of abscessed livers and abscess severity were determined by a trained technician using the Elanco system as Normal (no abscesses), A- (1 or 2 small abscesses or abscess scars), A (2 to 4 well organized abscesses less than 1 in diameter), or A+ (1 or more large active abscesses greater than 1 in diameter with inflammation of surrounding tissue). Video image data were obtained from the plant for ribeye area, RF, calculated USDA Yield Grade (YG), and USDA marbling scores. Dressing percentage was calculated as HCW/(final BW × 0.96). Estimated empty body fat (EBF) percentage and final BW at 28% EBF (AFBW) were calculated from observed carcass traits (Guiroy et al., 2002), and proportion of closely trimmed boneless retail cuts from carcass round, loin, rib, and chuck (Retail Yield, RY; Murphey et al., 1960).

Performance-adjusted Net Energy (paNE) was calculated from daily energy gain (EG; Mcal/d): EG = (carcass-adjusted ADG from d 20 to 117)$^{1.097}$ × $0.0557W^{0.75}$, where W is the mean equivalent shrunk BW [shrunk BW × (478/AFBW), kg; (NRC, 1996)] for the period from d 20 to 117. Maintenance energy required (EM; Mcal/d) was calculated by the following equation: EM = $0.077BW^{0.75}$ (Lofgreen and Garrett, 1968) where BW is the mean shrunk BW (using the average of carcass-adjusted final BW and BW from d 20). Using the estimates required for maintenance and gain the paNEm and paNEg values (Owens and Hicks, 2019) of the diet were generated using the quadratic formula: $x = \frac{-b \pm \sqrt{b^2-4ac}}{2c}$, where x = NEm, Mcal/kg, a = -0.41EM, b = 0.877EM + 0.41DMI + EG, c = -0.877DMI, and NEg was determined from: 0.877NEm – 0.41 (Zinn and Shen, 1998; Zinn et al., 2008). Rye NEg was calculated as follows: [(test diet NEg – Control diet NEg)/% rye inclusion] +68.0.

Statistical analysis

Growth performance, carcass traits, and efficiency of dietary energy utilization 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 effect of dietary treatment and the random of effect of block (source and pen location). Least squares means were generated using the LSMEANS statement of SAS. Distribution of USDA Yield and Quality grade, as well as liver abscess severity and prevalence data were analyzed as binomial proportions in the GLIMMIX procedure of SAS 9.4 with fixed and random effects in the model as described previously. An α of 0.05 or less determined significance and tendencies are discussed between 0.05 and 0.10.

RESULTS AND DISCUSSION

Animal growth performance

There were no differences amongst diets for final BW or ADG ($P \geq 0.44$; Table 3). Diet did influence DMI ($P = 0.01$). Steers fed diets containing hammer-milled rye ate more than either CON or UP (27.05 lbs. compared to 26.11 and 26.62, respectively). Steers fed dry-rolled rye ate 4.95 less DM compared to UP. Because of these differences in DMI, UP and HM tended to have 4.8% poorer feed conversion compared to CON and DR (P = 0.07). Estimated NEm and NEg values of the diet for UP (86.18 and 56.98 Mcal/cwt, respectively) were reduced (P = 0.05) compared to CON and DR (89.6 and 60.0 Mcal/cwt, respectively) with HM intermediate. There were no treatment effects on the ratio of observed to expected net energy values ($P = 0.13$). Net energy values for UP and HM rye were within 7% of current feeding standards when calculated using the substitution method. Rolling increased apparent ingredient NEg for rye by 30.1% compared to UP or HM rye.

Carcass characteristics

Dietary treatments had no effect on HCW, carcass measurements traits, percent empty body fatness (EBF), or final BW at 28% EBF ($P \geq 0.23$; Table 4). Diets did not influence the distribution of USDA Yield or Quality grades ($P \geq 0.23$). Treatments did not affect either the incidence or severity of liver abscesses in this experiment ($P = 0.25$).

Implications

Results of this study confirm our previous results examining partial replacement of corn with hybrid rye in finishing cattle diets and further support our conclusion that rye grain can be fed as a portion of the diet with little to no negative effects on performance or feed efficiency. Processing rye grain by dry-rolling increased dietary net energy values and tended to improve feed efficiency compared to not processing or using a hammer mill.

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Table 1. Composition of experimental finishing diets fed to steers from d 22 to 133 (DM basis).

	Treatment[1]			
Item	CON	UP	DR	HM
Dry-rolled corn, %	53.6	35.6	35.6	35.6
Hybrid rye, %	0.0	18.3	18.0	18.2
Modified distillers grains plus solubles, %	18.2	18.1	18.2	18.2
Corn silage, %	22.3	22.1	22.2	22.2
Grass hay, %	2.0	2.0	2.0	2.0
Rye silage, %	0.0	0.0	0.0	0.0
Liquid Supplement, %[2]	3.9	3.9	3.9	3.9
Nutrient Composition[3]				
CP, %	13.0	13.5	13.5	13.5
NDF, %	23.6	25.4	25.4	25.4
NEm, Mcal/cwt	91.54	89.02	89.03	89.02
NEg, Mcal/cwt	61.36	59.20	59.21	59.20

[1]CON = control diet; UP = unprocessed, whole rye grain; DR = dry-rolled rye grain; HM = hammer-milled rye grain.

[2]Provided 30 g/ton of monensin as well as vitamins and minerals to exceed requirements (NASEM, 2016)

[3] Tabular NE from (Preston, 2016) and actual nutrient compositions from weekly assays of the ingredients.

Table 2. Composition of experimental finishing diets fed to steers from d 134 to 147 (DM basis).

	Treatment[1]			
Item	CON	UP	DR	HM
Dry-rolled corn, %	64.0	40.6	40.7	40.6
Hybrid rye, %	0.0	20.6	20.4	20.6
Modified distillers grains plus solubles, %	18.3	18.1	18.2	18.2
Corn silage, %	0.0	0.0	0.0	0.0
Grass hay, %	0.0	0.0	0.0	0.0
Rye silage, %	13.8	14.1	14.1	14.1
Liquid Supplement, %[2]	4.0	4.4	4.4	4.4
Nutrient composition[3]				
CP, %	14.0	15.2	15.2	15.2
NDF, %	21.2	24.0	24.0	24.0
NEm, Mcal/cwt	92.13	88.88	88.89	88.88
NEg, Mcal/cwt	60.85	58.08	58.09	58.08

[1]CON = control diet; UP = unprocessed, whole rye grain; DR = dry-rolled rye grain; HM = hammer-milled rye grain.

[2]Provided 30 g/ton of monensin as well as vitamins and minerals to exceed requirements (NASEM, 2016)

[3] Tabular NE from (Preston, 2016) and actual nutrient compositions from weekly assays of the ingredients.

Table 3. Live animal growth performance responses for finishing cattle fed unprocessed, dry-rolled, or hammer-milled hybrid rye.[1]

	Treatment[2]					
Item	CON	UP	DR	HM	SEM[3]	*P* - value
Pens, n	6	6	6	6	-	-
Steers, n	48	48	47	48	-	-
Initial BW, lbs	901	904	906	904	-	-
Final BW, lbs	1457	1440	1450	1459	14.6	0.54
Cumulative						
ADG, lbs	3.78	3.64	3.69	3.78	0.097	0.44
DMI, lbs	26.11[bc]	26.62[ab]	25.31[c]	27.05[a]	0.440	0.01
G:F	0.145[g]	0.137[h]	0.146[g]	0.140[gh]	0.0035	0.07
F:G[4]	6.90	7.30	6.85	7.14	-	-
Observed NEm, Mcal/cwt[5]	89.61[a]	86.18[b]	89.57[a]	86.50[ab]	1.484	0.05
Observed NEg, Mcal/cwt[5]	59.99[a]	56.98[b]	59.95[a]	57.26[ab]	1.302	0.05
O/E NEm	0.99	0.97	1.01	0.98	0.016	0.13
O/E NEg	0.99	0.97	1.02	0.98	0.022	0.13
Rye NEg, Mcal/cwt[5, 6]	-	51.18	67.77	52.73	-	-

[1]A 4% shrink was applied to all BW measurements.
[2]CON = control diet; UP = unprocessed rye grain; DR = dry rolled rye grain; HM = hammer-milled rye grain.
[3]Standard Error of the Mean.
[4]Calculated as 1/G:F.
[5]Calculated using AFBW as mature BW.
[6]Rye NEg, Mcal/cwt = [(test diet NEg – control diet NEg)/Rye inclusion] + 68.0
[7]Rye inclusion (DM basis) for the entire study was 17.90, 17.65, and 17.88% for UP, DR, and HM, respectively.
[a, b] Means without a common superscript differ $P \leq 0.05$.

Table 4. Carcass characteristics and liver abscess severity and prevalence for finishing cattle fed unprocessed, dry-rolled, or hammer-milled hybrid rye.[1]

	Treatment[2]					
Item	CON	UP	DR	HM	SEM[3]	*P* - value
HCW, lbs	958	952	943	957	11.6	0.57
Dressing[4], %	65.71	66.16	65.05	65.58	0.511	0.23
REA, in^2	13.83	13.65	13.68	13.92	0.252	0.67
RF, in	0.76	0.75	0.71	0.72	0.047	0.69
Marbling[5]	573	564	538	558	20.0	0.38
KPH, %	1.83	1.83	1.83	1.80	0.033	0.67
Yield Grade	3.97	3.99	3.84	3.83	0.185	0.75
EBF[6], %	34.67	34.55	33.74	34.04	0.749	0.58
AFBW[6], lbs	1259	1255	1270	1280	17.3	0.50
Yield Grade, %						
1	0.00	0.00	0.00	0.00	-	0.64
2	6.25	10.42	2.17	8.33		
3	52.08	43.75	69.57	56.25		
4	37.50	39.58	26.09	31.25		
5	4.17	6.25	2.17	4.17		
Quality Grade, %						
Select	2.08	4.17	13.04	6.25	-	0.23
Low Choice	27.08	29.17	23.91	25.00		
Average Choice	31.25	31.25	36.96	31.25		
High Choice	22.92	31.25	19.57	31.25		
Prime	16.67	4.17	6.52	6.25		
CAB eligible, %						
No	37.50	39.58	43.48	45.83	-	0.83
Yes	62.50	60.42	56.52	54.17		
Liver abscess prevalence and severity[7], %						
Normal	81.25	85.42	73.91	89.58	-	0.25
A-	10.42	6.25	15.22	6.25		
A	6.25	2.08	2.17	0.00		
A+	2.08	6.25	8.70	4.17		

[1]A 4% shrink was applied to all BW measurements.
[2]CON = control diet; UP = unprocessed rye grain; DR = dry rolled rye grain; HM = hammer-milled rye grain.
[3]Standard Error of the Mean.
[4] Calculated as: (HCW/final BW shrunk 4%) × 100.
[5] 400 = $small^{00}$
[6] Calculated according to the equations described by Guiroy et al. (2001).
[7] Determined according to the Elanco Liver Scoring System.
[a, b] Means without a common superscript differ $P \leq 0.05$

SOUTHEAST RESEARCH FARM ANNUAL REPORT
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Evaluation of Rumen Protected B-Vitamin Blend on Finishing Steer Growth Performance, Efficiency of Dietary Net Energy Utilization, Carcass Trait Responses, and Liver Abscess Prevalence and Severity

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SUMMARY

Use of rumen protected B-vitamin (RPBV; 1 g/steer·d^{-1}) enhanced growth performance during the initial 28-d period; however, use of RPBV had no appreciable influence on any cumulative growth performance responses. Use of RPBV in finishing diets altered overall yield grade distribution, indicating that the additive induced changes in metabolism of the steers. Finally, RPBV application does not appear to reduce undesirable liver health outcomes.

Objective:

The objective of this experiment was to determine the influence a rumen-protected B-vitamin blend (containing pantothenic acid, pyridoxine, folic acid, biotin, and cyanocobalamin; Vivalto®—Trouw Nutrition, Isola Vicentina, Italy) has on growth performance, efficiency of dietary net energy (NE) utilization, carcass trait responses, and liver abscess severity and prevalence in yearling beef steers fed a finishing diet based upon corn and corn co-products.

METHODS:

Cattle and Treatments

Crossbred steers (n =292 steers) were sourced as two separate consignments from local South Dakota auction facilities approximately 5 d prior to the initiation of the present experiment. Steers from the first consignment were used in replicate pens 1 to 7 and steers from the second consignment were used in replicate pen 8. Steers were processed approximately 48 h after arrival (d -3). Initial processing included application of a unique identification ear tag, vaccination against viral respiratory (Bovi-Shield Gold 5, Zoetis, Parsippany NJ) and clostridia pathogens (Ultrabac 7/Somubac, Zoetis) and administered pour-on moxidectin (Cydectin, Bayer, Shawnee Mission, KS) according to label instructions. The BW collected on d -3 was used for allotment purposes. Steers selected for study enrollment based upon uniformity of BW and temperament on d -3 were again weighed on d 1 and allotted to their respective pen. The average of the BW measurements collected on d -3 and d 1 were used as the initial BW (n = 246 steers; initial

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average shrunk BW = 904 ± 55.9 lbs). This study used 8 replicate pens of 10 to 12 steers (10 steers per pen in replicate pens 1 to 7 and 12 steers per pen in replicate pen 8) assigned to each of the 3 dietary treatments (24 pens total). The study was conducted at the Southeast Research Farm (SERF) of the South Dakota Agricultural Experiment Station located in Beresford, SD. All steers were implanted on d 28 (98 d before harvest) with a 200 mg trenbolone acetate and 28 mg estradiol benzoate implant (Synovex Plus, Zoetis). All implants were checked on d 56 (28 d following implantation) and any implant abnormalities were noted, steers identified as missing, or abscessed-out missing were administered another implant. All steers were fed ractopamine HCl at a rate of 300 mg per steer daily for the final 28 d prior to harvest.

Treatments included:

1) Fed no rumen-protected B-vitamin blend (RPBV0)

2) Fed the rumen-protected B-vitamin blend at a rate of 1.0 g/steer·d-1 (RPBV1)

3) Fed the rumen-protected B-vitamin blend at a rate of 2.0 g/steer·d-1 (RPBV2)

Diets and Feeding

Cattle were fed 1X daily and bunks were managed for ad libitum access to feed with minimal day to day variation in the amount of feed not consumed. Cattle were transitioned to the 90% concentrate diet, over the course of 14 d (Table 1). The final diet (Table 2) was fed from d 15 until d 126 (d before harvest).

Feedstuff samples were taken weekly (every Monday morning) and analyzed for DM content. Weekly ingredient samples were composited monthly for CP, NDF, ADF, and ash determination using AOAC procedures. A single TMR sample was collected and analyzed for Ca, P, Co, Cu, Mn, Mo, Se, and Zn according to AOAC procedures. A water sample was collected at the culmination of the trial for water quality determination at a commercial laboratory (Table 3). Orts were collected, weighed, and dried in a forced air oven at 100°C for 24 h in order to determine DM content. The DMI of each pen was adjusted to reflect the total DM delivered to each pen after subtracting the quantity of dry orts for each interim period.

Feed was manufactured in a mixer (147 ft^3; 8 pens fed per batch) connected to a tractor, all ingredients were added into the mixer to the nearest 2 lbs, and feed was delivered to each pen separately (weighed out of the mixer to the nearest 2 lbs). Batching sequence was RPBV0 (8 pens), RPBV1 (8 pens), and RPBV2 (8 pens). Following each batch of feed, long stem grass hay (~10 lbs) was added to the mixer and used to flush out all residual feed remaining in the mixer. Mixing of the following batch did not occur until the scale head read 0 to 2 lbs.

Measurements and Records

Steers were individually weighed on d -3, 1, 28, 56, 98 (start RH) and 126 (d before harvest). Cumulative growth performance was calculated on live and carcass-adjusted basis. Initial BW was the average of the d -3 and d 1 BW. All live BW measures used were pencil shrunk 4% to account for gastrointestinal tract fill and carcass-adjusted final BW was calculated from hot carcass weight (HCW) divided by 0.625. Average daily gain (ADG) was determined as the difference between final and initial BW divided by days on feed (126 d). Dry matter intake (DMI) was tabulated at weekly intervals and summarized by interim period. Feed conversion ratio (G:F) was calculated using ADG divided by DMI.

Growth performance (live-basis) was used to calculate performance-based dietary NE in order to determine efficiency of dietary NE utilization. The performance-based dietary NE was calculated from daily energy gain (EG; Mcal/d): $EG = ADG^{1.097} \times 0.0557W^{0.75}$, where W is the mean equivalent shrunk BW [kg; (NRC, 1996)] from median feeding shrunk BW and final BW at 28% estimated empty body fatness (AFBW) calculated as: [median feeding shrunk BW × (478/AFBW), kg; (NRC, 1996)]. Maintenance energy (EM) was calculated by the equation: EM = 0.077 × median feeding shrunk BW, $kg^{0.75}$. Dry matter intake is related to energy requirements and dietary NEm (Mcal/kg) 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±√(b^2-4ac))/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 using the following equation: NEg (Mcal/kg) = 0.877NEm − 0.41 (Zinn, 1987).

Steers were marketed and harvested at a commercial abattoir with treatment blinded personnel determine that 60% of the population has sufficient fat cover to grade USDA Choice (estimated to be 140 d on feed). Steers were loaded onto trucks, shipped 56 miles, and harvested the following day at Tyson Fresh Meats in Dakota City, NE. Liver abscess prevalence and severity was be determined by a trained technician using the Elanco system as Normal (no abscesses), A- (1 or 2 small abscesses or abscess scars), A (2 to 4 well organized abscesses less than 1 in. diameter), or A+ (1 or more large active abscesses greater than 1 in. diameter with inflammation of surrounding tissue). Video image data was obtained from the plant for rib eye area, rib fat, kidney-pelvic-heart fat, calculated USDA Yield Grade and USDA marbling scores. Dressing percentage was calculated as HCW/(final BW × 0.96). Estimated empty body fat (EBF) percentage and AFBW was calculated from observed carcass traits (Guiroy et al., 2002), and proportion of closely trimmed boneless retail cuts from carcass round, loin, rib, and chuck was be determined according to the equation described by (Murphey et al., 1960).
A total of five steers were removed from the experiment for reasons not related to dietary treatment. One steer was removed due to hardware disease (RPBV1), one steer was removed due to musculoskeletal issues (RPBV1), one steer was removed for overall poor gain (RPBV2), and two steers were found as pen deads due to a perforated reticulo-rumen (both from RPBV2).

Laboratory Analysis
Weekly ingredient samples were stored in a freezer at -20° C until nutrient analyses were completed. After weekly DM determination (method no. 935.29), weekly samples from each ingredient were composited by month and analyzed for N (method no. 968.06; Rapid Max N Exceed; Elementar; Mt. Laurel, NJ), and ash (method no. 942.05) content (AOAC, 2012, 2016). Modified distillers grains plus solubles samples were analyzed for ether extract content using an Ankom Fat Extractor (XT10; Ankom Technology, Macedon, NY). Percentages of ADF and NDF were assumed to be 3 and 9 percent for dry-rolled corn (Preston, 2016). Analysis of ADF and NDF composition for all other feeds was conducted as described by (Goering and VanSoest, 1970). Diets presented in Table 1 and 2 are actual DM diet composition, actual nutrient concentrations, and tabular energy values (Preston, 2016).

Statistical analysis
Growth performance, carcass traits, and efficiency of dietary energy utilization was analyzed as a randomized complete block design (RCBD) using the MIXED procedure of SAS 9.4 (SAS Inst. Inc., Cary, NC) with pen as the experimental unit. The model included the fixed effect of dietary treatment and block will be considered a random variable. Distribution of USDA Yield and

Quality grade, as well as liver abscess severity and prevalence data were analyzed as multinomial distributions in the GLIMMIX procedure of SAS 9.4 to identify differences in the distributions among treatments. Individual steer served as the experimental unit for categorical outcome data and the same fixed and random effects in the model as described previously were used. The model specified a solutions function for the multinomial response, with the number of animals slaughtered identified in the denominator. Least squares means were generated using the LSMEANS statement of SAS. Treatment effects were evaluated by the use of orthogonal polynomials (Steel and Torrie, 1960). An α of 0.05 was used to determine significance and an α of 0.06 to 0.15 was considered a tendency.

RESULTS AND DISCUSSION

Growth performance during the receiving period, as well as cumulative growth performance responses are located in Table 4. Average daily gain was increased and feed efficiency was improved (quadratic effect; $P \leq 0.02$) during the initial 28-d receiving period for RPBV1 compared to other treatments. Dry matter intake was not appreciably influenced by the addition of a rumen-protected B-vitamin blend ($P \geq 0.13$). Live-basis final BW, ADG, and G:F were not different among treatments ($P \geq 0.25$). Carcass-adjusted final BW, ADG, nor G:F were not appreciably influenced by dietary treatment ($P \geq 0.59$). Observed dietary NE values for maintenance and gain based upon growth performance were not influenced by the addition of RPBV. The ratio of observed-to-expected dietary NE values were in close agreement with expectations (0.99) and were not influenced by dietary treatment ($P \geq 0.79$). Given that the RPBV0 steers observed growth performance was within close agreement with expectations, based upon dietary NE values and estimates for maintenance and retained energy, it is not surprising that there was no appreciable response to added RPBV in diets fed to yearling feedlot steers.

Carcass trait responses are located in Table 5. Hot carcass weight, dressing percentage, marbling, kidney-pelvic-heart fat, or BW at 28% EBF (AFBW) did not differ due to dietary treatment ($P \geq 0.11$). Rib eye area was altered by treatment (quadratic effect, $P = 0.02$), with steers from RPBV1 having decreased REA compared to others. Hence, calculated yield grade and percentage of wholesale cuts obtained from the round, loin, rib and chuck (retail yield) were also altered by dietary treatment (quadratic effect, $P \leq 0.01$) with steers from RPBV1 having increased yield grade and decreased retail yield compared to steers fed RBPV0 or RPBV2. Estimated empty body fatness tended to be greater from steers fed RPBV compared to control ($P = 0.06$) presumably due to increased RF depth, and to a smaller degree, lesser REA.

Categorical carcass outcomes are located in Table 6. The overall USDA Yield Grade distribution was altered by dietary treatment. There was similar levels of YG1 and YG5 carcasses among treatments, shifts among the groups occurred at the YG2, YG3, and YG4 outcome groups. The overall distribution of USDA Quality Grade was not altered by dietary treatment (P = 0.53). The overall distribution of liver scores tended to be altered by dietary treatment. Steers from RPBV0 and RPBV1 had more livers classified as normal compared to RPBV2 steers.

CONCLUSIONS

Use of RPBV (1 g/steer daily) improved growth and efficiency during the initial 28 d receiving period. However, RPBV had no appreciable influence on any cumulative growth performance responses. Use of RPBV in finishing diets altered carcass muscularity, rib fat accumulation, and overall yield grade distribution, indicating that the additive induced changes in metabolism of the steers. RPBV application does not appear to reduce undesirable liver health outcomes.

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Table 1. Actual ingredient inclusion and nutrient content based upon feed batching records.

Item	Step 1 (d 1 to 7)	Step 2 (d 8 to 14)
Dry-rolled corn	35.13	46.24
Modified distillers grains plus solubles	17.83	17.92
Corn silage	24.00	21.89
Grass Hay	19.20	10.01
Suspended supplement[1]	3.84	3.94
Analyzed nutrient composition		
DM, % as fed	59.18	54.65
CP, %	13.36	13.49
ADF, %	18.87	14.15
NDF, %	31.34	24.61
Ash, %	6.91	6.07
EE, %	3.61	3.70
NEg, Mcal/cwt	53.98	58.06

[1]Contained on a DM basis: 30,844 IU of Vitamin A/kg, 170 IU of Vitamin E/kg, 827 g of Monensin/ metric ton (Elanco Animal Health, Greenfield, IN), and 165 g of Tylosin/metric ton (Elanco Animal Health).

Table 2. Composition of finishing diet (dry matter basis)§.

Ingredient	Finishing diet fed from d 15 to 126
Dry-rolled corn	53.18
Modified distillers grains plus solubles	19.93
Corn silage	23.10
Suspended supplement[1]	3.79
Analyzed nutrient composition	
DM[3], % as fed	59.97
CP[3], %	13.41
NPN, %[2]	1.35
ADF[3], %	10.11
NDF[3], %	20.85
Ash[3], %	5.17
EE[3], %	3.91
NEg[3], Mcal/cwt	62.14
Calcium, %	0.66
Magnesium, %	0.25
Phosphorus, %	0.46
Potassium, %	0.96
Sulfur, %	0.20
Cobalt, mg/kg	0.50
Copper, mg/kg	12.00
Iron, mg/kg	109
Manganese, mg/kg	40.00
Selenium, mg/kg	0.5
Zinc, mg/kg	106

[1]Contained on a DM basis: 68,000 IU of Vitamin A/lb, 375 IU of Vitamin E/lb, 750 g of Monensin/ton (Elanco Animal Health, Greenfield, IN), and 165 g of Tylosin/metric ton (Elanco Animal Health).
[2]Non-protein nitrogen, CP equivalent.
[3] Weekly ingredient samples were stored in a freezer at -20° C until nutrient analyses were completed. After weekly DM determination (method no. 935.29), weekly samples from each ingredient were composited by month and analyzed for N (method no. 968.06; Rapid Max N Exceed; Elementar; Mt. Laurel, NJ), and ash (method no. 942.05) content (AOAC, 2012, 2016). Modified distillers grains plus solubles samples were analyzed for ether extract content using an Ankom Fat Extractor (XT10; Ankom Technology, Macedon, NY). Percentages of ADF and NDF were assumed to be 3 and 9 percent for dry-rolled corn (Preston, 2016). Analysis of ADF and NDF composition for all other feeds was conducted as described by Goering and Van Soest et al. (1970). Diets presented her are actual DM diet composition, actual nutrient concentrations, and tabular energy values (Preston, 2016).
§All steers received 300 mg/steer daily ractopamine hydrochloride for the final 28 d on feed.

Table 3. Chemical composition of water supplied to cattle.

Item	Result
pH, s.u.	8.37
Chloride, mg/L	19.1
Total Hardness, mg/L	170
Nitrate-Nitrogen, mg/L	0.6
Calcium, mg/L	40
Magnesium, mg/L	18
Phosphorous, mg/L	<0.5
Potassium, mg/L	7
Sodium, mg/L	84.5
Sulfate, mg/L	240
Aluminum, mg/L	0.07
Cobalt, mg/L	<0.005
Copper, µg/L	10
Iron, mg/L	0.09
Manganese (mg/L)	0.017
Molybdenum (µg/L)	10
Selenium (µg/L)	5
Total Dissolved Solids (mg/L)	448

Table 4. Growth performance responses for the 126 d experiment.[1]

	RPBV, g/steer·d^{-1}				*P* - value		
	0	1	2	SEM	Con vs. RPBV	Linear	Quadratic
Pens, n	8	8	8	-	-		
Steers, n	82	80	79	-	-		
Initial BW, lbs	908	906	909	-	-	-	-
Initial to d 28							
d 28 BW, lbs	1007	1014	1009	4.7	0.27	0.69	0.14
ADG, lbs	3.52	3.87	3.54	0.143	0.16	0.88	0.02
DMI, lbs	19.21	19.38	19.45	0.177	0.21	0.20	0.73
G:F	0.183	0.199	0.182	0.0066	0.20	0.89	0.01
F:G[2]	5.46	5.03	5.49	-	-	-	-
Cumulative Live basis							
Final BW, lbs	1436	1445	1444	9.3	0.32	0.43	0.54
ADG, lbs	4.19	4.28	4.24	0.075	0.31	0.52	0.34
DMI, lbs	26.47	27.06	26.92	0.371	0.13	0.25	0.27
G:F	0.158	0.158	0.158	0.0022	0.78	0.72	0.94
F:G[2]	6.33	6.33	6.33	-	-	-	-
Cumulative Carcass-adjusted basis							
Final BW (HCW/0.625), lbs	1488	1493	1493	13.7	0.64	0.68	0.84
ADG, lbs	4.60	4.66	4.63	0.096	0.61	0.75	0.65
G:F	0.174	0.172	0.172	0.0030	0.59	0.64	0.79
F:G[2]	5.75	5.81	5.81	-	-	-	-
Performance-adjusted Net Energy (NE), Mcal/cwt							
Maintenance	90.7	90.7	90.3	0.82	0.90	0.79	0.83
Gain	61.2	61.2	60.8	0.73	0.90	0.79	0.83
Observed-to-expected NE							
Maintenance	0.99	0.99	0.99	0.009	0.90	0.79	0.83
Gain	0.99	0.99	0.99	0.012	0.90	0.79	0.83

[1]All BW measures were shrunk 4% to account for digestive tract fill. [2] 1/G:F

Table 5. Carcass trait responses.

	RPBV, g/steer·d^{-1}				*P* - value		
	0	1	2	SEM	Con vs. RPBV	Linear	Quadratic
Pens, n	8	8	8	-	-		
Steers, n	82	80	79	-	-		
HCW, lbs	930	933	934	8.5	0.64	0.68	0.84
Dressing[1], %	64.74	64.58	64.66	0.342	0.70	0.82	0.70
REA, in[2]	13.98	13.48	13.84	0.144	0.08	0.47	0.02
RF, in	0.52	0.56	0.55	0.020	0.11	0.28	0.15
Marbling[2]	509	508	516	16.7	0.85	0.70	0.76
KPH, %	1.79	1.81	1.81	0.029	0.49	0.51	0.81
Yield Grade	3.22	3.50	3.35	0.087	0.02	0.19	0.01
Retail Yield[3]	50.04	49.46	49.78	0.187	0.02	0.18	0.01
EBF[4], %	31.08	31.77	31.50	0.306	0.06	0.19	0.09
AFBW[4], lbs	1344	1325	1335	14.5	0.27	0.53	0.27

[1] Dressing percentage was calculated as HCW/(final BW × 0.96).

[2] 400 = small^{00}

[3] Proportion of closely trimmed boneless retail cuts from carcass round, loin, rib, and chuck was be determined according to the equation described by (Murphey et al., 1960).

[4] Estimated empty body fat (EBF) percentage and AFBW was calculated from observed carcass traits (Guiroy et al., 2002).

Table 6. Categorical carcass outcomes.

	RPBV, g/steer·d^{-1}				*P* - value		
	0	1	2	SEM	Con vs. RPBV	Linear	Quadratic
Pens, n	8	8	8	-	-		
Steers, n	82	80	79	-	-		
Yield Grade, %							
1	1.2	1.3	1.3	-	Trt = 0.01	-	-
2	35.4	15.2	25.3	-	-	-	-
3	50.0	60.8	59.5	-	-	-	-
4	13.4	21.5	12.6	-	-	-	-
5	0.0	1.3	1.3	-	-	-	-
Quality Grade, %							
Select	11.0	14.29	9.0	-	Trt = 0.53	-	-
Choice	35.4	35.1	38.5	-	-	-	-
Average Choice	41.5	35.1	35.9	-	-	-	-
Upper Choice	8.5	11.7	15.4	-	-	-	-
Prime	3.7	3.9	1.3	-	-	-	-
Liver Scores[1], %							
Normal	89.0	89.9	79.8	-	Trt = 0.13	-	-
A-	7.3	5.1	12.7	-	-	-	-
A	0.0	0.0	1.3	-	-	-	-
A+	3.7	5.1	6.3	-	-	-	-

[1] Liver abscess prevalence and severity was be determined by a trained technician using the Elanco system as Normal (no abscesses), A- (1 or 2 small abscesses or abscess scars), A (2 to 4 well organized abscesses less than 1 in. diameter), or A+ (1 or more large active abscesses greater than 1 in. diameter with inflammation of surrounding tissue).

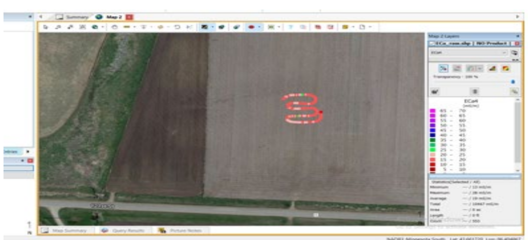
SOUTHEAST RESEARCH FARM ANNUAL REPORT
South Dakota State University
2022 Progress Report
Agricultural Experiment Station
Plant Science Department
South Dakota State University, Brookings, SD 57007
Southeast Research Farm, Beresford, SD 57004

Southeast-Farm Report on 2022 Spring Testing of the Geoprospector TopSoil Mapper

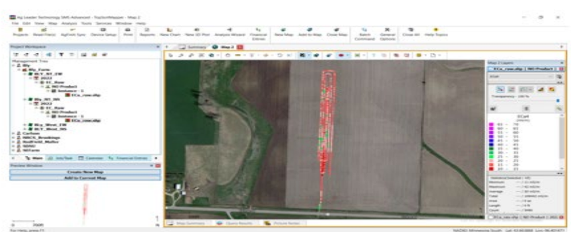
Joe Schumacher and Peter Sexton*

Goal: Test the TopSoil Mapper (TSM) in measuring soil apparent electrical conductivity (ECa) in wheel traffic rows and in non-compacted areas situated next to the compacted rows. Initial testing was performed at the SE Farm to check output from the unit and DGPS data tracking. Once accomplished the unit was taken to Farm Sites near Garretson SD where a wheel traffic area was identified with heavy compaction from grain cart traffic. The TSM unit records the depth of the ECa values at four different cumulative depth levels (Eca1, ECa2, ECa3, ECa4) with a maximum depth of 3.5 ft and a minimum of 4 inches-(unit 12 inches above the ground). During initial soil compaction testing the TSM unit was driven in line with crop rows and across the crop rows at a slow speed of 2 mph (3 feet per second) - the unit outputs ECa data at 4-5 times per second. Accordingly, the TSM unit should be able to pickup data values every 4 to 6 inches when driven at 2 mph.

Note: The TSM unit used at the Southeast Research Farm was evaluated using only the raw Electrical Conductivity (EC) data from the device and not the proprietary data/maps from Geoprospector).

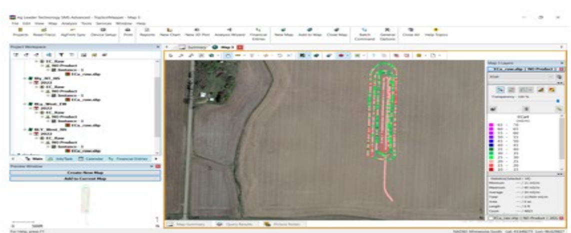


Bly NT 1 Acre EW



Bly NT 5 Acre NS

Bly West 1 Acre EW



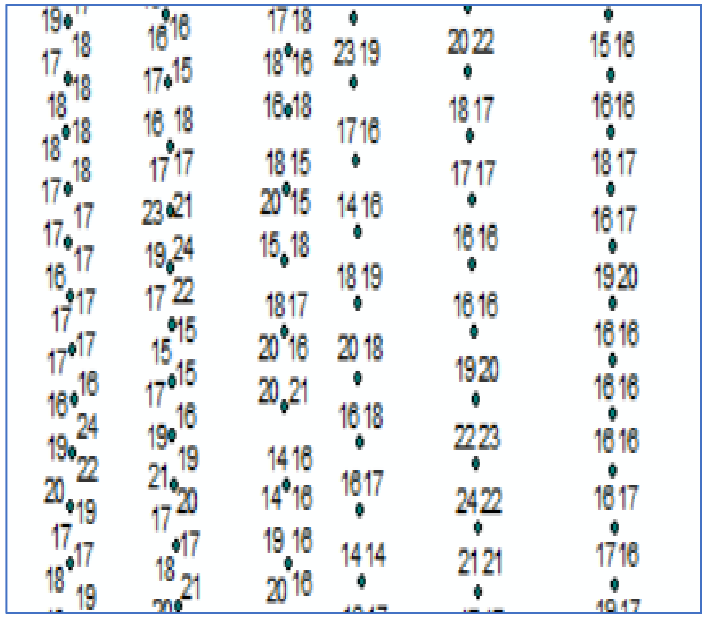
Bly West 5 Acre NS

* *Corresponding author; peter.sexton@sdstate.edu*

Depicted are the TSM runs driven East-West then North-South. ArcGIS software was used to visually display the values for inspection around the Wheel Traffic Area. The ECa data values are in mS/m a unit of Electrical Conductance. After looking through all the depth levels of ECa, we could perceive no distinct pattern when the vehicle was driven either across the rows or parallel with the rows.

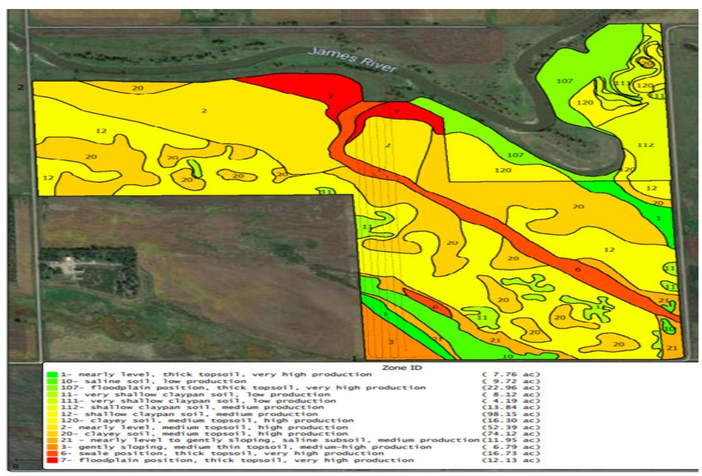
A section of the data pattern is shown below (there are four values for each GPS data point) - again no pattern developed for the Wheel Compacted Row in any of the runs for sensor values that were directly next to non-compacted areas. The SE-Farm and Garretson Field sites did not show distinct patterns of surface soil compaction or deep compaction as measured by the TSM device's ECa values. However, it is not known whether it may be possible to ascertain compaction differences under different soil types and soil conditions not examined.

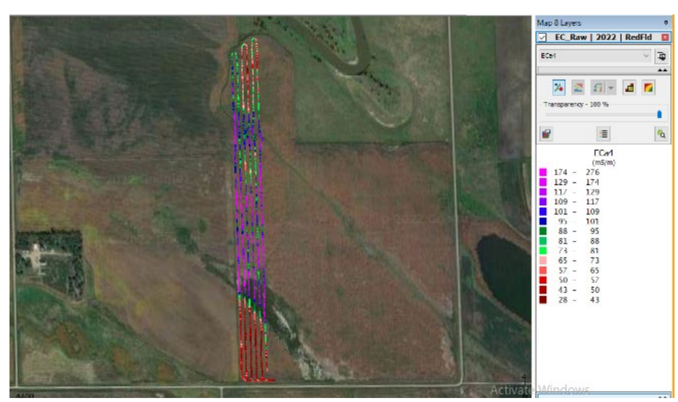
Garretson ECa3 labels:



Part 2: Redfield Site

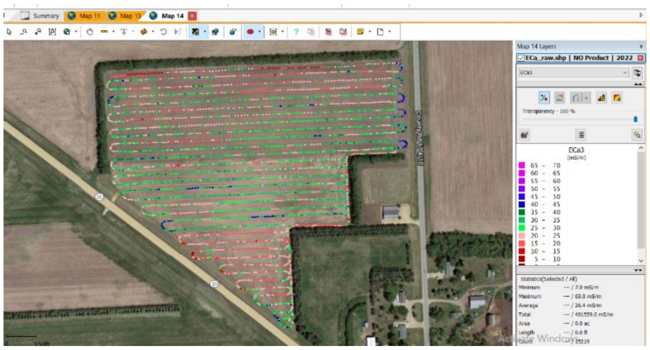
The unit was tested for typical use on a field area with known definitive soil type changes in the James River Valley near Redfield. The TSM unit's raw ECa values did appear to pickup the differences in the landscape with ECa values from the higher yielding areas contrasting with the much higher ECa readings in the low yielding saline affected soils. The soil consultant who picked the area expressed that while the unit did show utility it would not help him much as he could determine the different soil areas better and at lower costs through other means (i.e., aerial photography, topography and yield maps, soil sampling along with his own soil mapping skills). However, the ECa maps could be of utility to other soil/crop consultant's, especially ones without the soil expertise/background of this soil/crop consultant.

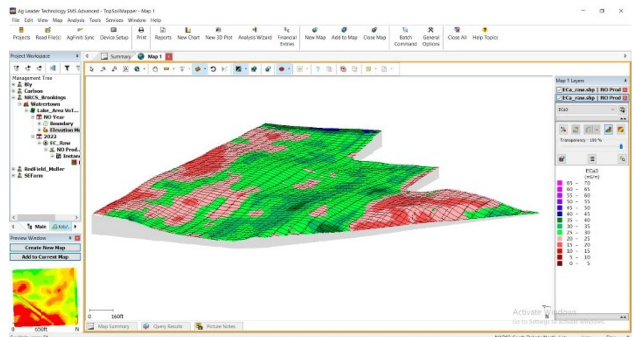




Part 3: Watertown Vo-Tech Field

The next TSM test was performed at a Watertown Vo-Tech field where NRCS Soil Specialists arranged to map the field. The TSM unit was driven across a 30 acre field with ECa units showing acceptable ECa output values. The soil specialist even stated that it may have picked up patterns where the field had soil removed due to road construction. The field is relativity flat but is also shown with an exaggerated elevation view due to availability of topographic data.





Part 4: SDSU Field Sites

SDSU Felt Farm:

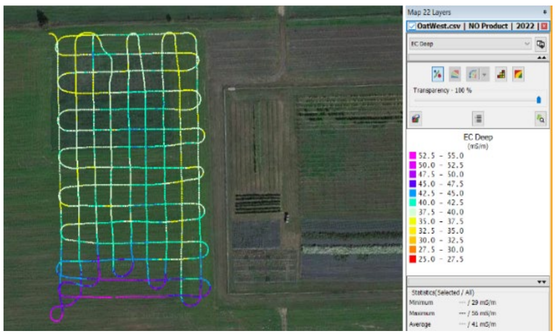
The first SDSU Field Site was at the Felt Farm. The TSM unit was driven diagonally by one of the SDSU researchers over the field plot area to minimize issues related to driving directly over a single row path. The field area is a test site for long term manure applications (longer than 10 years) with unmanured subplots and variations of manured subplot rates. The TSM machine did not indicate any patterns that might be associated with the manured applications in the plot area at all ECa depth levels.

SDSU Main Campus

The next SDSU field site was on the main campus over a field planted in Oats near the SDSU outdoor Weather Station. A SDSU researcher tested a Geonics EM38 MK2 soil electrical conductivity instrument that was pulled directly behind the TSM device during test runs. The EM38 MK2 relies on the same principles as the TSM sensor for electrical conductivity measurement.

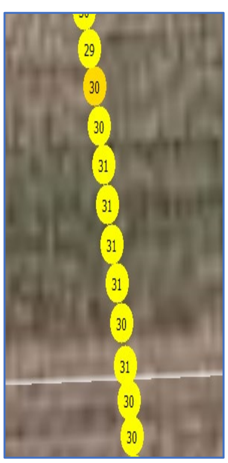
The TSM unit seemed to be performing as expected on this run at the SDSU field with the unit run both parallel and perpendicular to the field's planted oats. The Geonics EM38 MK2 unit was pulled directly behind the TSM unit in the same track path at the same time. The patterns developed by the Geonics Sensor and the TSM Sensor were similar. The differences in the two sensor ECa values may be due to device position placement. The TSM unit being vehicle mounted twelve inches above the ground. While the Geonics EM38 Device was placed in a sled and pulled on the ground by the ATM vehicle.

EM38 MK2



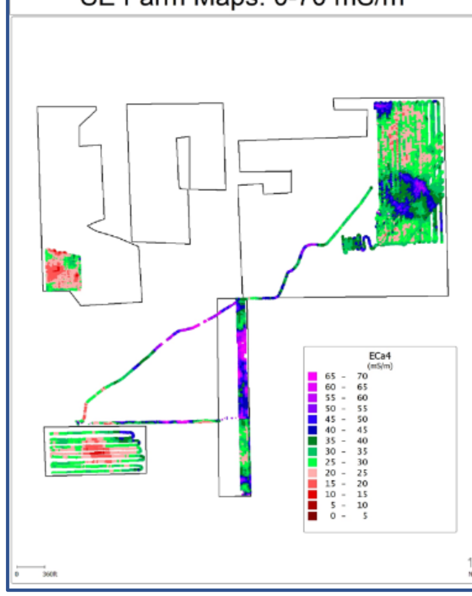
Part 5: SE-Farm TSM sensor runs

The TSM unit was run over approximately 280 acres at the SE-Farm with test runs of the unit starting in April and early May then final runs in late May. The early trial runs centered on evaluating the functioning of the TSM unit and data retrieval from the unit. The TSM instrument initially was tested on small plot areas at the SE Farm for soil compaction differences. The TSM unit was driven parallel with crop rows then slowly across the rows to see what differences appeared in the sensor output. However, the sensor did not pick up any distinct ECa value differences in uncompacted soil areas adjacent to compacted soil paths caused by wheel traffic. The most noticeable ECa sensor variations were from general terrain soil differences due to soil texture, soil moisture, plot treatment and traveling over grass roadways. The sensor picked up recognizable variations from ECa sensor output attributed to these soil field attributes. The images illustrate the sensor runs at the SE-Farm.



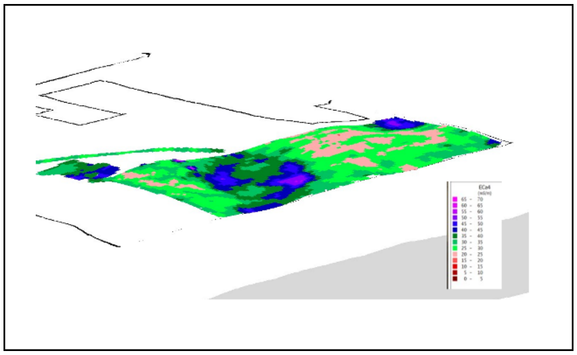
TSM sensor driven across a compacted soil area with sensor values shown.

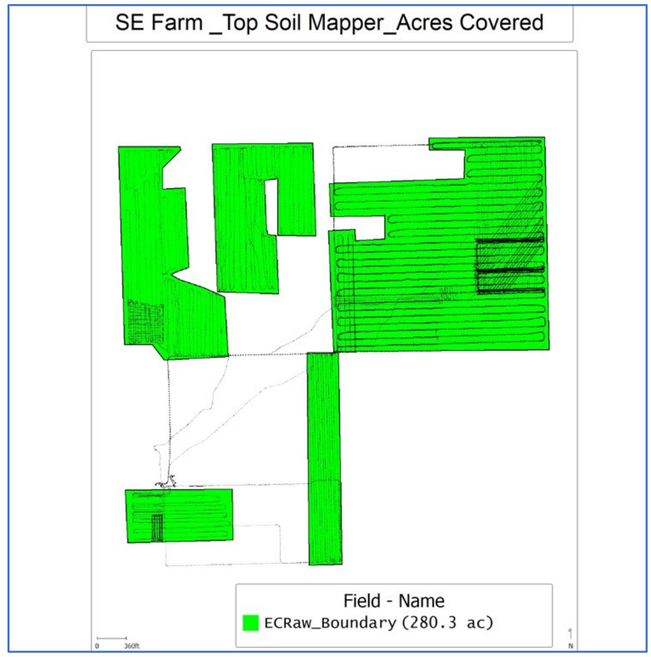
SE Farm Maps: 0-70 mS/m



The TSM sensor was driven across several fields in April- early May. The TSM sensor seemed to be picking up general field patterns that could be related to apparent electrical conductivity readings. It even appeared to pickup a disposal area in the NE Quarter connected to the old Farmstead. Large conductance readings of four hundred mS/m appeared right over the small area.

NE Quarter Site

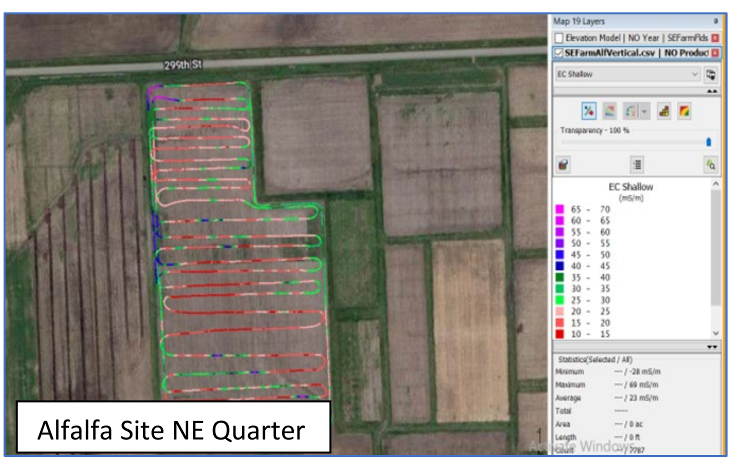




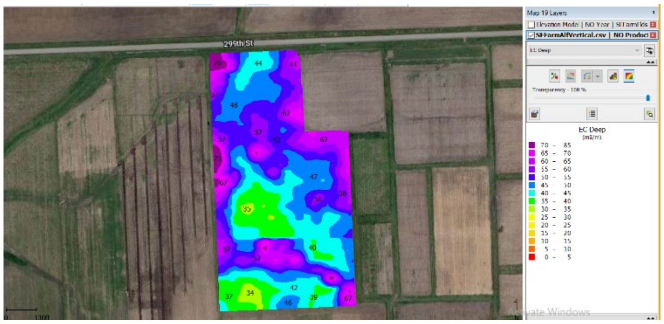
The TSM sensor covered a total of 280 acres on the SE Farm, but the late May runs, principally in the NW quarter, appeared to be inappropriate with high values. A total of 380 acres were covered by the device including from offsite runs, separate from the SE Farm.

Part 6: SE Farm: Geonics EM38 MK2 Sensor Runs

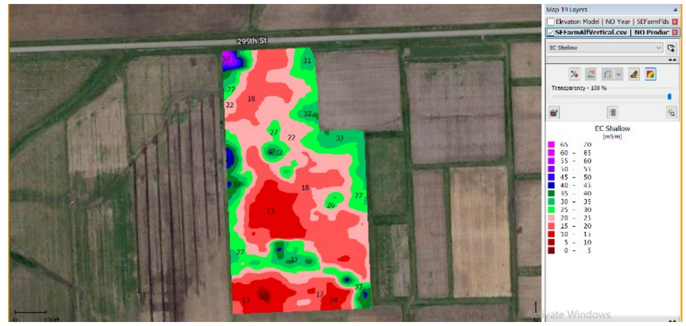
The Geonics Sensor has two modes (Horizontal and Vertical). The Horizonal mode measures ECa at cumulative depths of 0.375 m (1.25 ft: EC Shallow) and 0.75 meters (≈2.5 ft: EC Deep). The Vertical mode measures ECa at cumulative depths of 0.75 m (2.5 ft: EC Shallow) and 1.5 meters (≈4.5 ft: EC Deep). The SDSU EM38 instrument was tested on two SE Farm field areas. Images for the EM38 data collection maps follow:



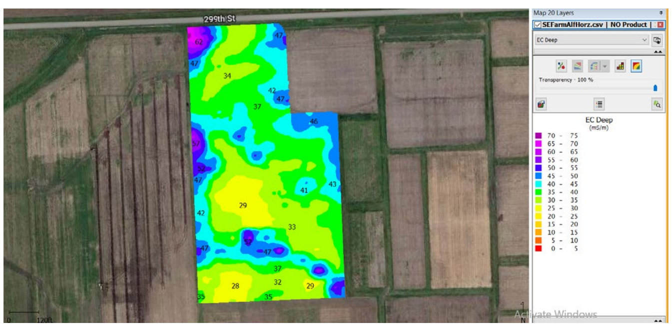
EC Deep Vertical



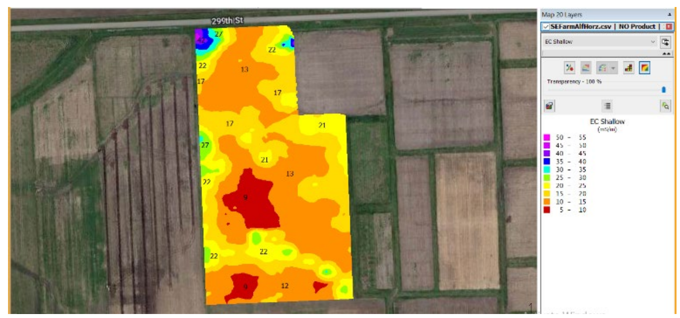
EC Shallow Vertical



EC Deep Horizontal

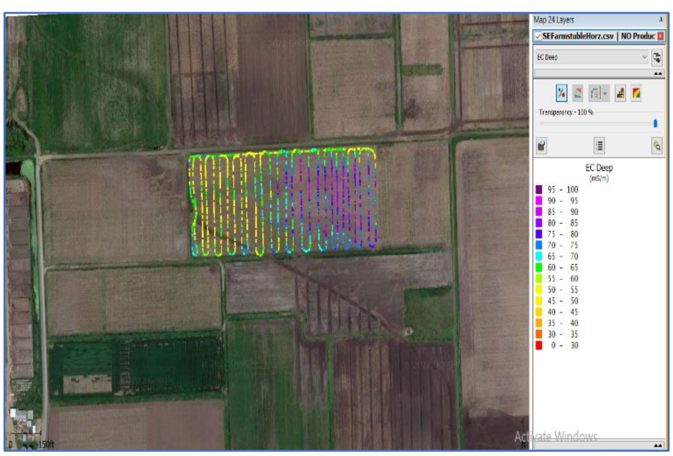


EC Shallow Horizontal



Site 2: Old Tree Break Plot Area

Geonics Horizontal Deep



Geonics Horizontal Shallow

Geonics EM38 MK2 Summary:

The Geonics ECa maps depicted are early initial runs performed by the SDSU device. Consequently, there is still a learning curve on interpreting the results and using the device to its capabilities. An off-hand comment is that the Zone patterns for the two fields are similar for the different cumulative depth levels even when the ECa sensor values were of a different extent. Since the SDSU instrument runs were initial feedback, it is best left to just display the output while the sensor is still being evaluated by SDSU personnel.

Comments: The EM38 device was easy to mechanically use and the Bluetooth merging of High accuracy DGPS data with the Geonics sensor worked exceedingly well. The capability of pulling the EM38 device on the ground-surface minimized the bouncing effect that the TSM Device exhibited during data collection. The EM38 device could be site calibrated while the TSM unit was factory calibrated. The TSM unit when working properly showed good utility for Field Zone development but the EM38 MK2 sensor also demonstrated that utility and seemed to have more definition of zones. Using raw EC data from the TSM device, we were not able to identify wheel tracks or known compacted areas in our preliminary trials.