EXTENSION
On-Farm Research

ON-FARM RESEARCH RESULTS 2020

University of Nebraska–Lincoln

Conference Publication Jan. 2021 **EC3054**

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NEBRASKA ON-FARM RESEARCH NETWORK

2021 Results Update Meetings

February 25

- **AUBURN** - 4-H Building Nemaha County Fairgrounds, 816 I St., Auburn, NE
- **BEATRICE** - Gage County Extension Office, 1115 West Scott, Beatrice, NE
- **CLAY CENTER** - Clay County fairgrounds, 701 N Martin Ave, Clay Center, NE
- **DAVID CITY** - David City Library, 399 N 5th St, David City, NE
- **WAHOO** - Lake Wanahoo Education Building, 655 County Road 16, East side of Lake Wanahoo, Wahoo, NE
- **YORK** - Cornerstone Event Center, Fairgrounds York, 2400 N. Nebraska Ave., York, NE
- **ONLINE PARTICIPATION**

February 26

- **ALLIANCE** - Knight Museum, 908 Yellowstone, Alliance, NE
- **CLAY CENTER** - Clay County fairgrounds 701 N Martin Ave, Clay Center, NE
- **KEARNEY** - Buffalo County Extension Office, 1400 E. 34th (Fairgrounds), Kearney, NE
- **NEBRASKA CITY** - Kimmel Orchard Education Building, 5995 G Rd. Nebraska
- **NORFOLK** - Madison County Extension, 1305 S. 13th Street, Norfolk, NE
- **NORTH PLATTE** - West Central Research, Extension, and Education Center (WCREEC), 402 W. State Farm Road, North Platte, NE
- **OSCEOLA** - Polk County fairgrounds, Ag Hall, 12931 N Blvd, Osceola, NE
- **SEWARD**- Harvest Hall, Fairgrounds Seward, 1625 Fairgrounds Circle, Seward, NE
- **WEST POINT** - Nielsen Center- West Point, 200 Anna Stalp Ave, West Point, NE
- **WILBER**- Saline County Extension Office, 306 W 3rd Street, Wilber, NE
- **ONLINE PARTICIPATION**

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NEBRASKA SOYBEAN CHECKOFF

Nebraska Dry Bean Commission

University of Nebraska–Lincoln Institute of Agriculture and Natural Resources

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Table of Contents

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NEBRASKA ON-FARM RESEARCH NETWORK

Special thanks to the cooperators involved with the
on-farm research projects listed in this report.

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Thank you also to the companies and businesses
that assisted with the research projects.

NEBRASKA ON-FARM RESEARCH NETWORK

In production ag it's what you think you know, that you really don't know, that can hurt you.

Nebraska Extension On-Farm Research Network Introduction

Laura Thompson
Nebraska Extension Educator and
On-Farm Research Network Coordinator

On-farm research can provide a great avenue to accelerate learning about topics that impact farm productivity and profitability. It is research that you do on your field, using your equipment, and with your production practices. This means the research is directly applicable to your operation. The Nebraska On-Farm Research Network approaches topics that are critical to farmer productivity, profitability, and sustainability. These topics include nutrient management, pest control, irrigation strategies, conservation programs, new technologies, soil amendments, cultural practices, and hybrid and variety selection. Research comparisons are identified and designed to answer producers' production questions. Projects' protocols are developed first and foremost to meet individual cooperator needs. Multiple-year comparisons are encouraged.

We thank all the cooperators who were involved in the valuable research studies contained in this report. Your efforts lead to new discovery and validate current production practices. We also thank the Nebraska Corn Board, Nebraska Corn Growers Association, Nebraska Soybean Board, and Nebraska Dry Bean Commission for the financial support that makes this research, publication, and update meetings possible.

We invite you to become an on-farm research participant. To learn more or to discuss this report, please contact Nebraska Extension On-Farm Research Coordinator, Laura Thompson (contact information is on page 6), visit us online at http://cropwatch.unl.edu/on-farm-research, or find us on Facebook and Twitter.

Unless otherwise noted, data in this report were analyzed using Statistixs 10.0 Analytical Software and means were separated using Tukey's HSD (honest significant difference) test.

Statistics 101

Replication: In statistics, replication is the repetition of an experiment or observation in the same or similar conditions. Replication is important because it adds information about the reliability of the conclusions or estimates to be drawn from the data. The statistical methods that assess that reliability rely on replication.

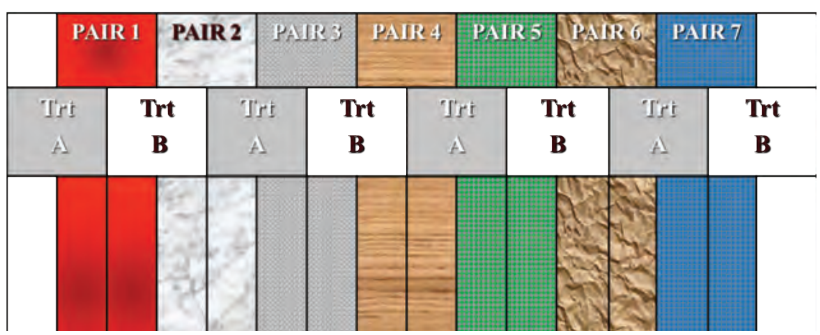
Randomization: Using random sampling as a method of selecting a sample from a population in which all the items in the population have an equal chance of being chosen in the sample. Randomization reduces the introduction of bias into the analysis. Two common designs that meet these criteria are shown below.

What is the P-Value? In field research studies we impose a *treatment* – this treatment may be a new product or practice that is being compared to a standard management. Both the **treatments** that we are testing and **random error** (such as field variability) influence research results (such as yield). You intuitively know that this error exists – for example, the average yield for each combine pass will not come out exactly the same, even if no treatments were applied. The Probability (P) -Value reported for each study assists us in determining if the differences we detect are due to error or due to the treatment we have imposed.

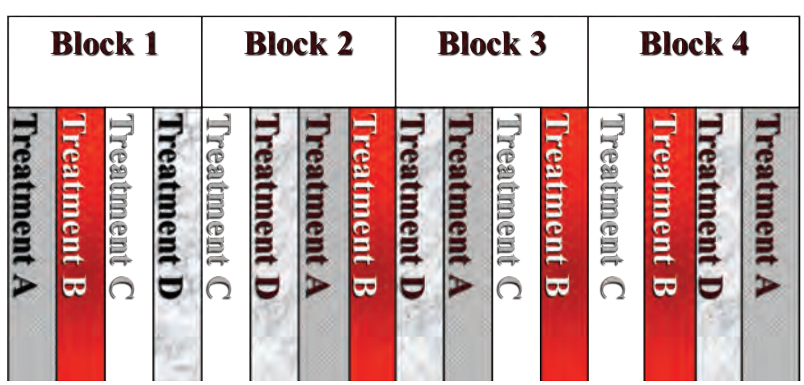
- As the P-Value decreases, the probability that differences are due to random chance decreases.
- As the P-Value increases, we are less able to distinguish if the difference is due to error or the treatment (hence, we have less confidence in the results being due to the treatment).

For these studies, we have chosen a cutoff P-Value of 10%; therefore, if the P-Value is greater than 10% we declare that there are not statistically significant differences due to the treatments. If the value is less than 10%, we declare that differences between treatments are statistically significant. When this is the case, we follow the yield values with different letters to show they are statistically different. The value of 10% is arbitrary – another cutoff could be chosen. As you increase your cutoff value, however, you increase the chance that you will declare that treatments are different when they really are not. Conversely, if you lower the P-Value, you are more likely to miss real treatment differences.

Paired comparison design



Randomized complete block design



PROFIT CALCULATION

Many of our studies include a net return calculation. It is difficult to make this figure applicable to every producer. In order to calculate revenue for our research plots we use input costs provided by the producer, application costs from Nebraska Extension's 2020 Nebraska Farm Custom Rates and an average commodity market price for 2020.

Average market commodity prices for the 2020 report are:

Corn	$3.51/bu
Soybeans	$9.50/bu
Cereal Rye	$6.01/bu
Pinto Beans	$24/cwt ($14.40/bu at 60 lb/bu)

For each study, net return is calculated as follows:
Net Return = gross income (yield × commodity price) - treatment cost.

In order to make this information relevant to your operation, you may need to refigure return per acre with costs that you expect.

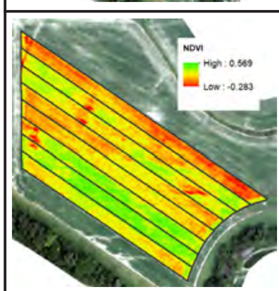
RAINFALL DATA

Rainfall data is provided for each study based on the field location. The rainfall graphs are developed using data from National Weather Service radar and ground stations that report rainfall for 1.2 × 1.2 mile grids.

FarmLogs https://farmlogs.com

AERIAL IMAGERY

For many studies, aerial imagery was captured using a drone or airplane. Drone imagery may be captured through a number of different platforms. Airplane imagery was acquired from TerrAvion (https://www.terravion.com/). Throughout this report, imagery may be displayed in several ways:

	**True Color Imagery/RGB:** True Color imagery displays the Earth in colors similar to what we might see with our own eyes. This product is a combination of the red, green, and blue wavebands of visible light and, as such, is sometimes referred to as RGB imagery.
	**Normalized Difference Vegetation Index (NDVI):** NDVI is calculated using the red and near-infrared (NIR) wavebands as follows: NDVI = (NIR-Red)/(NIR+Red). This index is often correlated with plant biomass and chlorophyll content. Higher NDVI values are indicative of greater plant biomass and/or a higher chlorophyll concentration. In the example at left, NDVI was displayed with a green to red color ramp: areas with higher NDVI values appear bright green, areas with lower NDVI values appear red and intermediary values are yellow. **Normalized Difference Red Edge (NDRE) Index:** This index is similar to NDVI, and is displayed similarly to NDVI, but is calculated with the red edge waveband in place of the red waveband as follows: NDRE = (NIR-Red Edge)/(NIR+Red Edge). NDRE is also correlated with plant biomass and chlorophyll content. This index is often preferred over NDVI when looking at high biomass crops (such as corn in the mid and late growth stages). Higher NDRE values are indicative of greater plant biomass and/or higher chlorophyll concentration.

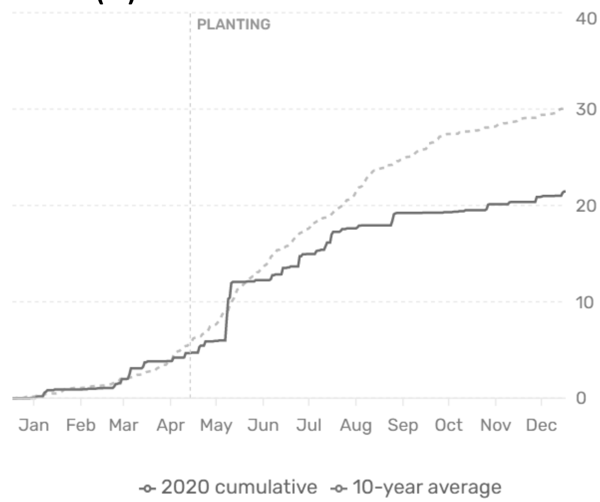
CROP PRODUCTION

CLICK TO WATCH A VIDEO ABOUT THIS STUDY https://go.unl.edu/cornvr

Impact of Variable-Rate Corn Seeding on Yield and Profitability

Study ID: 0908079202001
County: Hall
Soil Type: Hall silt loam sandy substratum 0-1% slope
Planting Date: 4/28/20
Harvest Date: 10/13/20
Population: Varied
Row Spacing (in): 30
Hybrid: Fontanelle Hybrids® 13D843
Reps: 7
Previous Crop: Soybean
Tillage: Strip/ridge-till; fall strip-till, strips freshened in spring. Ridges made at V10.
Herbicides: ***Pre:*** 32 oz/ac Roundup®, 64 oz/ac Degree®, 1.5 qt/ac Warrant®, 2.5 lb/ac AMS ***Post:*** 32 oz/ac Roundup®, 3 oz/ac Status®, 2.5 lb/ac AMS
Seed Treatment: Acceleron® Basic
Foliar Insecticides: None
Foliar Fungicides: None

Fertilizer: 150 lb/ac MAP in mid-March; 27 gal/ac 32-0-0 UAN in early spring; 3.5 gal/ac 10-34-0; 1 pt/ac chelated zinc 10% in-furrow while planting; 25 gal/ac 32-0-0 UAN sidedressed in mid-May
Note: Field experienced ~15% wind damage/green snap
Irrigation: Gravity, Total: ~16"
Rainfall (in):



Introduction: The objective of this study was to evaluate a variable-rate seeding prescription for corn. Passes with the variable-rate prescription were compared to passes of a single, standard flat rate (Figure 1). The portion of the field chosen for the study has higher soil textural variability and higher sand content than the majority of the field. The variable-rate seeding prescription was developed by reviewing past yield data, then delineating differing yield zones based on areas with consistently lower yields than the remainder of the field. In the variable-rate prescription, the lowest seeding rate was 22,000 seeds/ac, corresponding to the lowest yielding portion of the field (~15% lower yields than surrounding areas). The 26,000 seeds/ac rate corresponded to yields that were ~12% lower than the surrounding field; the 31,500 seeds/ac rate corresponded to yields that were ~8% lower than the surrounding field; the 34,500 seeds/ac rate corresponded to yields that were ~5% lower than the surrounding field. In the variable rate plot area, the average seeding rate for the variable-rate strips was 30,880 seeds/ac. The average seeding rate for the standard, flat-rate strips was 34,060 seeds/ac. The same planter was used for both variable-rate and flat-rate strips. Stand counts were taken in different, representative areas of variable-rate and flat-rate strips on June 8, 2020 and are shown in Figure 2.

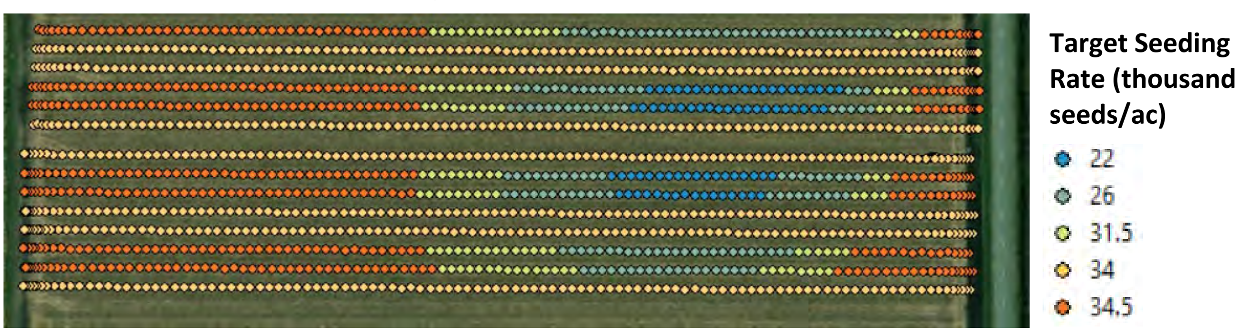


Figure 1. Variable seeding rate strips with rates ranging from 22,000 to 34,500 seed/ac compared to standard flat-rate strips of 34,000 seed/ac.

Results:

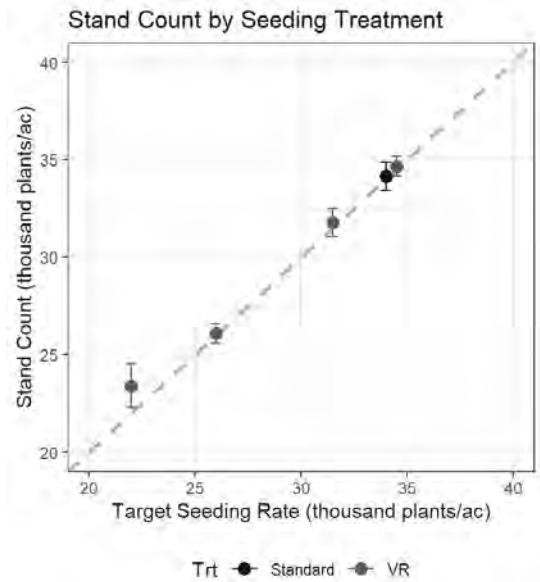


Figure 2. Mean (dots) and standard deviation (bars) for stand count versus target seeding rate for standard and variable-rate treatments. Points falling above the grey dashed line indicate stand counts were higher than the target seeding rate.

	Moisture (%)	Yield (bu/ac)†	Marginal Net Return‡ ($/ac)
Standard Seeding	14.7 A*	231 A	792.89 A
VR Seeding	14.6 A	230 A	808.45 A
P-Value	0.419	0.924	0.268

*Values with the same letter are not significantly different at a 90% confidence level.
†Yield values are from cleaned yield monitor data. Bushels per acre corrected to 15.5% moisture.
‡Marginal net return based on $3.51/bu corn and $275/80,000 seeds.

	Yield by Seeding Zone Analysis†		
	Low Zone (VR: 22,000 seeds/ac vs. Standard: 34,000 seeds/ac)	**Mid Zone (VR: 31,500 seeds/ac vs. Standard: 34,000 seeds/ac)**	**High Zone (VR: 34,500 seeds/ac vs. Standard: 34,000 seeds/ac)**
Standard Seeding	164 A*	233 A	263 B
VR Seeding	165 A	228 A	266 A
P-Value	0.932	0.245	0.056

*Values with the same letter are not significantly different at a 90% confidence level.
†Yield values are from cleaned yield monitor data. Bushels per acre corrected to 15.5% moisture.

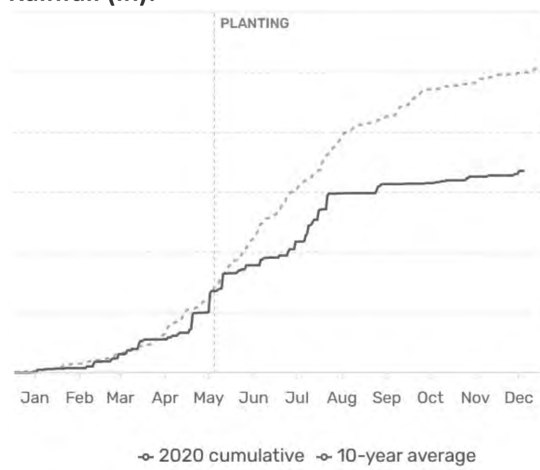
Summary:

- Overall, stand counts were close to the target seeding rates. At the lowest variable-rate target of 22,000 seeds/ac, stand counts were higher than the target rate (Figure 2).
- Overall, there was no difference in grain moisture or yield between the standard-rate and variable-rate treatments.
- Net return was not statistically different between the standard-rate and variable-rate treatments.
- Seeding rate impact on yield was also evaluated within three of the management zones. In the low and mid zones, the lower seeding rates used in the VR strips did not result in different yields than the higher seeding rates used in the standard rate strips showing an opportunity to save on seed costs. However, in the high zone, despite very similar seeding rates for the VR seeding and standard seeding (34,500 seeds/ac versus 34,000 seeds/ac) there was a yield difference. It is unknown what would have caused this yield difference.

Organic Soybean Planting Population

Study ID: 0641047202001
County: Dawson
Soil Type: Cozad silt loam; Cozad silty clay loam; Hord silt loam; Hord silty clay loam
Planting Date: 5/19/20
Harvest Date: 10/2/20
Row Spacing (in): 36
Hybrid: 291GHXG
Reps: 5
Previous Crop: Corn
Tillage: Full Tillage, Chisel 3/15/17
Herbicides: ***Pre:*** None ***Post:*** None
Seed Treatment: None
Foliar Insecticides: None
Foliar Fungicides: None
Fertilizer: None

Irrigation: Pivot, Total: 7.2”
Rainfall (in):



Soil Tests:

Soil pH 1:1	Soluble Salts 1:1 mmho/cm	OM LOI-%	KCl Nitrate ppm N	Nitrate Lbs N/ac	P ppm	-Ammonium Acetate- K ppm	Ca ppm	Mg ppm	NA ppm	M-3 Sulfate ppm S	------------DTPA------------ Zn ppm	Fe ppm	Mn ppm	Cu ppm	Hot Water Boron ppm	Sum of Cations Me/100g	% Base ---Saturation--- H	K	Ca	Mg	Na
7.6	0.31	2.6	2.4	6	32	571	2194	726	262	51.4	1.27	34.5	5.7	1.01	1.08	19.6	0	7	56	31	6
7.3	0.40	2.6	1.6	4	44	602	2115	787	265	84.8	1.29	34.9	7.5	1.21	1.32	19.8	0	8	53	33	6
7.3	0.15	2.1	3.6	9	20	326	2059	324	38	10.1	.60	12.6	5.8	.45	.39	14	0	6	74	19	1
7.3	.21	3.0	3.8	9	21	403	3293	452	58	17.5	.95	26.4	6.9	.80	.46	21.5	0	5	76	18	1
6.8	.20	2.4	2.4	6	15	310	1957	335	42	8.3	.69	24.1	9.3	.59	.50	13.6	0	6	72	21	1
7.3	.18	2.0	.3	1	18	322	2029	324	34	8.9	.76	12.7	6.2	.47	.38	13.8	0	6	73	20	1

Introduction: Previous on-farm research has demonstrated that soybean planting rates of 80,000 to 120,000 seeds/ac were sufficient to optimize yield and could result in higher profitability. The objective of this study was to evaluate the impact of soybean planting population on canopy closure, weed cover, and yield for irrigated organic soybean production. Three soybean seeding rates were evaluated: 135,000 seeds/ac, 160,000 seeds/ac, and 185,000 seeds/ac. Canopy closure is beneficial in reducing weed pressure, particularly in organic systems; therefore, canopy closure and weed pressure were evaluated throughout the growing season to determine how they were impacted by seeding rate. Canopy closure was evaluated using the Canopeo app (Patrignani and Ochsner, 2015). Photos were taken directly over the top of the center two rows of each treatments in three locations. The percent of the image with green cover is reported for each date (Figure 1). Weed pressure was also evaluated with the assistance of the Canopeo app and visual assessment. A 1 m^2 quadrant was flagged and the Canopeo app was used to take a picture of the entire quadrant and determine percent green matter. A visual evaluation was then performed to determine how much of the percent green matter recorded by the Canopeo app was actually weeds. Percent weed cover is reported in Figure 2. Plant stand, yield, and net return were also measured.

Results:

	Early Season Stand Count (plants/ac)	Harvest Stand Count (plants/ac)	Lodging (%)	Pods/ plant	Moisture (%)	Yield (bu/ac)†	Marginal Net Return‡ ($/ac)
135,000 seeds/ac	106,667 C*	101,533 B	1 A	58 A	7.7 A	75 A	646.07 A
160,000 seeds/ac	129,067 B	114,867 A	2 A	49 A	7.9 A	73 A	621.34 B
185,000 seeds/ac	142,800 A	116,000 A	3 A	44 A	7.6 A	75 A	629.62 AB
P-Value	0.001	0.014	0.423	0.179	0.201	0.137	0.063

*Values with the same letter are not significantly different at a 90% confidence level.
†Yield values are from cleaned yield monitor data. Bushels per acre corrected to 13% moisture.
‡Marginal net return based on $9.50/bu soybean and $64.90/unit of 140,000 seeds.

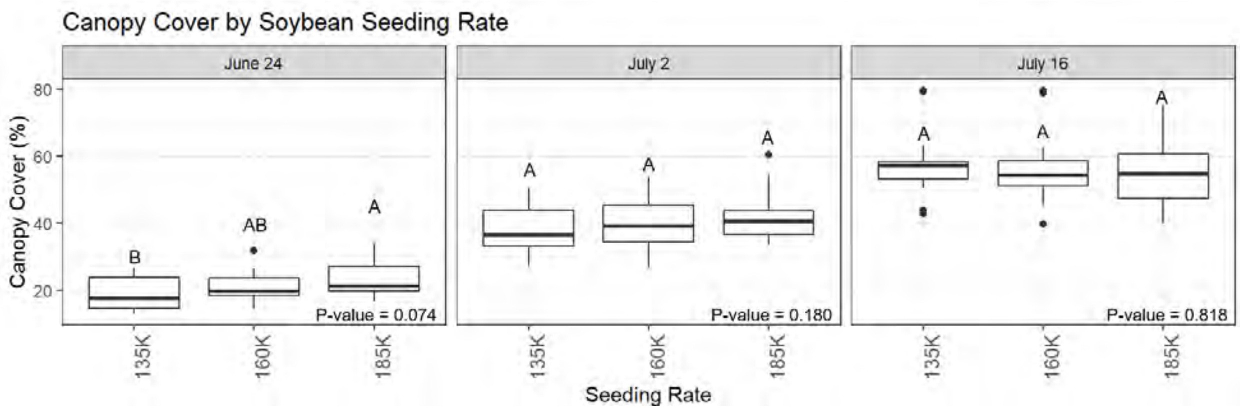


Figure 1. Percent green cover measured with the Canopeo app at three dates for the 135,000, 160,000, and 185,000 seeds/ac soybean planting populations to determine canopy cover.

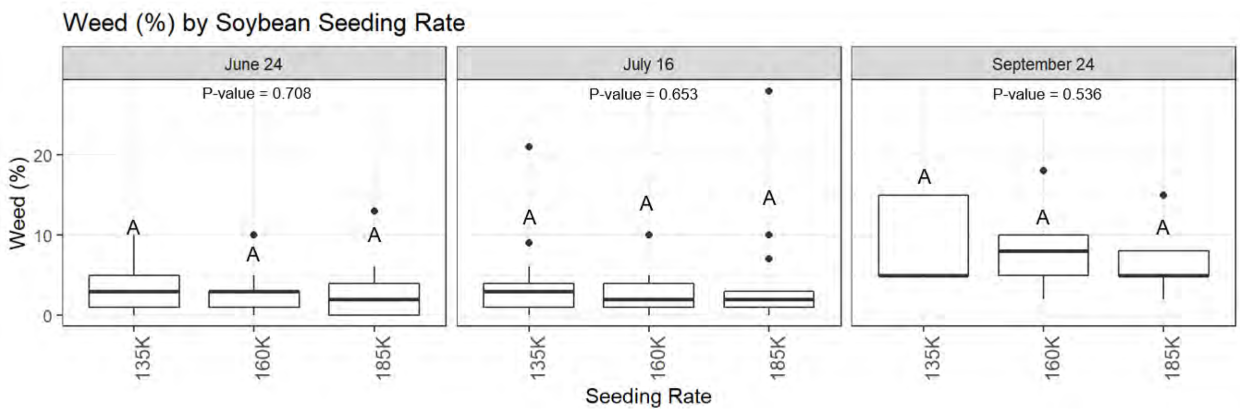


Figure 2. For each seeding rate, the percent of green matter in a 1 m^2 quadrat was recorded using the Canopeo app. Visual assessment was used to determine the percent of green matter in the quadrant that represented weeds.

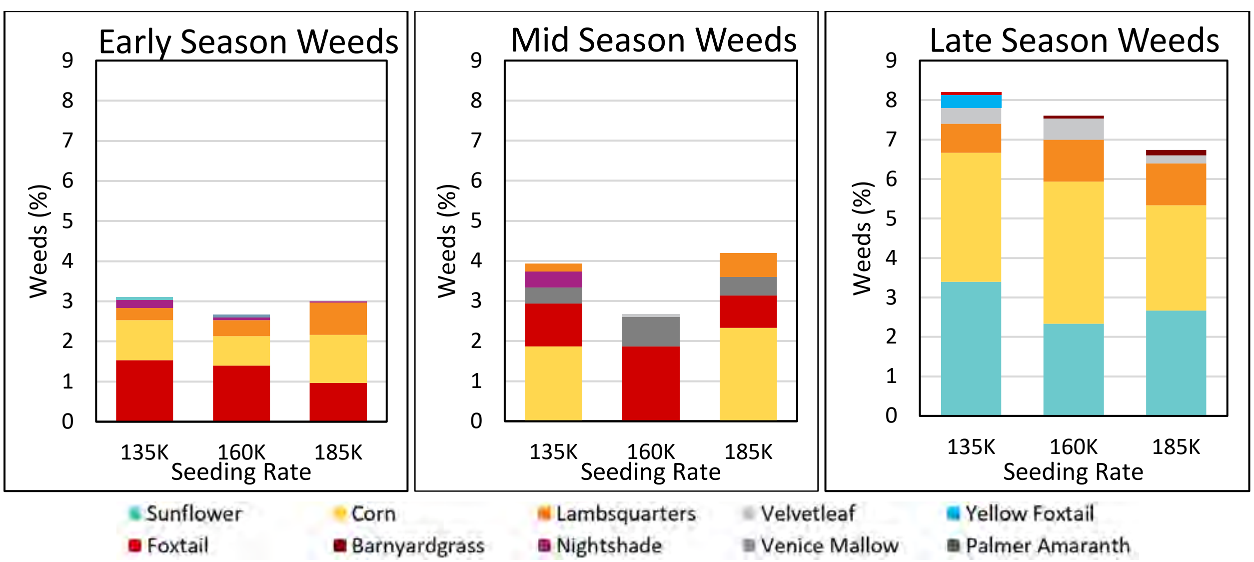


Figure 3. Weeds present for each seeding rate during early, mid, and late season for volunteer corn (*Zea mays*), Palmer Amaranth (*Amaranthus palmeri*), Foxtail species (*Setaria spp.*), Common Lambsquarter (*Chenopodium album*), Common Sunflower (*Helianthus annus*), Venice Mallow (*Hibiscus trionum*), Barnyardgrass (*Echinochloa crusgalli*), Eastern Black Nightshade (*Solanum ptycanthum*), and Velvetleaf (*Abutilon theophrasti*).

	Canopy Closure (% green cover)			Weed Pressure (% of green cover that is weeds)		
	June 24	July 2	July 16	June 24	July 16	September 24
135,000 seeds/ac	19 B	39 A	58 A	3 A	4 A	8 A
160,000 seeds/ac	21 AB	40 A	56 A	3 A	3 A	8 A
185,000 seeds/ac	24 A	42 A	56 A	3 A	4 A	7 A
P-Value	0.074	0.180	0.818	0.708	0.653	0.536

Summary:

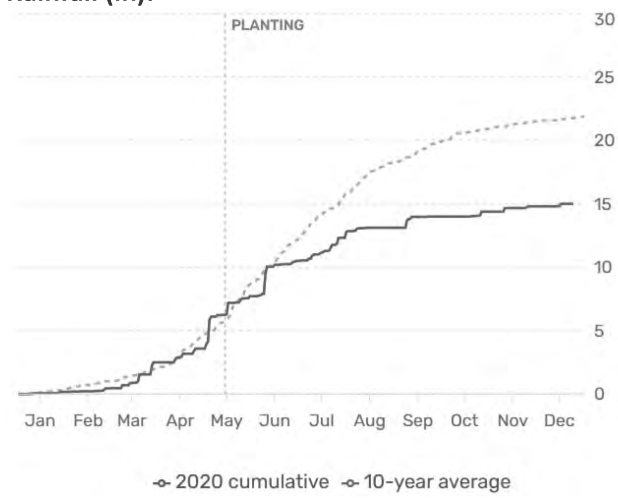
- On June 24, the 135,000 seeds/ac treatment had lower percent canopy cover than the 185,000 seeds/ac; however, on July 2 and July 16, there was no difference in canopy cover between the three seeding rates.
- Percent weed cover was not different between the treatments. Total weed pressure increased as the season progressed, with more weed pressure on September 24 than June 24 or July 16. Weed species on June 24 and July 16 were primarily corn and foxtail. On September 24, weed species were primarily sunflower and corn.
- There was no difference in lodging, pods per plant, or soybean grain moisture between the three seeding rates.
- Yield was not different among the seeding rates evaluated. The 135,000 seeds/ac treatment resulted in higher marginal net return than the 160,000 seeds/ac treatment.

Patrignani, A. and Ochsner, T.E., 2015. Canopeo: A powerful new tool for measuring fractional green canopy cover. Agronomy Journal, 107(6), pp.2312-2320.

Irrigated Soybean Population Study

Study ID: 0153101202001
County: Keith
Soil Type: Kuma loam
Planting Date: 5/14/20
Harvest Date: 10/6/20
Row Spacing (in): 30
Hybrid: Asgrow® AG27X8
Reps: 4
Previous Crop: Corn
Tillage: No-Till
Herbicides: ***Pre:*** Roundup®, Authority® MTZ ***Post:*** Tavium®
Seed Treatment: Inoculant and Fungicide
Foliar Insecticides: None
Foliar Fungicides: None
Fertilizer: None

Irrigation: Pivot, Total: 21.5”
Rainfall (in):



Introduction: Previous on-farm research has demonstrated that soybean planting rates of 80,000 to 120,000 seeds/ac resulted in the highest profitability. The purpose of this study was to evaluate four seeding rates to determine the seeding rate that maximized yield and profit. The target seeding rates were 90,000, 130,000, 160,000, and 190,000 seeds/ac. Stand counts were taken in the 90,000, 130,000, and 160,000 seeds/ac treatments by counting the stems after harvest. Yield, moisture, and net return were evaluated for all seeding rates.

Results:

	Stand Count (plants/ac)	Moisture (%)	Yield (bu/ac)†	Marginal Net Return‡ ($/ac)
90,000 seeds/ac	100,250 A*	6.6 A	54 A	468.06 A
130,000 seeds/ac	96,500 A	6.6 A	55 A	461.30 A
160,000 seeds/ac	108,500 A	6.5 A	55 A	454.57 A
190,000 seeds/ac	N/A	6.7 A	54 A	426.19 B
P-Value	0.285	0.134	0.306	0.009

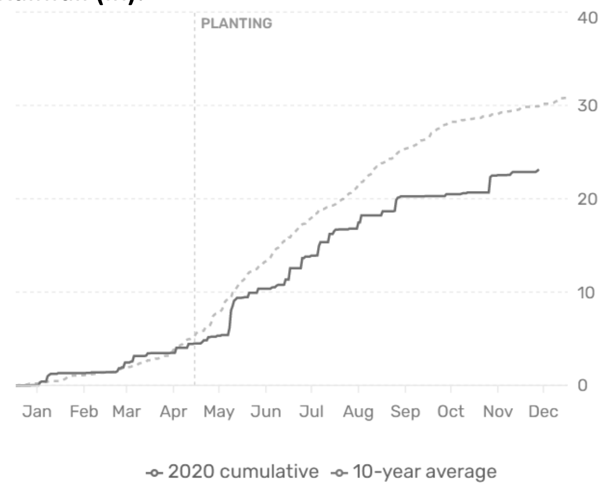
*Values with the same letter are not significantly different at a 90% confidence level.
†Yield values are from cleaned yield monitor data. Bushels per acre corrected to 13% moisture.
‡Marginal net return based on $9.50/bu soybean and $61.80/unit of 140,000 seeds.

Summary:

- Stand counts were only taken in the 90,000, 130,000, and 160,000 seeds/ac treatments. There was no difference in plant stand between the seeding rates evaluated. Stand counts were not close to the target seeding rates and were not consistently higher or lower than the target. The as-planted file was examined and actual seeding rates were within 10% of the target seeding rates.
- Yield and grain moisture were not different between the four seeding rates evaluated.
- Marginal net return was lower for the 190,000 seeds/ac treatment.

Irrigated Soybean Population Study

Study ID: 0276185202002
County: York
Soil Type: Hastings silt loam
Planting Date: 4/29/20
Harvest Date: 9/21-22/20
Row Spacing (in): 30
Hybrid: Pioneer® P27A30X
Reps: 12
Previous Crop: Corn
Tillage: Spring tillage, row cultivation, hilling
Herbicides: ***Pre:*** 5 oz/ac Sonic® at planting ***Post:*** 1.5 pt/ac Ultra Blazer®, 1.33 pt/ac Brawl™, and 26 oz/ac Durango® on 6/11/20; 6 oz/ac Targa® on 6/22/20
Seed Treatment: PPST 120+Lumisena™, EverGol® Energy, PPST 2030, Gaucho®
Foliar Insecticides: 5 oz/ac Hero® on 7/24/20
Foliar Fungicides: 5 oz/ac Top Guard® on 7/24/20
Fertilizer: 175 lb/ac MESZ on 11/20/19
Irrigation: Pivot, Total: 2"
Rainfall (in):



Soil Tests (November 2019, 2 samples were collected in the study area):

Soil pH 1:1	Modified WDRF BpH	Soluble Salts 1:1 mmho/cm	Organic Matter LOI-%	KCl Nitrate ppm N	Nitrate Lbs N/A	M-3 ppm P	-Ammonium Acetate- K ppm	Ca ppm	Mg ppm	NA ppm	M-3 Sulfate ppm S	----------DTPA---------- Zn Ppm	Fe Ppm	Mn Ppm	Cu ppm	Sum of Cations Me/100g	% Base ---Saturation--- H	K	Ca	Mg	Na
6.3	6.6	0.17	3.2	5.4	16	11	402	2078	306	34	9.1	2.54	39.3	12.8	.75	17.9	21	6	58	14	1
6.8		0.21	3.4	4.1	12	32	547	2912	536	44	9.0	2.33	36.0	7.8	1.16	20.6	0	7	70	22	1

Introduction: Previous on-farm research has demonstrated that soybean planting rates of 80,000 to 120,000 seeds/ac were sufficient to optimize yield and could result in higher profitability. The goal of this research was to utilize precision agriculture technology for conducting on-farm research. This study tested four soybean planting rates: 80,000 seeds/ac, 110,000 seeds/ac, 140,000 seeds/ac, and 170,000 seeds/ac. The remainder of the filed was planted at 120,000 seeds/ac and 130,000 seeds/ac. Treatments were randomized and replicated in 60' wide by 250' long blocks across the field (Figure 1). Variable-rate prescription maps were created and uploaded to the in-cab monitor to implement the study. Geospatial yield monitor data were collected at the end of the growing season and post-processed to remove errors with Yield Editor software from the USDA. The as-planted data were evaluated and only areas that achieved planting rates within 10% of the target seeding rate were included for yield analysis; 12 blocks shown in Figure 1 were used in the yield analysis. Stand counts were taken on September 14 for six of the replications.

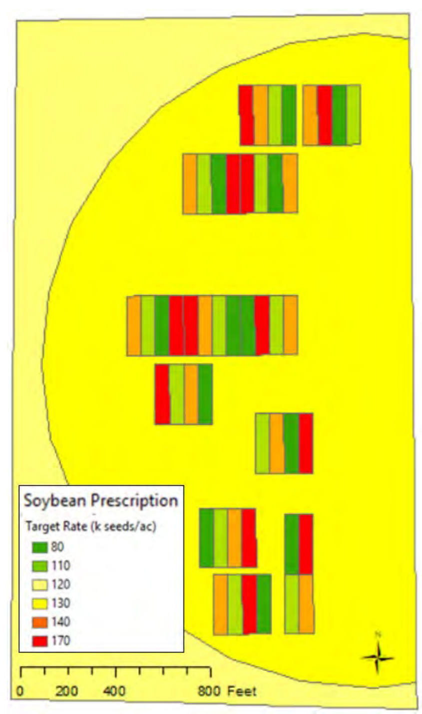


Figure 1. Soybean seeding rate prescription map for 2020 field

Results:

	Stand Count (plants/ac)	Yield (bu/ac)†	Marginal Net Return‡ ($/ac)
80,000 seeds/ac	71,083 D*	87 A	793.45 A
110,000 seeds/ac	91,083 C	88 A	786.55 A
140,000 seeds/ac	121,000 B	87 A	767.23 AB
170,000 seeds/ac	137,417 A	86 A	737.82 B
P-Value	<0.0001	0.348	0.0004

*Values with the same letter are not significantly different at a 90% confidence level.
†Yield values are from cleaned yield monitor data. Bushels per acre corrected to 13% moisture.
‡Marginal net return based on $9.50/bu soybean and $62.30/140,000 seeds.

Summary:

- Plant populations at this site ranged from 81% to 89% of the target seeding rate.
- Yield was not different among the four seeding rates evaluated.
- Net return was higher for the 80,000 and 110,000 seed/ac treatments than for the 170,000 seed/ac treatment. The 140,000 seed/ac treatment did not have a statistically different net return than the other treatments.

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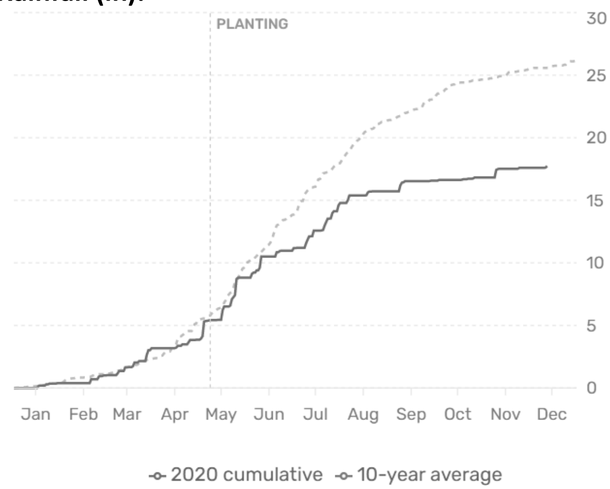
Irrigated Soybean Population Study

Study ID: 0709047202005
County: Dawson
Soil Type: Cozad silt loam; Hord silt loam; Wood River silt loam
Planting Date: 5/8/20
Harvest Date: 10/3/20
Population:
Row Spacing (in): 30
Hybrid: Pioneer® P29A25 and Channel® 2519R2X
Reps: 10
Previous Crop: Corn
Tillage: Strip-till
Herbicides: ***Pre:*** 24 oz/ac Mad Dog® 5.4#, 12.8 oz/ac Engenia®, 2.5 oz/ac Valor® XLT on 5/15/20
Post: 24 oz/ac Mad Dog® 5.4# on 6/23/20
Seed Treatment: NemaStrike™, Optimize® inoculant, Acceleron® Elite
Fertilizer: 1 gal/ac Altura™, 1 gal/ac ReaX™ Mn, 0.125 gal/ac ReaX™ Zn on 5/8/20 in-furrow starter

Irrigation: Pivot, Total: 4"
Rainfall (in):



Soil Tests (December 2019, 6 sample points from within the study area):

Soil pH 1:1	Soluble Salts 1:1 mmho/cm	Organic Matter LOI %	KCl Nitrate – N ppm N	Nitrate lb N/A	Mehlich P-III ppm P	$CaPO_4$ SO_4-S ppm	Ammonium Acetate (ppm) K	Ca	Mg	Na	Sum of Cations me/100g	DPTA (ppm) Zn	Fe	Mn	Cu
7.2	0.6	2.7	8	19	35	8	395	2826	368	51	18	1.0	17.5	6.0	0.6
7.3	0.6	2.6	6	14	25	8	425	3337	390	53	21	0.9	22.2	6.3	0.7
6.9	0.7	3.0	6	14	75	34	480	2949	413	63	20	1.5	25.7	6.5	0.7
6.9	0.5	3.4	8	19	63	6	503	2477	357	53	17	2.1	32.7	8.1	0.9
6.8	0.5	3.9	18	43	179	12	639	2997	428	45	20	4.0	35.5	9.4	1.1
7.0	0.6	3.4	17	41	101	13	594	2689	447	56	19	2.4	31.5	8.0	1.1

Introduction: Previous on-farm research has demonstrated that soybean planting rates of 80,000 to 120,000 seeds/ac were sufficient to optimize yield and could result in higher profitability. The goal of this research was to utilize precision agriculture technology for conducting on-farm research. This study tested four soybean planting rates: 80,000 seeds/ac, 110,000 seeds/ac, 140,000 seeds/ac, and 170,000 seeds/ac. The remainder of the field was planted at 120,000 seeds/ac. Treatments were randomized and replicated in 90' wide by 300' long blocks across the field (Figure 1). A variable-rate prescription map was created and uploaded to the in-cab monitor to implement the study. Geospatial yield monitor data were collected at the end of the growing season and post-processed to remove errors with Yield Editor software from the USDA. The as-planted data were evaluated and only areas that achieved planting rates within 10% of the target seeding rate were included for yield analysis; 10 of the 14 originally planned blocks were used in the yield analysis (Figure 1). Stand counts were taken on June 29 and September 30 for eight of the replications. There were two varieties used in this study. There were no interactions between variety and seeding rate; therefore, seeding rate data is presented in the results table.

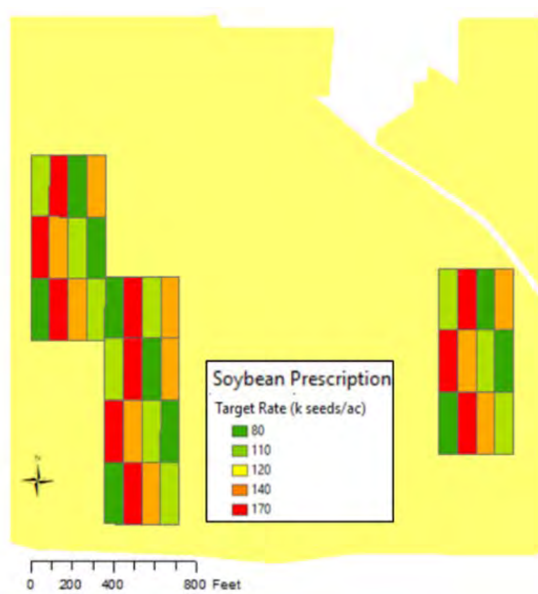


Figure 1. Soybean seeding rate prescription map for 2020 field site.

Results:

	Early Season Stand Count (plants/ac)	Harvest Stand Count (plants/ac)	Moisture (%)	Yield (bu/ac)†	Marginal Net Return‡ ($/ac)
80,000 seeds/ac	67,458 D*	63,708 D	10.1 A	81 A	740.97 A
110,000 seeds/ac	93,792 C	83,458 C	9.8 A	79 A	711.72 A
140,000 seeds/ac	119,542 B	99,417 B	10.0 A	81 A	714.47 A
170,000 seeds/ac	148,500 A	123,875 A	9.9 A	82 A	718.79 A
P-Value	<0.0001	<0.0001	0.314	0.685	0.602

*Values with the same letter are not significantly different at a 90% confidence level.
†Bushels per acre corrected to 13% moisture.
‡Marginal net return based on $9.50/bu soybean and $50/140,000 seed unit.

Summary:

- Plant populations at this site ranged from 83% to 87% of the target seeding rate.
- Yield and net return were not statistically different among the four seeding rates evaluated.

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Soybean Maturity Group Studies

With early planting of soybean (in April or as close to May 1 as possible), a longer-season variety may help take advantage of the longer growing season. However, some growers in South-Central Nebraska are also obtaining high yields with mid-group 2 varieties. The goal of this study was to determine if growers should plant a longer-season maturity soybean to achieve optimum yields when planting early. Group 2 and group 3 soybeans were evaluated at ten sites in 2018, 2019, and 2020. The varieties used and exact maturity dates varied among sites.

SITES

Ten studies were conducted in Seward, York, and Merrick counties in 2018 through 2020 (Figure 1). Site details are displayed in Table 1.

Table 1. Sites, location, year, replications, varieties used, planting date, and irrigation status for ten sites evaluating soybean maturity groups.

ID	Report ID	County	Year	Reps	Group 2 Variety	Group 3 Variety	Planting	Irrigation
2018-1	0006159201801	Seward	2018	6	Big Cob BC24cr2x	Big Cob BC35wr2x	5/2/18	Pivot
2018-2	0802159201801	Seward	2018	3	Pioneer 25A12X	Pioneer 31A22X	5/7/18	None
2018-3	0118185201801	York	2018	7	Golden Harvest GH 2788X	NK S30-C1	5/2/18	Pivot
2019-1	0802159201901	Seward	2019	3	Pioneer 21A28X	Pioneer 31A22X	4/22/19	None
2019-2	0802159201902	Seward	2019	4	Pioneer 24A99X, Pioneer 27A17X	Pioneer 31A22X, Pioneer 33A53X	5/2/19	Gravity
2019-3	0118185201902	York	2019	6	Golden Harvest GH 2788X	Golden Harvest GH 3475X	5/16/19	Pivot
2020-1	0802159202002	Seward	2020	3	Pioneer 21A28X	Pioneer 31A22X	4/15/20	None
2020-2	0802159202003	Seward	2020	3	Pioneer 21A28X	Pioneer 31A22X	4/11/20	None
2020-3	0802159202001	Seward	2020	4	Pioneer 21A28X, Pioneer 25A04X, Pioneer 27A17X	Pioneer 31A22X	5/1/20	Gravity
2020-4	1118121202001	Merrick	2020	3	Pioneer 21A20	Pioneer 34A50	4/25/20	Pivot

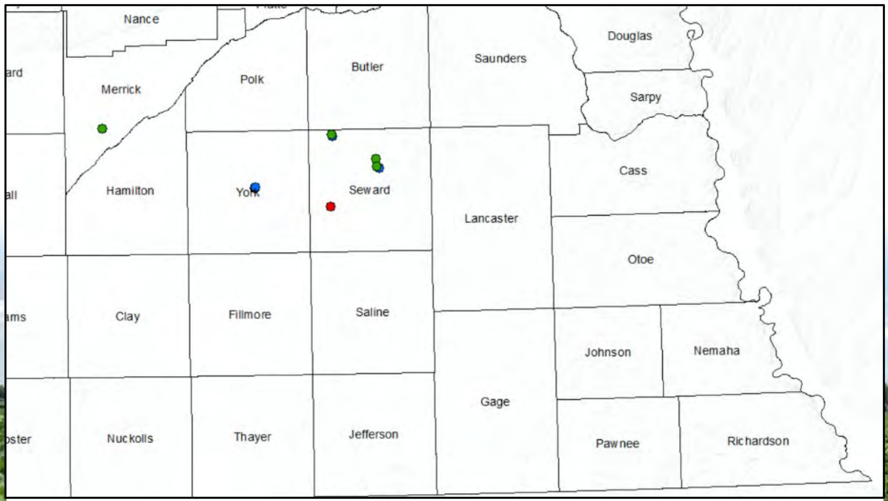


Figure 1. Locations of the 2018, 2019, and 2020 soybean maturity group studies.

RESULTS

Yield from the studies were analyzed as a large group by comparing the group 2 yields versus the group 3 yields (Table 2).

Table 2. Yield, pods per plant, and nodes per plant for group 2 and group 3 soybeans across 10 sites.

	Yield (bu/acre)†	Pods/plant	Nodes/plant
Group 2	70 A*	52.4 A	20.4 A
Group 3	70 A	53.3 A	20.8 A
Site (P>F)	*<0.0001*	*0.0005*	*<0.0001*
Treatment (P>F)	*0.6978*	*0.690*	*0.140*
*Site*Treatment*	*<0.0001*	*0.393*	*0.0008*

*Values with the same letter are not significantly different at a 90% confidence level.
†Bushels per acre corrected to 13% moisture.

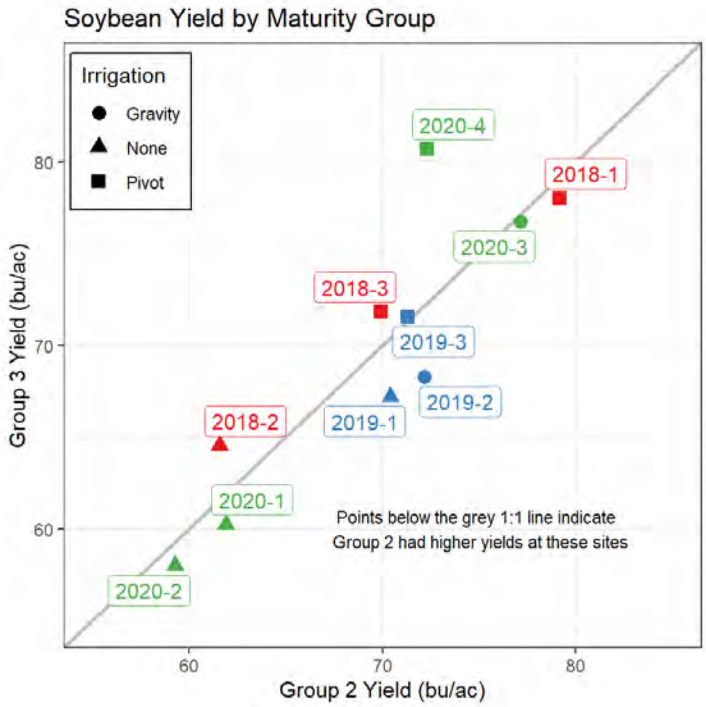
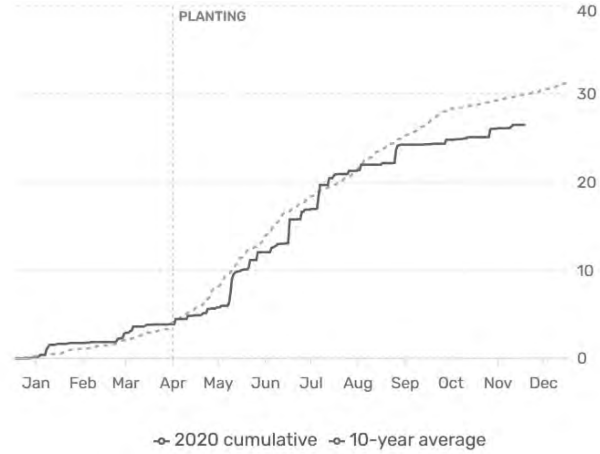


Figure 2. Distribution of yield for group 2 and group 3 soybeans across 10 sites. The grey diagonal line shows the zero-yield difference line. Sites falling below this line indicate higher yield for the group 2 soybeans.

Summary: Yield response to maturity group differed by site. Overall, yield, pods per plant, and nodes per plant were not different between the group 2 and group 3 soybeans. Individual sites from 2020 are reported in more detail in the following pages. In general, it is estimated that there is a 1 day delay in harvest for every 0.1 increase in maturity group. The similar yield results between maturity group 2 and maturity group 3 in this study demonstrate an opportunity for growers to plant a variety of maturities to spread out harvest. Additionally, for non-irrigated fields, planting a range of high-yield maturities can spread out risk due to uncertainty of rainfall timing. Finally, by planting a shorter season maturity group, growers can establish cover crops earlier or plant winter wheat.

Group 2.1 versus Group 3.1 Soybean Maturity

Study ID: 0802159202002
County: Seward
Soil Type: Hastings silt loam 1-3% slope; Crete silt loam 1-3% slope; Fillmore silt loam frequently ponded
Planting Date: 4/15/20
Harvest Date: 9/15/20 for group 2.1 and 9/23/20 for group 3.1
Population: 146,087
Row Spacing (in): 30
Hybrid: Pioneer® P21A28X, P31A22X
Reps: 3
Previous Crop: Corn
Tillage: No-Till
Herbicides: ***Pre:*** 23 oz/ac Roundup PowerMAX®, 6 oz/ac Zidua® PRO, 8 oz/ac 2,4-D LV6, 2.55 lb/ac AMS on 4/7/20 ***Post:*** 32 oz/ac Roundup PowerMAX®, 32 oz/ac Symbol™ Release, 6 oz/ac Flexstar®, 6 oz/ac Select Max®, 2.55 lb/ac AMS on 6/18/20
Seed Treatment: LumiGEN™, Lumisena™, EverGol®, Gaucho®, PPST 2030, PPST 120+
Foliar Insecticides: None
Foliar Fungicides: None
Fertilizer: None
Irrigation: None
Rainfall (in):



Introduction: With early planting of soybean (in April or as close to May 1 as possible), a longer-season variety may help take advantage of the longer growing season. However, some growers are also obtaining high yields with mid-group 2 varieties. The goal of this study was to determine if growers need to plant a longer-season maturity soybean to achieve optimum yields when planting early. A group 2 (Pioneer® P21A28X) and group 3 (Pioneer® P31A22X) were evaluated. The soybeans were planted on April 15 at soil temp of 50°F prior to 5" of snow within 24 hours. The group 2 soybeans were harvested on September 15 and the group 3 soybeans on September 23.

Results:

	Harvest Stand Count (plants/ac)	Pods/ plant	Nodes/ plant	Moisture (%)	Test Weight (lb/bu)	Yield (bu/ac)†	Marginal Net Return‡ ($/ac)
Group 2.1 (Pioneer® P21A28X)	126,333 A	49 A	20 B	12.2 A	57 A	62 A	543.31 A
Group 3.1 (Pioneer® P31A22X)	114,667 B	46 A	21 A	10.4 B	57 A	60 A	521.86 A
P-Value	0.060	0.235	0.057	0.007	0.208	0.372	0.264

*Values with the same letter are not significantly different at a 90% confidence level.
†Bushels per acre corrected to 13% moisture.
‡Marginal net return based on $9.50/bu soybean, $44.77/ac for Pioneer® P21A28X, and $50.27/ac for Pioneer® P31A22X. Both varieties has the same seed treatment, so this cost is not included in the comparison.

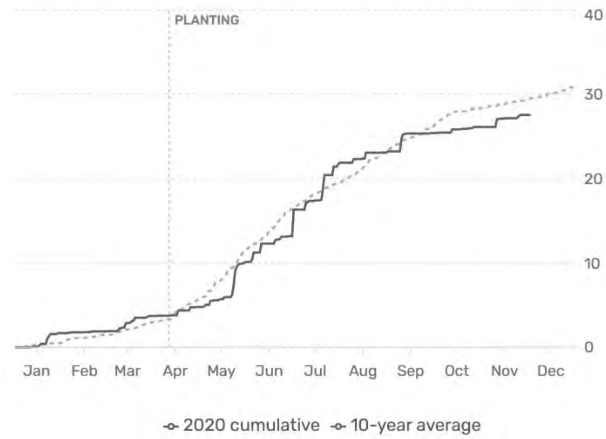
Summary:

- Test weight, pods per plant, yield, and net return were the same between the group 2 and group 3 soybean varieties evaluated.
- The group 3 soybeans had a greater number of nodes per plant and had a lower harvest stand count.

Group 2.1 versus Group 3.1 Soybean Maturity

Study ID: 0802159202003
County: Seward
Soil Type: Muir silt loam 1-3% slope; Hastings silt loam 7-11% slopes, eroded; Hall silt loam 0-1% slope
Planting Date: 4/11/20
Harvest Date: 9/15/20 for group 2.1 and 9/23/20 for group 3.1
Population: 146,087
Row Spacing (in): 30
Hybrid: Pioneer® P21A28X and Pioneer® P31A22X
Reps: 3
Previous Crop: Corn
Tillage: No-Till
Herbicides: ***Pre:*** 23 oz/ac Roundup PowerMAX®, 6 oz/ac Zidua® PRO, 2,4-D LV6, 2.55 lb/ac AMS on 4/8/20 ***Post:*** 32 oz/ac Roundup PowerMAX®, 6 oz/ac Select Max®, 32 oz/ac Symbol™ Release, 8 oz/ac Flexstar®, 2.55 lb/ac AMS on 6/18/20

Seed Treatment: LumiGEN®, EverGol®, Gaucho®, PPST 2030, PPST 120+
Foliar Insecticides: None
Foliar Fungicides: None
Fertilizer: None
Irrigation: None
Rainfall (in):



Introduction: With early planting of soybean (in April or as close to May 1 as possible), a longer-season variety may help take advantage of the longer growing season. However, some growers are also obtaining high yields with mid-group 2 varieties. The goal of this study was to determine if growers need to plant a longer-season maturity soybean to achieve optimum yields when planting early. A group 2 (Pioneer® P21A28X) and group 3 (Pioneer® P31A22X) were evaluated. The soybeans were planted on April 11 with a soil temp of 50°F prior to a cold weekend. The group 2 soybeans were harvested on September 15 and the group 3 soybeans on September 23.

Results:

	Harvest Stand Count (plants/ac)	Pods/ plant	Nodes/ plant	Test Weight (lb/bu)	Moisture (%)	Yield (bu/ac)†	Marginal Net Return‡ ($/ac)
Group 2.1 (Pioneer® P21A28X)	125,500 A*	45 A	19 B	56.7 B	11.5 A	59 A	518.33 A
Group 3.1 (Pioneer® P31A22X)	125,333 A	51 A	22 A	57.1 A	10.0 B	58 A	502.67 A
P-Value	0.958	0.434	0.035	0.020	0.020	0.186	0.128

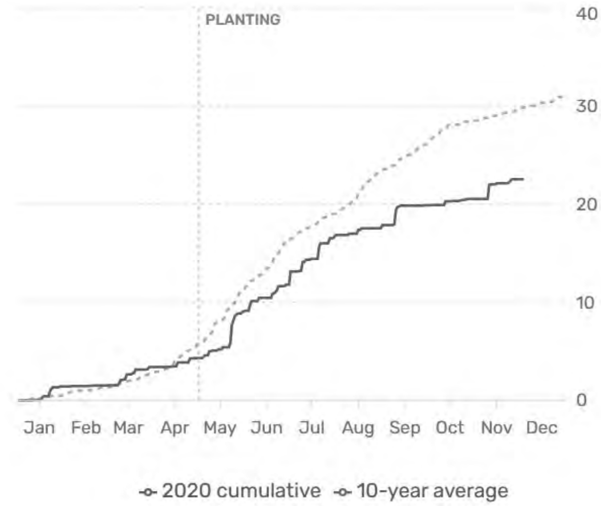
*Values with the same letter are not significantly different at a 90% confidence level.
†Bushels per acre corrected to 13% moisture.
‡Marginal net return based on $9.50/bu soybean, $44.77/ac for Pioneer® P21A28X, and $50.27/ac for Pioneer® P31A22X. Both varieties has the same seed treatment, so this cost is not included in the comparison.

Summary:

- Test weight, pods per plant, yield, stand counts, and net return were the same between the group 2 and group 3 soybeans varieties evaluated.
- The group 3 soybeans had a greater number of nodes per plant.

Group 2.1 versus Group 2.5 versus Group 2.7 versus Group 3.1 Soybean Maturity

Study ID: 0802159202001
County: Seward
Soil Type: Hastings silt loam 0-1% slope; Fillmore silt loam frequently ponded
Planting Date: 5/1/20
Harvest Date: 9/25-26/20
Population: 146,087
Row Spacing (in): 30
Hybrid: Pioneer® P21A28X, P25A04X, P27A17X, P31A22X
Reps: 4
Previous Crop: Corn
Tillage: No-Till
Herbicides: ***Pre:*** 23 oz/ac Roundup PowerMAX®, 6 oz/ac Zidua® PRO, and 2,4-D with 2.55 lb/ac AMS on 4/21/20 ***Post:*** 23 oz/ac Roundup PowerMAX®, 22 oz/ac XtendiMax® with VaporGrip® Technology, and 6 oz/ac Select Max® on 6/12/20
Seed Treatment: LumiGEN™, Lumisena™, EverGol®, Gaucho®, PPST 2030, PPST 120+
Foliar Insecticides: None
Foliar Fungicides: None
Fertilizer: None
Irrigation: Gravity, Total: 9.11”
Rainfall (in):



Introduction: With early planting of soybean (in April or as close to May 1 as possible), a longer-season variety may help take advantage of the longer growing season. However, some growers are also obtaining high yields with mid-group 2 varieties. The goal of this study was to determine if growers need to plant a longer-season maturity soybean to achieve optimum yields when planting early. Three group 2 soybeans (Pioneer® P21A28X, Pioneer® P25A04X, and Pioneer® P27A17X, and a group 3 (Pioneer® P31A22X) were evaluated. The soybeans were planted on May 1 and harvested on September 25 and 26.

Results:

	Harvest Stand Count (plants/ac)	Pods/ plant	Nodes/ plant	Test Weight (lb/bu)	Moisture (%)	Yield (bu/ac)†	Marginal Net Return‡ ($/ac)
Group 2.1 (Pioneer® P21A28X)	134,500 A	51 A	20 A	55.7 B	10.3 B	73 C	646.84 C
Group 2.5 (Pioneer® P25A04X)	122,750 B	55 A	20 A	56.3 A	9.9 B	79 A	700.39 A
Group 2.7 (Pioneer® P27A17X)	122,500 B	61 A	21 A	56.4 A	9.9 B	80 A	708.51 A
Group 3.1 (Pioneer® P31A22X)	120,125 B	53 A	20 A	56.2 AB	11.0 A	77 B	678.74 B
P-Value	0.001	0.137	0.636	0.042	0.003	<0.0001	<0.0001

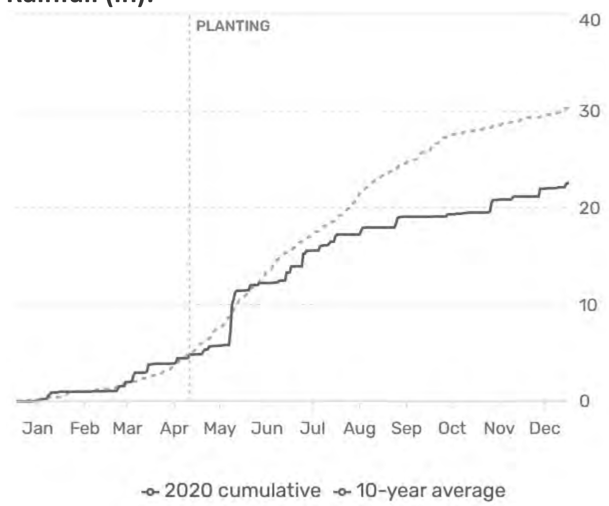
*Values with the same letter are not significantly different at a 90% confidence level.
†Bushels per acre corrected to 13% moisture.
‡Marginal net return based on $9.50/bu soybean, $44.77/ac for Pioneer® P21A28X, $50.27/ac for Pioneer® P25A04X, $47.52/ac for Pioneer® P27A17X, and $50.27/ac for Pioneer® P31A22X. All varieties have the same seed treatment, so this cost is not included in the comparison.

Summary:

- Average pods per plant and nodes per plant were the same between the varieties tested.
- Pioneer® P21A28X had higher harvest stand counts than the other three varieties.
- Pioneer® P25A04X and Pioneer® P27A17X had the highest yield and marginal net return.

Group 2.1 versus Group 3.4 Soybean Maturity

Study ID: 1118121202001
County: Merrick
Soil Type: Lex loam occasionally flooded; Cozad loam wet sub-stratum
Planting Date: 4/25/20
Harvest Date: 9/22/20
Seeding Rate: 185,000
Row Spacing (in): 10
Reps: 4 total, 3 for yield, moisture, and net return
Previous Crop: Seed Corn
Tillage: No-Till
Herbicides: ***Pre:*** 6 oz/ac Authority® Supreme, 3 oz/ac Spartan® FL 4F on 4/10/20; 36 oz/ac Durango® on 4/30/20 ***Post:*** 1.33 pt/ac Me-Too-Lachlor™ II on 6/2/20; 3 pt/ac Warrant® on 6/20/20
Seed Treatment: PPST 2030, PPST 120+
Foliar Insecticides: None
Foliar Fungicides: None
Fertilizer: None
Irrigation: Pivot
Rainfall (in):



Introduction: With early planting of soybean (in April or as close to May 1 as possible), a longer-season variety may help take advantage of the longer growing season. However, some growers are also obtaining high yields with mid-group 2 varieties. The goal of this study was to determine if growers need to plant a longer-season maturity soybean to achieve optimum yields when planting early. A group 2 (Pioneer® P21A20) and group 3 (Pioneer® P34A50) were evaluated. The soybeans were planted on April 25 and harvested on September 22.

Results:

	Stand Count (plants/ac)	Moisture (%)	Yield (bu/ac)†	Marginal Net Return‡ ($/ac)
Group 2.1 (Pioneer® P21A20)	142,750 A*	10.2 A	72 B	608.52 B
Group 3.4 (Pioneer® P34A50)	104,200 A	11.1 A	80 A	686.35 A
P-Value	0.114	0.669	0.073	0.074

*Values with the same letter are not significantly different at a 90% confidence level.
†Yield values are from cleaned yield monitor data. Bushels per acre corrected to 13% moisture.
‡Marginal net return based on $9.50/bu soybean, $78.37/ac for Pioneer® P21A20-21, and $80.11/ac for Pioneer® P34A50-34.

Summary:

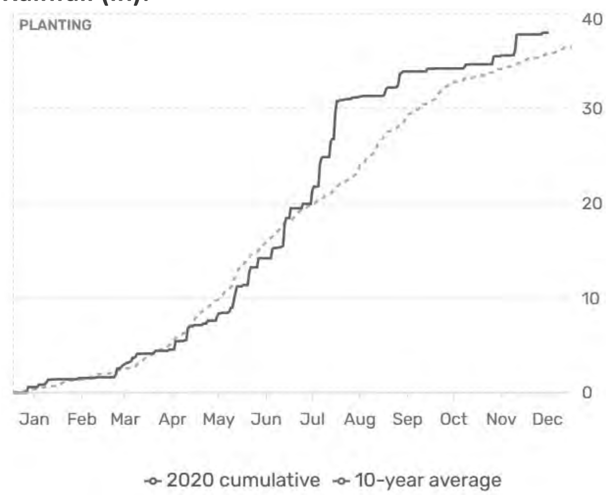
- There were no differences in stand count or moisture between the two varieties evaluated. Variability in stand counts between the treatments may be due to adjustments made to the drill after the first replication to try to better hit the target seeding rate.
- The Pioneer® P34A50 yielded 8 bu/ac higher and had $77.83/ac greater profit than the Pioneer® P21A20.

CLICK TO WATCH A VIDEO ABOUT THIS STUDY https://go.unl.edu/soybenchmarking

Soybean Benchmarking: Baseline vs Improved Soybean Practices

Study ID: 0821KS013202001
County: Brown, KS
Soil Type: Wymore silty clay loam 1-3% slope
Harvest Date: 10/12/20
Row Spacing (in): 15
Hybrid: Pioneer® P37A27X
Reps: 4
Previous Crop: Corn
Tillage: No-Till

Irrigation: None
Rainfall (in):



Soil Tests (June 2020 - average of study area)

pH	BpH	CEC	1:1 S Salts	OM	Nitrate-N	K	S	Zn	Fe	Mn	Cu	Ca	Mg	Na	H	K	Ca	Mg	Na	Mehlich P-III
		meq/100g	mmho/cm	%	ppm	----------------------------ppm------------------------									-----------%----------					---ppm--
6.8	7.2	13.1	0.1	4	5.4	224	6.2	2.69	47.9	18.7	0.81	2176	190	8	0	4	83	12	0	15

Introduction: Analysis of producer survey data revealed: (1) an average yield gap of 20-30% between current farmer yield and potential yield as determined by climate, soil, and genetics, and (2) a number of agronomic practices that, for a given soil-climate context, can be fine-tuned to close the gap and improve soybean producer profit. In Nebraska, three practices were identified as being important for improving yield and producer profit. These practices relate to planting date, seeding rate, and the use of foliar fungicides and insecticides. This study collectively tested the "baseline" practices versus the "improved" practices. Across four Nebraska sites in 2019, the improved treatment resulted in an average 8 bu/ac yield increase and $46/ac profit increase compared to the baseline treatment. This is part of a multi-state effort; to view the entire 2019 report visit https://cropwatch.unl.edu/OnFarmResearch/2020_BootsOnTheGround_final.pdf. Soybean cyst nematode tests for this field came back negative.

Baseline: Soybeans planted on May 12, at a rate of 160,000 seeds/ac, with no foliar fungicide or insecticide.

Improved: Soybeans planted on April 23, at a rate of 130,000 seeds/ac with a foliar fungicide (4 oz/ac Priaxor®) and insecticide (4 oz/ac Hero®) application on July 24.

Results:

	Stand Count (plants/ac)	Yield (bu/ac)†	Marginal Net Return‡ ($/ac)
Baseline	150,000 A*	69 B	595.16 B
Improved	119,500 B	78 A	665.80 A
P-Value	0.003	0.001	0.002

*Values with the same letter are not significantly different at a 90% confidence level.
†Bushels per acre corrected to 13% moisture.
‡Marginal net return based on $9.50/bu soybean, $49.45/unit seed ($56.51/ac for baseline and $45.92/ac for improved), $452/gal Priaxor® and $138/gal Hero® ($18.44/ac for fungicide and insecticide for improved treatment), and $6.94/ac for application of fungicide and insecticide on improved treatments.

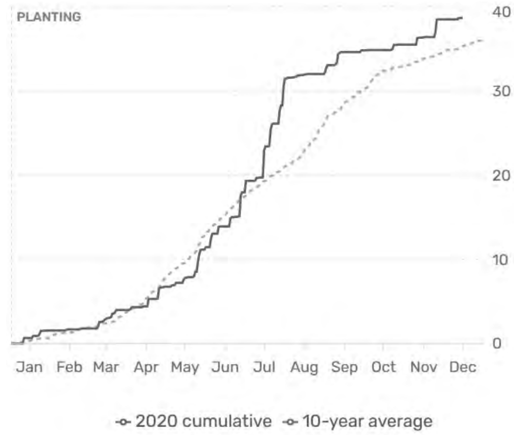
Summary: In 2020, the improved treatment (lower seeding rate, early planting, and fungicide and insecticide application) resulted in an 9 bu/ac yield increase and a $70.00/ac increase in profit.

This study was conducted in cooperation with a regional study funded by the North Central Region Soybean Research Program.

Soybean Benchmarking: Baseline vs Improved Soybean Practices

Study ID: 1124147202001
County: Richardson
Soil Type: Nodaway silt loam occasionally flooded; Zook silty clay loam occasionally flooded
Harvest Date: 10/30/20
Row Spacing (in): 15
Hybrid: Pioneer® P42A96X
Reps: 4
Previous Crop: Corn
Tillage: No-Till
Herbicides: ***Pre:*** 9 oz/ac Authority® Supreme, 8 oz/ac 2,4-D LV6, 12 oz/ac Veritas™ LV, and 20 oz/ac glyphosate on 4/30/20 ***Post:*** 30 oz/ac glyphosate, 1 qt/ac Warrant®, 12.8 oz/ac Engenia®, and 8 oz/ac clethodim on 6/16/20
Seed Treatment: PPST 120+, PPST 2030 G, Gaucho®, EverGol® Energy, Lumisena™, ILeVO®

Fertilizer: 109 lb K/ac as 0-0-60; 5.7 lb N/ac and 27 lb P/ac as 11-52-0; 13 oz/ac ENC®FLEX foliar applied on 6/16/20
Irrigation: None
Rainfall (in):



Soil Tests (June 2020 - average of study area)

pH	BpH	CEC	1:1 S Salts	OM	Nitrate-N	K	S	Zn	Fe	Mn	Cu	Ca	Mg	Na	H	K	Ca	Mg	Na	Mehlich P-III
		meq/100g	mmho/cm	%	ppm	------------------------------ppm--------------------------									-----------%----------					---ppm--
7.3	7.2	15.4	0.15	2.7	5.7	207	4.2	1.73	42.3	8	1.21	2522	271	10	0	3	82	15	0	59

Introduction: Analysis of producer survey data revealed: (1) an average yield gap of 20-30% between current farmer yield and potential yield as determined by climate, soil, and genetics, and (2) a number of agronomic practices that, for a given soil-climate context, can be fine-tuned to close the gap and improve soybean producer profit. In Nebraska, three practices were identified as being important for improving yield and producer profit. These practices relate to planting date, seeding rate, and the use of foliar fungicides and insecticides. This study collectively tested the "baseline" practices versus the "improved" practices. Across four Nebraska sites in 2019, the improved treatment resulted in an average 8 bu/ac yield increase and $46/ac profit increase compared to the baseline treatment. Soybean cyst nematode tests for this field came back negative.

Baseline: Soybeans planted on May 13, at a rate of 160,000 seeds/ac, with no foliar fungicide or insecticide.

Improved: Soybeans planted on May 1, at a rate of 128,000 seeds/ac with a foliar fungicide (4 oz/ac Priaxor® and 4 oz/ac Propi-Star® EC) and insecticide (4 oz/ac Hero®) aerially applied on August 6, 2020.

Results:

	Stand Count (plants/ac)	Test Weight (lb/bu)	Moisture (%)	Yield (bu/ac)†	Marginal Net Return‡ ($/ac)
Baseline	146,500 A*	57 A	11.9 A	67 B	553.27 B
Improved	110,833 B	57 A	11.8 A	70 A	564.97 A
P-Value	0.006	0.214	0.799	0.016	0.060

*Values with the same letter are not significantly different at a 90% confidence level.
†Bushels per acre corrected to 13% moisture.
‡Marginal net return based on $9.50/bu soybean, $76.25/unit seed with seed treatments ($87.14/ac for baseline and $67.71/ac for improved), $403.20/gal Priaxor®, $60/gal for Propi-Star® EC, and $151.70/gal Hero® ($20.40/ac for fungicide and insecticide for improved treatment), and $9.00/ac for application of fungicide and insecticide on improved treatments.

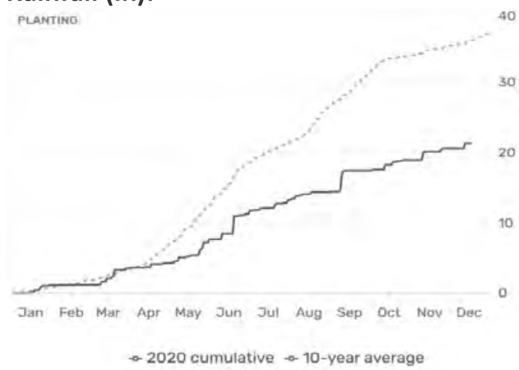
Summary: In 2020, the improved treatment (lower seeding rate, early planting, and fungicide and insecticide application) resulted in an 3 bu/ac yield increase and a $11.70/ac increase in profit.

This study was conducted in cooperation with a regional study funded by the North Central Region Soybean Research Program.

Soybean Benchmarking: Baseline vs Improved Soybean Practices

Study ID: 0572177202001
County: Washington
Soil Type: Marshall silty clay loam 0-2% slope; Marshall silty clay loam 6-11% slopes; Marshall silty clay loam 2-6% slopes
Harvest Date: 10/8/20
Row Spacing (in): 15
Hybrid: Pioneer® P31A22
Reps: 3
Previous Crop: Corn
Tillage: No-Till
Herbicides: 5 oz/ac Sonic®, 22 oz/ac FeXapan®, 32 oz/ac Abundit™ Extra, 7 oz/ac Assure® II
Seed Treatment: LumiGEN®
Fertilizer: Municipal biosolids have been applied to the field several times in the last 25 years.

Irrigation: None
Rainfall (in):



Soil Tests (June 2020 - average of study area)

pH	BpH	CEC	1:1 S Salts	OM	Nitrate-N	K	S	Zn	Fe	Mn	Cu	Ca	Mg	Na	H	K	Ca	Mg	Na	Mehlich P-III
		meq/100g	mmho/cm	%	ppm	ppm									%					ppm
6.8	6.6	17.9	0.13	4.5	34	122	13	5.78	76.7	14.1	3.20	2330	222	7	23	2	65	10	0	89

Introduction: Analysis of producer survey data revealed: (1) an average yield gap of 20-30% between current farmer yield and potential yield as determined by climate, soil, and genetics, and (2) a number of agronomic practices that, for a given soil-climate context, can be fine-tuned to close the gap and improve soybean producer profit. In Nebraska, three practices were identified as being important for improving yield and producer profit. These practices relate to planting date, seeding rate, and the use of foliar fungicides and insecticides. This study collectively tested the "baseline" practices versus the "improved" practices. Across four Nebraska sites in 2019, the improved treatment resulted in an average 8 bu/ac yield increase and $46/ac profit increase compared to the baseline treatment. Soybean cyst nematode tests for this field came back positive, with 40 eggs per 100 cc's of soil (3 oz) low. The field had a cereal rye cover crop that was grazed in the spring and terminated on April 30, 2020. The field was scouted for insects and disease pressure on the application date (July 17, 2020) and very low disease pressure was observed and no evidence of insects.

Baseline: Soybeans planted on May 12, at a rate of 160,000 seeds/ac, with no foliar fungicide or insecticide.

Improved: Soybeans planted on April 27, at a rate of 130,000 seeds/ac with a foliar fungicide (6.8 oz/ac Aproach® Prima) and insecticide (1 oz/ac Lamcap® II) applied on July 17, 2020.

Results:

	Stand Count (plants/ac)	Moisture (%)	Yield (bu/ac)†	Marginal Net Return‡ ($/ac)
Baseline	155,976 A*	8.5 A	56 B	473.20 B
Improved	128,109 A	8.3 A	63 A	535.89 A
P-Value	0.177	0.121	0.005	0.007

*Values with the same letter are not significantly different at a 90% confidence level.
†Bushels per acre corrected to 13% moisture.
‡Marginal net return based on $9.50/bu soybean, $50/unit seed ($62.34/ac for baseline and $54.86/ac for improved), $12.69 for fungicide and insecticide for the improved treatment, and $6.94/ac for application of fungicide and insecticide on improved treatment.

Summary:

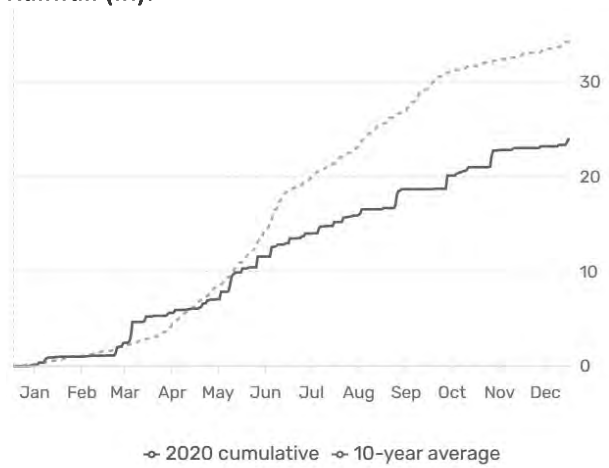
- According to early season stand counts, there was no statistical difference in plant population between the two treatments.
- In 2020, the improved treatment (lower seeding rate with early planting and fungicide and insecticide application) resulted in a 7 bu/ac increase and $62.70/ac increase in profit.

This study was conducted in cooperation with a regional study funded by the North Central Region Soybean Research Program.

Soybean Benchmarking: Baseline vs Improved Soybean Practices

Study ID: 0926039202001
County: Cuming
Soil Type: Moody silty clay loam 6-11% slopes; Alcester silty clay loam 2-6% slopes; Moody silty clay loam 2-6% slopes, eroded; Calco silty clay loam occasionally flooded
Harvest Date: 9/25/20
Row Spacing (in): 30
Variety: Midland Genetics® 2990
Reps: 4
Previous Crop: Corn
Tillage: Disk
Herbicides: ***Pre:*** Treflan® ***Post:*** Enlist®
Fertilizer: None

Irrigation: None
Rainfall (in):



Introduction: Analysis of producer survey data revealed: (1) an average yield gap of 20-30% between current farmer yield and potential yield as determined by climate, soil, and genetics, and (2) a number of agronomic practices that, for a given soil-climate context, can be fine-tuned to close the gap and improve soybean producer profit. In Nebraska, three practices were identified as being important for improving yield and producer profit. These practices relate to planting date, seeding rate, and the use of foliar fungicides and insecticides. This study collectively tested the "baseline" practices versus the "improved" practices. Across four Nebraska sites in 2019, the improved treatment resulted in an average 8 bu/ac yield increase and $46/ac profit increase compared to the baseline treatment. Soybean cyst nematode tests for this field came back negative.

Baseline: Soybeans planted on May 15, at a rate of 160,000 seeds/ac, with no foliar fungicide or insecticide.

Improved: Soybeans planted on May 4, at a rate of 135,000 seeds/ac with a foliar fungicide (8 oz/ac Delaro®) and insecticide (8 oz/ac Tundra® Supreme) application on July 23.

Results:

	Stand Count (plants/ac)	Moisture (%)	Yield (bu/ac)†	Marginal Net Return‡ ($/ac)
Baseline	127,500 A*	12.9 A	55 B	476.50 B
Improved	113,667 B	12.3 A	60 A	503.95 A
P-Value	0.015	0.118	0.038	0.090

*Values with the same letter are not significantly different at a 90% confidence level.
†Bushels per acre corrected to 13% moisture.
‡Marginal net return based on $9.50/bu soybean, $43.56/unit seed ($50/ac for baseline and $42/ac for improved), $12.50/ac for fungicide and insecticide for improved treatment, and $7.50/ac for application of fungicide and insecticide on improved treatments.

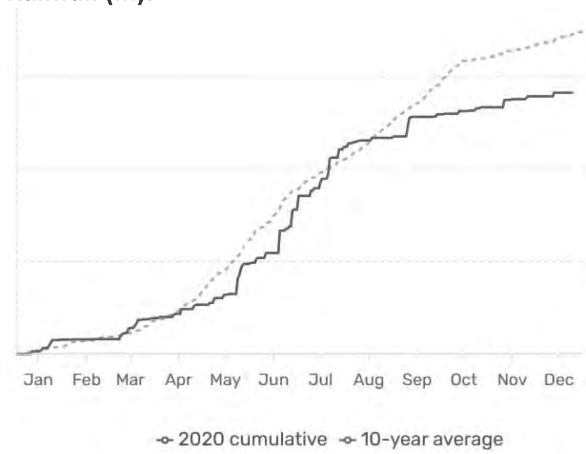
Summary: In 2020, the improved treatment (lower seeding rate, early planting, and fungicide and insecticide application) resulted in a 5 bu/ac yield increase and a $27.45/ac increase in profit.

This study was conducted in cooperation with a regional study funded by the North Central Region Soybean Research Program.

Soybean Benchmarking: Baseline vs Improved Soybean Practices

Study ID: 1126131202001
County: Otoe
Soil Type: Judson silt loam
Harvest Date: 10/2/20
Seeding Rate: 130,000
Row Spacing (in): 30
Variety: Pioneer® P37A69X
Reps: 4
Previous Crop: Corn
Tillage: Disk
Herbicides: ***Pre:*** 16 oz/ac Sulfen Met for burndown; 16 oz/ac Stalwart® C ***Post:*** 22 oz/ac Buccaneer Plus® on 6/10/20
Seed Treatment: PPST

Fertilizer: Average 150 lb/ac 11-52-0 from variable-rate application
Irrigation: None
Rainfall (in):



Soil Tests (June 2020 - average of study area)

pH	BpH	CEC	1:1 S Salts	OM	Nitrate-N	K	S	Zn	Fe	Mn	Cu	Ca	Mg	Na	H	K	Ca	Mg	Na	Mehlich P-III
		meq/100g	mmho/cm	%	ppm	---------------------------ppm-------------------------									-----------%----------					---ppm--
6.6	7.2	13.1	0.16	3.6	9.7	167	10.3	2.61	44.5	11.7	0.81	2241	172	12	0	3	85	11	0	39

Introduction: Analysis of producer survey data revealed: (1) an average yield gap of 20-30% between current farmer yield and potential yield as determined by climate, soil, and genetics, and (2) a number of agronomic practices that, for a given soil-climate context, can be fine-tuned to close the gap and improve soybean producer profit. In Nebraska, three practices were identified as being important for improving yield and producer profit. These practices relate to planting date, seeding rate, and the use of foliar fungicides and insecticides. This study collectively tested the "baseline" practices versus the "improved" practices. Across four Nebraska sites in 2019, the improved treatment resulted in an average 8 bu/ac yield increase and $46/ac profit increase compared to the baseline treatment. Soybean cyst nematode tests for this field came back negative.

Baseline: Soybeans planted on May 15, at a rate of 140,000 seeds/ac, with no foliar fungicide or insecticide.

Improved: Soybeans planted on April 22, at a rate of 130,000 seeds/ac with a foliar fungicide (16 oz/ac Quilt Xcel®) and insecticide (4 oz/ac Hero®) application on July 14.

Results:

	Stand Count (plants/ac)	Test Weight (lb/bu)	Moisture (%)	Yield (bu/ac)†	Marginal Net Return‡ ($/ac)
Baseline	128,333 A*	58 A	10.1 A	50 B	421.07 B
Improved	113,667 B	58 A	9.3 A	58 A	470.42 A
P-Value	0.026	0.868	0.245	0.008	0.022

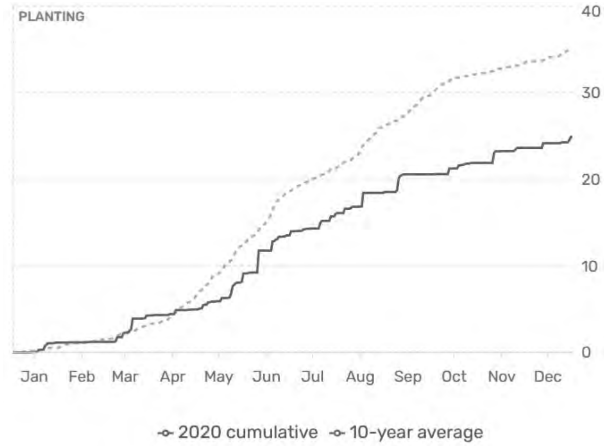
*Values with the same letter are not significantly different at a 90% confidence level.
†Bushels per acre corrected to 13% moisture.
‡Marginal net return based on $9.50/bu soybean, $55/unit seed ($55/ac for baseline and $51.07/ac for improved), $26/ac for fungicide and insecticide for improved treatment, and $6.94/ac for application of fungicide and insecticide on improved treatments.

Summary: In 2020, the improved treatment (lower seeding rate, early planting, and fungicide and insecticide application) resulted in a 8 bu/ac yield increase and a $49.35/ac increase in profit.

This study was conducted in cooperation with a regional study funded by the North Central Region Soybean Research Program.

Soybean Benchmarking: Baseline vs Improved Soybean Practices

Study ID: 1133053202001
County: Dodge
Soil Type: Gibbon loam 0-2% slope; Saltine-Gibbon complex occasionally flooded
Harvest Date: 9/25/20
Row Spacing (in): 30
Variety: Pioneer® P29A25X
Reps: 4
Previous Crop: Corn
Tillage: Disked twice in fall, field cultivated in spring
Herbicides: ***Pre:*** 9.8 oz/ac Authority® Supreme on 5/1/20 ***Post:*** 22 oz/ac XtendiMax® with VaporGrip® Technology, 1 pt/ac Medal® EC, 8 oz/ac Targa®, and 24 oz/ac Roundup PowerMAX® on 6/9/20
Seed Treatment: PPST
Fertilizer: 40 lb/ac N as 44% ESN
Irrigation: Pivot, Total: 2.5"
Rainfall (in):



Introduction: Analysis of producer survey data revealed: (1) an average yield gap of 20-30% between current farmer yield and potential yield as determined by climate, soil, and genetics, and (2) a number of agronomic practices that, for a given soil-climate context, can be fine-tuned to close the gap and improve soybean producer profit. In Nebraska, three practices were identified as being important for improving yield and producer profit. These practices relate to planting date, seeding rate, and the use of foliar fungicides and insecticides. This study collectively tested the "baseline" practices versus the "improved" practices. Across four Nebraska sites in 2019, the improved treatment resulted in an average 8 bu/ac yield increase and $46/ac profit increase compared to the baseline treatment. Soybean cyst nematode tests for this field came back positive at a low rate of 120 eggs per 100 cc's of soil (3 oz).

Baseline: Soybeans planted on May 14, at a rate of 154,500 seeds/ac, with no foliar fungicide or insecticide.

Improved: Soybeans planted on April 30, at a rate of 120,000 seeds/ac with a foliar fungicide (14 oz/ac Affiance®) and insecticide (3.8 oz/ac lambda-cyhalothrin) application on July 2.

Results:

	Stand Count (plants/ac)	Moisture (%)	Yield (bu/ac)†	Marginal Net Return‡ ($/ac)
Baseline	134,544 A*	11.2 A	58 A	505.87 A
Improved	102,541 B	11.2 A	53 A	452.18 A
P-Value	0.003	0.731	0.223	0.175

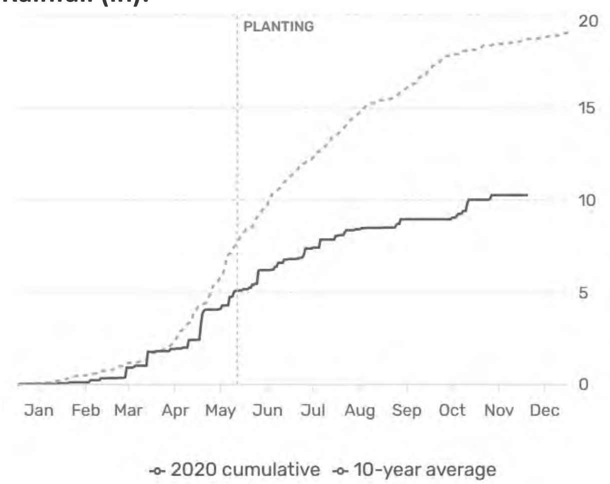
*Values with the same letter are not significantly different at a 90% confidence level.
†Bushels per acre corrected to 13% moisture.
‡Marginal net return based on $9.50/bu soybean, $43.50/unit seed ($48/ac for baseline and $36/ac for improved), $19.19/ac for fungicide and insecticide for improved treatment, and $6.94/ac for application of fungicide and insecticide on improved treatments.

Summary: The improved treatment at this site did not result in a statistically higher yield or profit.

This study was conducted in cooperation with a regional study funded by the North Central Region Soybean Research Program.

Pinto Bean Planting Population for Direct-Harvested Dry Beans

Study ID: 0809013202001
County: Box Butte
Soil Type: Valentine sandy loam 3-9% slopes
Planting Date: 5/26/20
Harvest Date: 9/19/20
Row Spacing (in): 20
Hybrid: Lumen
Reps: 4
Previous Crop: Sugarbeets
Tillage: Ripped with no-till ripper then roller harrow, rolled after planting
Herbicides: ***Pre:*** 1.25 qt/ac Warrant® on 5/24/20; 32 oz/ac Liberty® 280 SL, 32 oz/ac Roundup PowerMAX®, 2.5 lb/ac AMS and 0.2 pt/ac MSO on 6/1/20 ***Post:*** 1 pt/ac Medal® EC on 6/21/20; 1 pt/ac Basagran®, and 4 oz/ac Raptor® with 25.6 oz/ac Herbimax® and 2.5 lb/ac AMS on 6/29/20 ***Desiccant:*** 1 qt/ac Gramoxone® SL 2.0, 2 oz/ac Sharpen®, 1.6 pt/ac MSO and 12.5 lb/ac AMS on 9/12/20
Seed Treatment: Maxim®, Apron®, Rancona®, Vibrance®, Cruiser®
Foliar Insecticides: 3.4 oz/ac Capture® LFR® on 5/27/20
Foliar Fungicides: 12 oz/ac Aproach® on 7/17/20 and 32 oz/ac Nu-Cop 3L on 8/11/20
Fertilizer: 2 oz/ac Radiate® and 2 gal/ac 7-17-3 RiseR® on 5/27/20; 2 gal/ac 12-0-0-26S thiosulfate, 18 gal/ac 32-0-0 UAN, 2 qt/ac BlackMax® 22, and 2 qt/ac Pro Tetra 4-0-0 on 5/28/20; 1 qt/ac Awaken®, and 2 oz/ac Radiate® on 7/17/20;
Irrigation: Pivot, Total: 10-12"
Rainfall (in):



Introduction: The purpose of this study was to compare three planting rates of dry edible beans (Lumen pinto variety) planted in 20" row spacing. The target populations in this study were 60,000, 100,000 and 130,000 plants per acre. Due to planter issues these populations were not achieved. Actual populations were determined by early season stand counts and were 52,478, 82,201, and 106,752 plants/ac. To estimate the treatment seeding rate and subsequent seed costs, 10% was added to the stand count values; this resulted in treatment seeding rates of approximately 57,700, 90,400, and 117,400 seeds/ac, and assumes all treatments had similar emergence and germination. The plots were direct harvested on September 19 with a John Deere® S780 combine and MacDon® FD75-S 35-foot FlexDraper® head. Temperature at harvest was 72°F at 38% relative humidity.

Samples from each plot were analyzed for bean quality parameters. Pod height measurements were taken to determine the percent of pods 2" or greater above the soil surface. Harvest loss estimates were determined by taking counts in one-square-foot frames randomly chosen in the harvested area, but equally representing the left side of header, center of header, and right side of header area behind the combine.

Results:

Target population (seeds/ac)	Stand Count (plants/ac)	Pods >2" above ground (%)	Harvest Loss (bu/ac)	Small (%)	Moisture (%)	Density (lb/bu)	Seeds per lb	Yield (bu/ac)†	Marginal Net Return‡ ($/ac)
60,000	52,478 C*	66 C	2 A	5 A	12.6 A	62.5 B	1,195 AB	53 B	712.54 B
100,000	82,201 B	79 B	2 A	3 A	12.2 AB	63.3 AB	1,192 B	57 A	738.11 AB
130,000	106,752 A	85 A	2 A	3 A	11.3 B	63.8 A	1,216 A	59 A	753.02 A
P-Value	<0.0001	0.0004	0.200	0.507	0.079	0.056	0.082	0.003	0.059

*Values with the same letter are not significantly different at a 90% confidence level.
†Bushels per acre corrected to 14% moisture and adjusted for clean yield (% splits, % small, and % foreign material removed).
‡Marginal net return based on $24/cwt ($14.40/bu at 60 lb/bu). Seed cost for the treated Lumen pinto bean seed was $84.00 per 100,000 seeds.

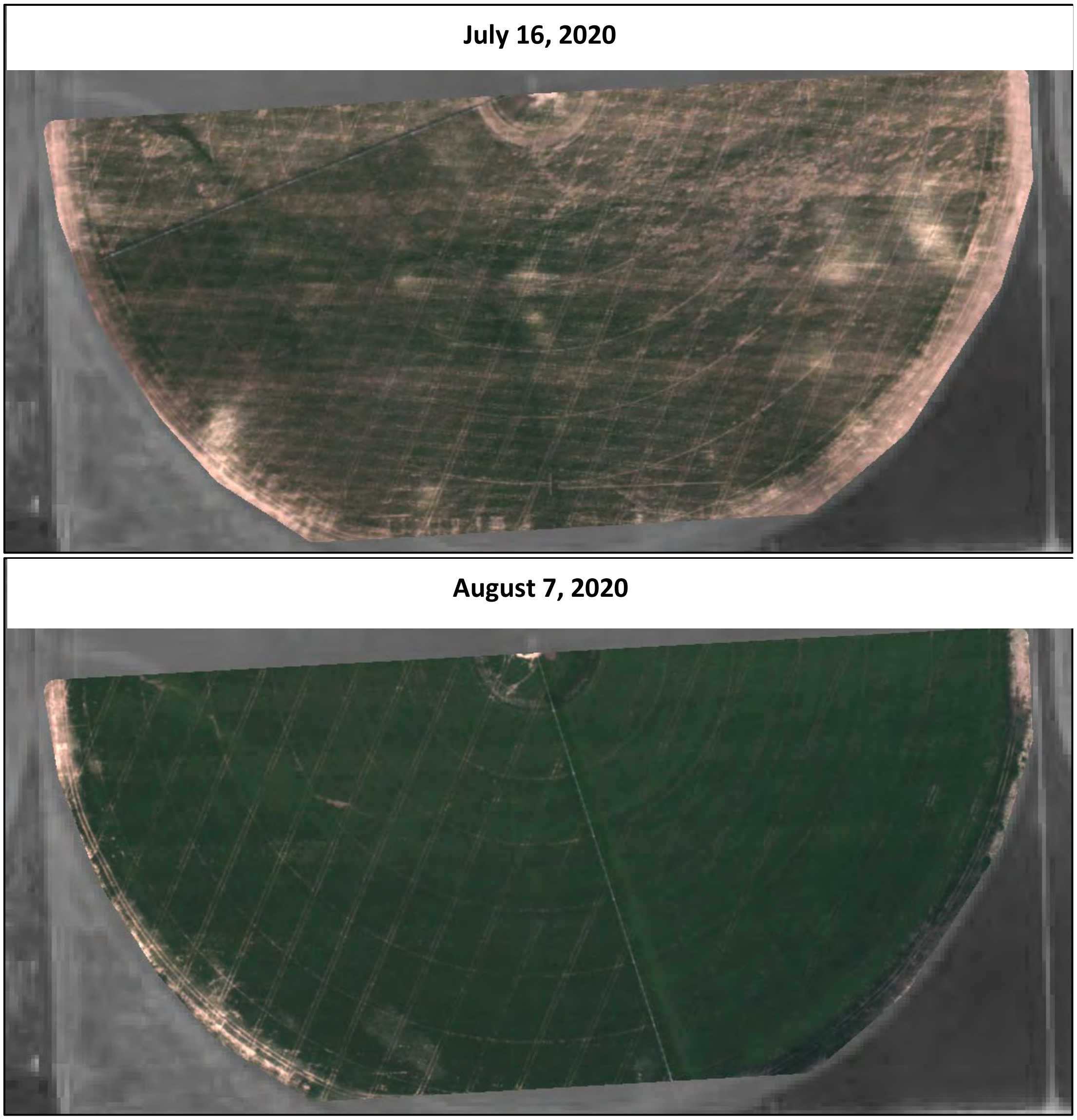


Figure 1. Aerial imagery from July 16, 2020 (top) and August 7, 2020 (bottom).

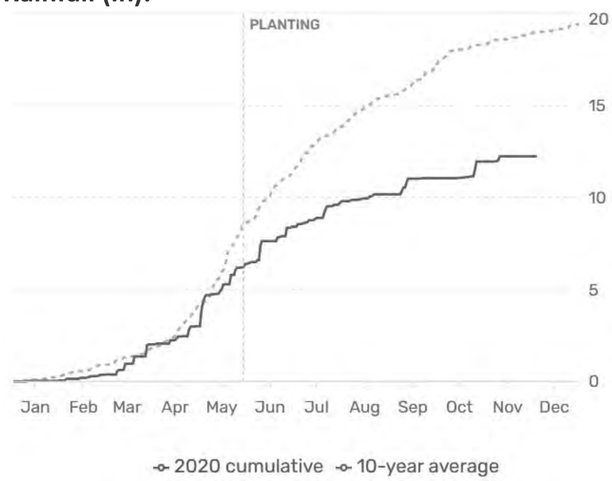
Summary:

- The percent of pods greater than 2” increased with increasing plant population. For the 52,478 plants/ac population, only 66% of pods were greater than 2” above the ground.
- There were no differences in harvest loss or percent small seeds between the three planting populations evaluated.
- Yield was significantly lower for the 52,478 plants/ac population; there were no statistically significant differences in yield between the 82,201 and 106,752 plants/ac populations.
- Marginal net return was higher for the 106,752 plants/ac population than for the 52,478 plants/ac population. The 82,201 plants/ac population did not have a statistically different marginal net return than the other two populations.
- Horizontal stripes of lighter green on the July 16 image (Figure 1) reflect slower canopy closure for the lower population treatments. By the August 7 image (Figure 1), biomass increase resulted in complete row closure across all population treatments.
- High August temperatures and wind caused plant stress during the bean reproduction growth stages, resulting in a 10-15% reduction in yield across the dry bean growing region.

Pinto Bean Planting Population for Direct-Harvested Dry Beans

Study ID: 0809123202002
County: Morrill
Soil Type: Valentine sandy loam 3-9% slopes
Planting Date: 5/29/20
Harvest Date: 9/14/20
Row Spacing (in): 20
Hybrid: Vibrant slow darkening pinto
Reps: 4
Previous Crop: Corn
Tillage: No-till, rolled after planting
Herbicides: ***Pre:*** 1.25 qt/ac Warrant® on 5/27/20; 32 oz/ac Liberty® 280 SL, 32 oz/ac Roundup PowerMAX®, 2.5 lb/ac AMS and 1.44 pt/ac MSO on 6/2/20 ***Post:*** 1 pt/ac Medal® EC on 6/23/20; 1 pt/ac Basagran®, 8 oz/ac Intensity®, and 4.8 oz/ac Raptor®, with 25.6 oz/ac Herbimax® and 2.5 lb/ac AMS on 7/6/20 ***Desiccant*:** 1 qt/ac Gramoxone® SL 2.0, 2 oz/ac Sharpen®, 1.6 pt/ac MSO and 2.5 lb/ac AMS on 9/2/20
Seed Treatment: Maxim®, Apron®, Rancona®, Vibrance®, Cruiser®

Foliar Insecticides: 4 oz/ac Mustang® Maxx covering 20.72 ac border spray on 7/1/20; 6.8 oz/ac Sniper® and 15.36 oz/ac Herbimax® covering 42.71 ac area on 7/9/20
Foliar Fungicides: 12 oz/ac Aproach® on 7/20/20
Fertilizer: 2 oz/ac Radiate® and 2 gal/ac 7-17-3 RiseR®; 1 qt/ac Awaken®, 2 oz/ac Radiate® on 7/20/20
Irrigation: Pivot, Total: 10-12"
Rainfall (in):



Introduction: The purpose of this study was to compare three planting rates of dry edible beans (Vibrant pinto variety) planted in 20" row spacing. The target populations in this study were 60,000, 100,000 and 130,000 plants per acre. Due to planter issues these populations were not achieved. Actual populations were determined by early season stand counts and were 46,381, 66,196, and 84,977 plants/ac. To estimate the treatment seeding rate and subsequent seed costs, 10% was added to the stand count values; this resulted in treatment seeding rates of approximately 51,000, 73,000, and 93,000 seeds/ac, and assumes all treatments had similar emergence and germination. The plots were direct harvested on September 14 with a John Deere® S780 combine and a MacDon® FD75-S 35-foot FlexDraper® head. Temperature at harvest was 87°F at 16% relative humidity.

Samples from each plot were analyzed for bean quality parameters. Pod height measurements were taken to determine the percent of pods 2" or greater above the soil surface. Harvest loss estimates were determined by taking counts in one-square-foot frames randomly chosen in the harvested area, but equally representing the left side of header, center of header, and right side of header area behind the combine.

Results:

Target Population (seeds/ac)	Stand Count (plants/ac)	Pods >2" Above Ground (%)	Harvest Loss (bu/ac)	Small (%)	Moisture (%)	Density (lb/bu)	Seeds per lb	Yield (bu/ac)†	Marginal Net Return‡ ($/ac)
60,000	46,381 C*	68 C	3.4 A	3 B	8.8 A	62.0 A	1,361 B	33.9 B	444.59 B
100,000	66,196 B	75 B	2.7 A	4 AB	8.9 A	61.6 A	1,412 A	37.3 A	475.42 AB
130,000	84,977 A	84 A	2.1 A	5 A	8.8 A	61.7 A	1,395 AB	39.2 A	486.21 A
P-Value	<0.0001	0.001	0.206	0.053	0.472	0.502	0.041	0.005	0.069

*Values with the same letter are not significantly different at a 90% confidence level.
†Bushels per acre corrected to 14% moisture and adjusted for clean yield (% splits, % small, and % foreign material removed).
‡Marginal net return based on $24/cwt ($14.40/bu at 60lb/bu). Seed cost for the treated Vibrant pinto bean seed was $84.00 per 100,000 seeds.

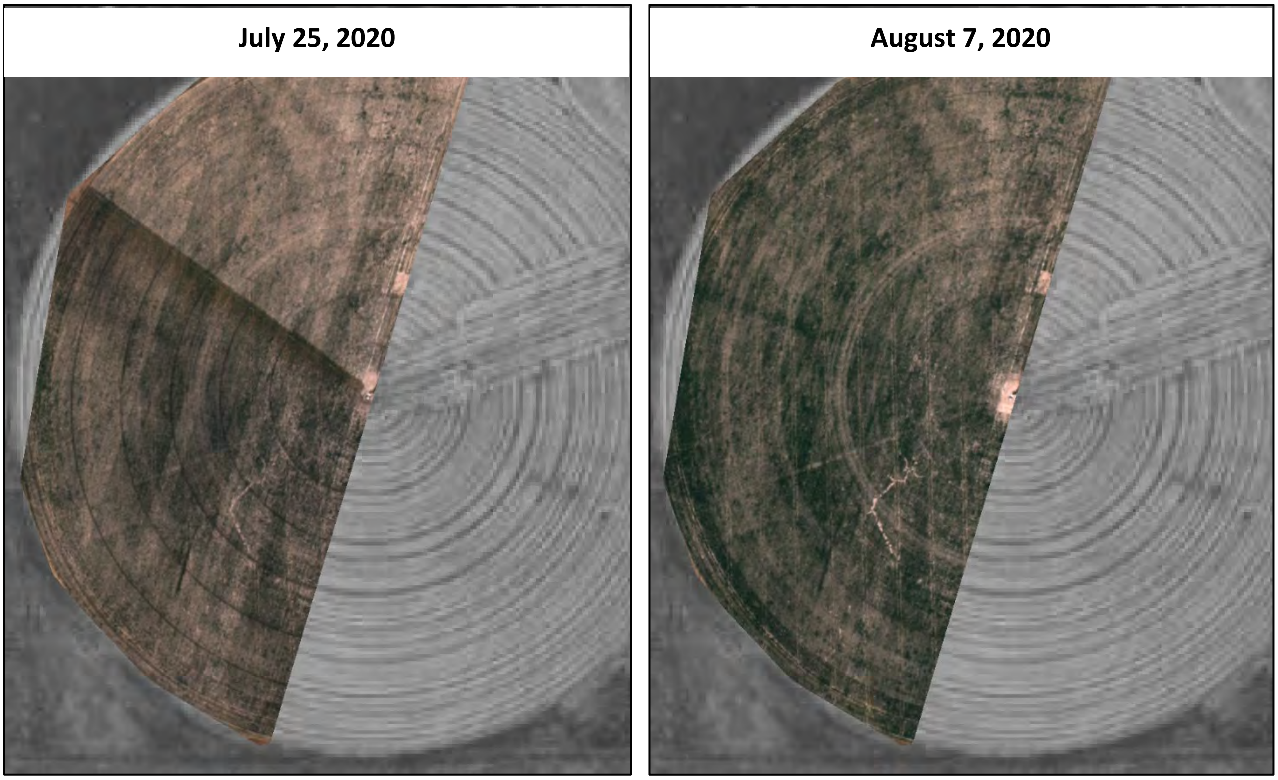


Figure 1. Aerial imagery from July 25, 2020 (left), and August 7, 2020 (right).

Summary:

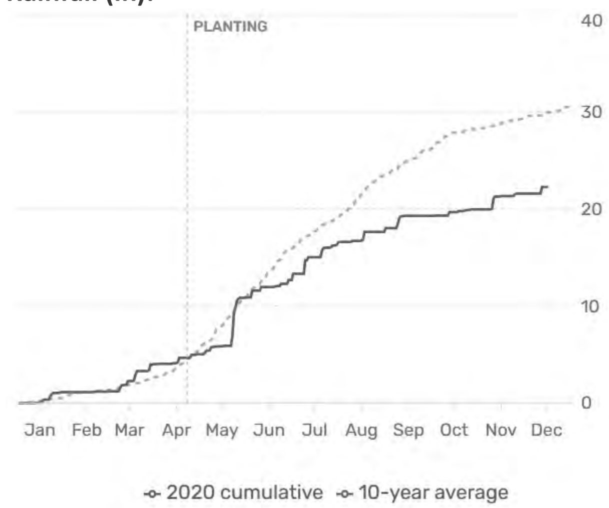
- The percent of pods greater than 2” increased with increasing plant population. For the 46,381 plants/ac population, only 68% of pods were greater than 2” above the ground.
- There were no differences in harvest loss or grain moisture. The 84,977 plants/ac population had a greater percent of small seeds than the 46,381 plants/ac population.
- Yield was significantly lower for the 46,381 plants/ac population; there were no statistically significant differences in yield between the 66,196 and 84,977 plants/ac populations.
- Marginal net return was higher for the 84,977 plants/ac population than for the 46,381 plants/ac population. The 66,196 plants/ac population did not have a statistically different marginal net return than the other two populations.
- Due to planter issues, the low population treatment was well below recommended seeding rate.
- Vertical light stripes on the July 25 image (Figure 1) reflect population treatment differences in the lower population. The August 7 image (Figure 1) still reflects some treatment differences; lack of row closure across all populations remained throughout the season.
- High August temperatures and wind caused plant stress during the bean reproduction stages causing a 10-15% reduction in yield across the dry bean growing region.

Fertility & Soil Management

Impact of Compass Minerals® Season Long Program on Soybeans

Study ID: 1116081202001
County: Hamilton
Soil Type: Ortello fine sandy loam; Thurman fine sandy loam; Coly silt loam
Planting Date: 4/22/20
Harvest Date: 9/21/20-9/22/20
Population: 115,000
Row Spacing (in): 30
Hybrid: LG Seeds® 2417
Reps: 3
Previous Crop: Corn
Tillage: No-Till
Herbicides: ***Pre:*** Dual®II Magnum and Roundup®
Post: Roundup® and Warrant®
Foliar Insecticides: None
Foliar Fungicides: Delaro®
Fertilizer: None

Irrigation: Pivot, Total: 6"
Rainfall (in):



Introduction: This study evaluated Compass Minerals® season long program for soybeans versus an untreated check. The Compass Minerals® season long program is outlined below:

- At planting, Rocket Seeds Moly Dry was used at a rate of 3 oz/50 lb seed as a replacemennt for talc. Rocket Seeds Moly Dry is a dry seed nutritional with a formulation of 1.5% Fe, 3% Mn, 3% Mo, and 10.5% Zn.
- Also, at planting Abundance® was applied in furrow at 1.5 pt/ac. Abundance® is a soil inoculant containing *Bacillus amyloliquefaciens*, *Bacillus subtilis*, and *Bacillus pumilus*.
- At flowering, a foliar application of 7 oz/ac of ProAcqua® Pulse was applied. ProAcqua® Pulse contains 6% P, 4% K, 1% Mg, 1.3% S, 0.5% Co, 10% Mo, 1.5% Ni, and 6% Zn.
- At beginning seed development, a foliar application of 3 lb/ac of ProAcqua® Flow was applied. ProAcqua® Flow contains 5% N, 10% P, 20% K, 9% Mg, 11.5% S, and 0.5% B.

Results:

	Moisture (%)	Yield (bu/ac)†	Marginal Net Return‡ ($/ac)
Control	10.8 A*	89 A	846.48 A
Compass Minerals® season long program	10.6 A	92 A	857.82 A
P-Value	0.346	0.227	0.579

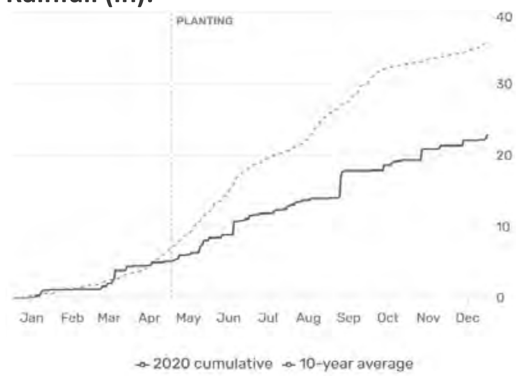
*Values with the same letter are not significantly different at a 90% confidence level.
†Bushels per acre corrected to 13% moisture.
‡Marginal net return based on $9.50/bu soybean and $18.50/ac for Compass Minerals® season long program.

Summary: There was no difference in moisture, yield, or net return between the Compass Minerals® treatment and the untreated check.

Impact of Pell Lime on Soybean Production

Study ID: 0018177202001
County: Washington
Soil Type: Nora silt loam 6-11% slopes
Planting Date: 5/2/20
Harvest Date: 10/5/20
Seeding Rate: 165,000
Row Spacing (in): 30
Hybrid: Pioneer® P33A53X
Reps: 6
Previous Crop: Corn
Herbicides: ***Pre:*** 2 qt/ac trifluralin ***Post:*** 3.5 oz/ac Flexstar® GT and 7.5 oz/ac clethodim on 6/17/20
Seed Treatment: Gaucho®, Lumisena™, EverGol® Energy and LumiGEN™ L-2030 G

Foliar Insecticides and Fungicides: None
Fertilizer: 4 gal/ac 6-21-10 and 3.4 gal/ac S
Irrigation: None
Rainfall (in):



Soil Samples (May 2020):

OM %	Bray P1 (ppm)	Bray P2 (ppm)	K (ppm)	Mg (ppm)	Ca (ppm)	pH	BpH	CEC Me/100g	K%	Mg%	Ca%	H%	Nitrate-N (ppm)	Nitrate-N (lb/ac)	S (ppm)	Zn (ppm)
3.6	11	18	306	407	2814	6.4	6.7	20.0	3.9	17.0	70.3	8.8	13	23	9	1.1
3.5	19	33	267	591	3317	6.4	6.7	24.4	2.8	20.2	68.0	9.0	15	27	7	1.1
2.9	26	79	210	592	2634	5.3	6.7	27.0	2.0	18.3	48.8	30.9	19	34	6	0.8
3.1	15	41	350	410	2329	5.7	6.5	20.2	4.4	16.9	57.6	21.1	19	34	8	1.5
2.6	8	24	236	472	2781	5.8	6.5	22.7	2.7	17.3	61.3	18.7	7	13	7	0.8
3.0	5	12	209	432	2681	5.8	6.6	21.6	2.5	16.7	62.1	18.7	7	13	7	0.6

Introduction: The purpose of this study was to evaluate the impact of pell lime application on crop yield and soil pH. Pell lime was chosen as it is easier to spread and may provide more uniform applications. The pH in the field ranged from 5.3 to 6.4 and averaged 5.9. The buffer pH ranged from 6.5 to 6.7 and averaged 6.6. The University of Nebraska—Lincoln lime recommendations (https://go.unl.edu/limerec) indicate that for each 0.1 pH buffer reading below 7.0, application of 1,000 to 1,200 lb/ac of ag-lime (with 60% effective calcium carbonate equivalent or ECCE) is recommended to raise the soil pH to approximately 6.5 in the top 7 inches. Based on this recommendation and an average buffer pH of 6.6 from soil tests, 4,000 to 4,800 lb/ac of ag lime would be recommended. This study used pell lime, which has a calcium carbonate equivalent (CCE) of 90-95%. This would result in a recommended application rate of approximately 2,520 to 3,024 lb/ac to bring the pH up to 6.5. The study applied 300 lb/ac pell lime on April 6, 2020, incorporated with 1 disk pass versus a check with no pell lime. Both the area with pell lime and the check were disked on April 19, 2020.

Results:

	Early Season Stand Count (plants/ac)	Moisture (%)	Test Weight (lb/bu)	Yield (bu/ac)†	Marginal Net Return‡ ($/ac)
Check	160,117 A*	7.7 A	55 A	52 A	491.42 A
Pell Lime	160,117 A	7.8 A	55 A	53 A	479.99 A
P-Value	1	0.625	0.472	0.434	0.32

*Values with the same letter are not significantly different at a 90% confidence level.
†Bushels per acre corrected to 13% moisture.
‡Marginal net return based on $9.50/bu soybean and $20.25/ac for pell lime.

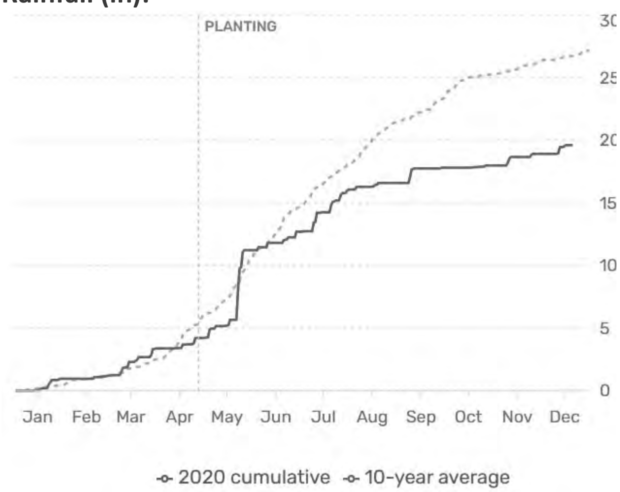
Summary:

- There were no differences in stand count, moisture, test weight, yield, or net return between the soybeans with pell lime and the check. There were no visual differences between treatments.
- The study will continue in order to document the long term impacts of the lime application.

Comparing Starter Fertilizers In-Furrow:
CHS® Lumen™ vs. Aurora Cooperative AgPro vs 10-34-0

Study ID: 1120019202004
County: Buffalo
Soil Type: Coly silt loam 6-30% slopes
Planting Date: 4/27/20
Harvest Date: 10/8/20
Seeding Rate: 34,000
Row Spacing (in): 30
Hybrid: DEKALB® DKC64-35 VT2PRIB
Reps: 4
Previous Crop: Soybean
Tillage: Strip-Till
Herbicides: ***Pre:*** 1.5 qt/ac Degree Xtra®, 3 oz/ac mesotrione, 32 oz/ac Roundup PowerMAX® , 1% COC, 8.5 lb AMS per 100 gal water ***Post:*** 1.5 qt/qc Degree Xtra®, 1 pt/ac atrazine, 32 oz/ac Roundup PowerMAX®, 8.5 lb AMS per 100 gal water
Foliar Insecticides: None
Foliar Fungicides: Delaro® at VT

Fertilizer: 35-40-0-11 strip-till, 3 gal/ac in-furrow starters (tested in this study), 12 gal/ac 32% UAN dribbled starter at planting, and 41 gal/ac 32% UAN fertigated
Irrigation: Pivot
Rainfall (in):



Soil Tests (October 2019):

pH	Soluble Salts	Excess Lime	% OM	Nitrate (ppm)	Nitrate (lb/ac)	P (ppm)
7.8	0.12	Low	2.5	6	18	16
7.9	0.12	Low	2.2	4.3	13	14

Introduction: This study evaluated three different starter fertilizer products. CHS® Lumen™ has an analysis of 5-15-3-0S-0.8Zn-0.1Fe. Aurora Cooperative AgPro has an analysis of 9-24-3. The check was the grower's typical 10-34-0 starter. Stand counts, moisture, yield, and net return were evaluated. The field experienced green snap.

Results:

	Early Season Stand Count (plants/ac)	Harvest Stand Count (plants/ac)	Moisture (%)	Yield (bu/ac)†	Marginal Net Return‡ ($/ac)
3 gal/ac Aurora Cooperative AgPro	32,583 A*	24,083 A	18.7 A	216 A	744.41 A
3 gal/ac 10-34-0 (check)	30,750 A	25,000 A	18.2 A	218 A	756.08 A
3 gal/ac CHS® Lumen™	33,083 A	29,083 A	18.4 A	220 A	743.45 A
P-Value	0.577	0.102	0.127	0.724	0.723

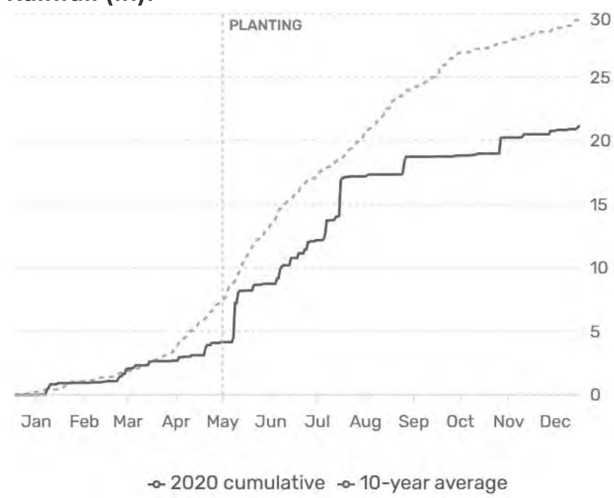
*Values with the same letter are not significantly different at a 90% confidence level.
†Bushels per acre corrected to 15.5% moisture.
‡Marginal net return based on $3.51/bu corn, $7.35/ac 10-34-0, $27/ac CHS® Lumen™, and $12/ac Aurora Cooperative AgPro

Summary: There were no statistically significant differences in stand counts, grain moisture, yield, or net return for the three starter products evaluated.

Impact of Starter Fertilizer on Soybean

Study ID: 1127001202001
County: Adams
Soil Type: Holder silt loam
Planting Date: 5/15/20
Harvest Date: 10/5/20
Seeding Rate: 150,000
Row Spacing (in): 36
Hybrid: Aurora Cooperative 3019E3
Reps: 6
Previous Crop: Corn
Tillage: No-Till
Herbicides: ***Post:*** 1 qt/ac Liberty® 280 SL and 3 pt/ac Sequence® on 6/21/20
Seed Treatment: Signum® inoculant, CruiserMaxx®
Foliar Insecticides: None
Foliar Fungicides: None
Fertilizer: 100 lb/ac MAP, 64 lb/ac AMS, 3.5 lb/ac 36% zinc, on 3/15/20; 1 qt/ac Aurora Cooperative Heighten™ foliar fertilizer on 6/21/20

Irrigation: Pivot, Total: 10"
Rainfall (in):



Soil Samples (November 2018, minimum, maximum, and average values from grid sample):

	pH	Buffer pH	P (ppm)	K (ppm)	OM	CEC	S (ppm)	Calcium (ppm)	Magnesium (ppm)	Zn (ppm)	% Base Saturation K	% Base Saturation Ca	% Base Saturation Mg	% Base Saturation Na
Min	5.6	6.5	15.2	277.3	1.4	10.5	3.9	1472	212	0.8	5	47	14	1
Max	7.1	7.2	71.5	521.8	2.6	18.4	9	2817	418	3.6	8	76	21	1
Avg	6.5	7	32.2	360.3	1.8	13.7	6.7	1892.2	294.9	2.3	6.9	68.8	18.1	1

Introduction: The purpose of this study was to evaluate the impact of Aurora Bean Starter™ on soybeans. Aurora Bean Starter™ is a proprietary micronutrient blend from Aurora Cooperative. Stand counts were taken on June 26, 2020, at V5 growth stage and on September 30, 2020, prior to harvest. Yield and net return were evaluated.

Results:

	Early Season Stand Count (plants/ac)	Harvest Stand Count (plants/ac)	Yield (bu/ac)†	Marginal Net Return‡ ($/ac)
Check	163,717 A*	149,435 A	79 A	750.78 A
1 qt/ac Aurora Bean Starter™	163,368 A	149,870 A	79 A	739.27 A
P-Value	0.953	0.894	0.947	0.594

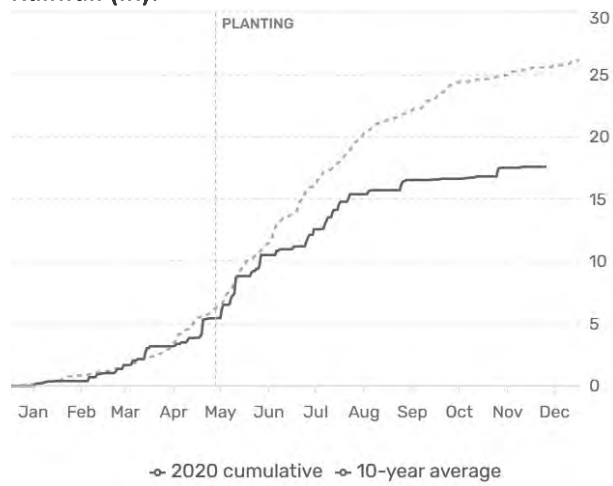
*Values with the same letter are not significantly different at a 90% confidence level.
†Bushels per acre corrected to 13% moisture.
‡Marginal net return based on $9.50/bu soybean and $10/ac for Aurora Bean Starter.

Summary: There were no statistically significant differences in stand counts, yield, or net return between the soybeans with Aurora Bean Starter™ and the check.

Altura™ vs 10-34-0 in Strip-Till Fertilizer Application on Corn

Study ID: 0709047202001
County: Dawson
Soil Type: Coly-Hobbs silt loam; Cozad silt loam; Hord silt loam
Planting Date: 5/12/20
Harvest Date: 10/23/20
Population: 34,000
Row Spacing (in): 30
Hybrid: Channel® 209-15VT2
Reps: 7
Previous Crop: Soybean
Tillage: Strip-Till, Ridge-Till
Herbicides: ***Pre:*** 24 oz/ac Durango® DMA® and 3 qt/ac Vilify™ on 5/14/20
Seed Treatment: None

Irrigation: Gravity, Total: 12"
Rainfall (in):



Soil Tests (December 2019):

Soil pH 1:1	Soluble Salts 1:1 mmho/cm	OM LOI %	Nitrate lb N/A	Mehlich P-III ppm P	SO_4-S ppm	Ammonium Acetate (ppm) K	Ca	Mg	Na	Sum of Cations meq/100g	DPTA (ppm) Zn	Fe	Mn	Cu
6.8	0.5	2.6	17	14	2	404	2971	484	59	20	1.5	19.9	10.3	0.9
7.1	0.6	2.6	17	18	6	378	3407	432	63	22	1.8	18.1	7.4	0.8
6.9	0.5	2.9	17	17	2	398	2396	420	66	17	1.5	28.1	13.6	0.9
6.4	0.3	3.1	14	15	2	378	2071	418	72	15	1.5	28.1	13.6	0.9
6.9	0.5	2.8	12	23	15	361	2409	373	85	16	0.8	22.9	10.5	0.6
6.9	0.5	2.7	10	15	2	328	2542	423	71	17	0.4	21.7	10.1	0.6
7.0	0.4	2.5	12	15	2	254	2271	365	73	15	0.7	15.2	7.9	0.6

Introduction: The purpose of this study is to evaluate the impact of Altura™ fertilizer versus 10-34-0 fertilizer. Altura™ is a 7-21-0 fertilizer with 6% organic matter derived from leonardite, 1% gluconic acid, and 0.2% zinc. The two treatments were applied with strip-till on May 11, 2020:

Check: 15 gal/ac 32% UAN, 5 gal/ac 12-0-0-26S, 0.25 gal/ac chelated zinc, and 15 gal/ac 10-34-0.

Altura™: 15 gal/ac 32% UAN, 5 gal/ac 12-0-0-26S, 0.25 gal/ac chelated zinc, and 5 gal/ac Altura™.

Additional fertilizer on the field was the same for both treatments and included an in-furrow starter fertilizer application of 1 gal/ac Altura™, 1 gal/ac ReaX™ K, and 0.5 gal/ac ReaX™ Zn on May 12, 2020, and a sidedress application of 43 gal/ac 32% UAN and 8 gal/ac 12-0-0-26S on June 24, 2020. A previous cover crop of wheat, turnip, and rapeseed was terminated on April 30, 2020. This study will be continued for 3 years with treatment applied to the same strips to document if soil fertility levels change with the use of Altura™.

Results:

	Early Season Stand Count (plants/ac)	Harvest Stand Count (plants/ac)	Moisture (%)	Yield (bu/ac)†	Marginal Net Return‡ ($/ac)
Check (10-34-0)	30,952 A*	30,667 A	18.5 A	190 A	632.01 A
Altura™	32,667 A	31,191 A	18.5 A	188 A	623.74 A
P-Value	0.261	0.406	0.573	0.545	0.545

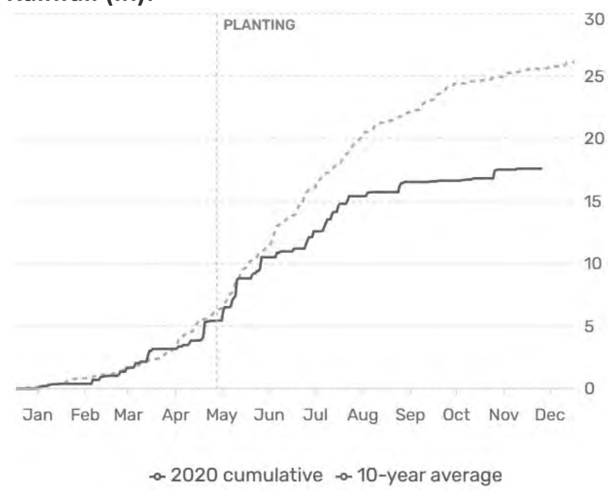
*Values with the same letter are not significantly different at a 90% confidence level.
†Bushels per acre corrected to 15.5% moisture.
‡Marginal net return based on $3.51/bu corn, $38.45 for strip-till with 10-34-0, and $35.00 for starter with Altura™.

Summary: The treatments did not result in differences in early season or at harvest stand counts. After one year of the study, there were no statistically significant differences in grain yield or marginal net return.

ReaX™ Mn in Starter on Corn

Study ID: 0709047202002
County: Dawson
Soil Type: Coly-Hobbs silt loam; Cozad silt loam; Hord silt loam
Planting Date: 5/12/20
Harvest Date: 10/23/20
Population: 34,000
Row Spacing (in): 30
Hybrid: Channel® 209-15VT2
Reps: 7
Previous Crop: Soybean
Tillage: Strip-Till, Ridge-Till
Herbicides: ***Pre:*** 24 oz/ac Durango® DMA®, and 3 qt/ac Vilify™ on 5/14/20
Seed Treatment: None

Irrigation: Gravity, Total: 12"
Rainfall (in):



Soil Tests (grid sampling, December 2019):

Soil pH 1:1	Soluble Salts 1:1 mmho/cm	OM LOI %	Nitrate lb N/A	Mehlich P-III ppm P	SO_4-S ppm	Ammonium Acetate (ppm) K	Ca	Mg	Na	Sum of Cations meq/100g	DPTA (ppm) Zn	Fe	Mn	Cu
6.8	0.5	2.6	17	14	2	404	2971	484	59	20	1.5	19.9	10.3	0.9
7.1	0.6	2.6	17	18	6	378	3407	432	63	22	1.8	18.1	7.4	0.8
6.9	0.5	2.9	17	17	2	398	2396	420	66	17	1.5	28.1	13.6	0.9
6.4	0.3	3.1	14	15	2	378	2071	418	72	15	1.5	28.1	13.6	0.9
6.9	0.5	2.8	12	23	15	361	2409	373	85	16	0.8	22.9	10.5	0.6
6.9	0.5	2.7	10	15	2	328	2542	423	71	17	0.4	21.7	10.1	0.6
7.0	0.4	2.5	12	15	2	254	2271	365	73	15	0.7	15.2	7.9	0.6

Introduction: The purpose of this study is to evaluate the impact of ReaX™ Mn in starter fertilizer. Soil tests indicated Mn levels ranged from 7.4 to 13.6 ppm. The producer's goal is to increase Mn levels to 20 ppm. ReaX™ Mn is a 4% Mn C2 powdered manganese. The two treatments were applied with starter at planting on May 12, 2020:

Check: 1 gal/ac Altura™, 1 gal/ac ReaX™ K, and 0.125 gal/ac ReaX™ Zn.

ReaX™Mn: 1 gal/ac Altura™, 1 gal/ac ReaX™ K, 0.125 gal/ac ReaX™ Zn, and 0.5 gal/ac ReaX™ Mn.

Additional fertilizer on the field was the same for both treatments and included a strip-till application of 15 gal/ac 32% UAN, 5 gal/ac 12-0-0-26S, 0.25 gal/ac chelated zinc, and 15 gal/ac 10-34-0 on May 11, 2020, and a sidedress application of 43 gal/ac 32% UAN and 8 gal/ac 12-0-0-26S on June 24, 2020. A previous cover crop of wheat, turnip, and rapeseed was terminated on April 30, 2020. This study will be continued for 3 years on the same locations to document if soil fertility levels change with the use of ReaX™ Mn.

Results:

	Early Season Stand Count (plants/ac)	Harvest Stand Count (plants/ac)	Moisture (%)	Yield (bu/ac)†	Marginal Net Return‡ ($/ac)
Check	33,286 A*	32,095 A	18.5 A	196 A	688.83 A
ReaX™ Mn	32,714 A	31,333 A	18.5 A	199 A	689.29 A
P-Value	0.213	0.316	0.486	0.202	0.944

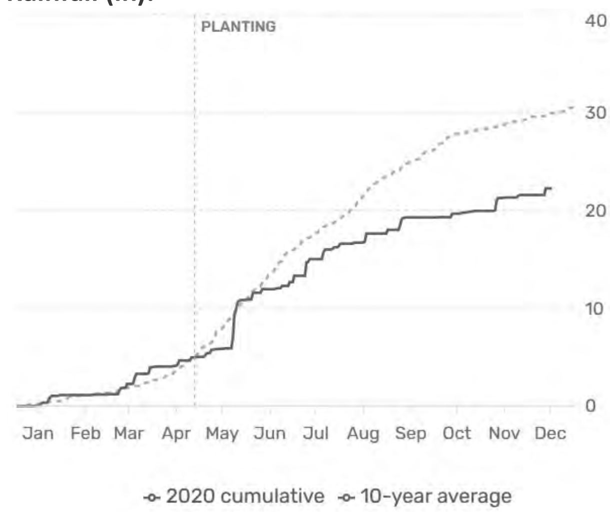
*Values with the same letter are not significantly different at a 90% confidence level.
†Bushels per acre corrected to 15.5% moisture.
‡Marginal net return based on $3.51/bu corn and $8.50/ac for ReaX™ Mn.

Summary: The ReaX™ Mn did not result in statistically significant differences in early season or at harvest stand counts. After one year of the study, there were no differences in grain yield or marginal net return.

Impact of Envita™ at Three N Rates on Corn Yield

Study ID: 1116081202002
County: Hamilton
Soil Type: Hastings silt loam
Planting Date: 4/27/20
Harvest Date: 10/21/20
Population: 33,000
Row Spacing (in): 30
Hybrid: Allied Genetics® 112C17
Reps: 4
Previous Crop: Soybean
Tillage: No-Till
Herbicides: ***Pre:*** SureStart® II, Roundup®, and atrazine ***Post:*** Callisto® and atrazine
Foliar Insecticides: None
Foliar Fungicides: Delaro® at VT

Irrigation: Pivot, Total: 6"
Rainfall (in):



Introduction: Envita™ contains a nitrogen-fixing bacteria *(Gluconacetobacter diazotrophicus)* for use on corn. According to the Envita™ website, Envita™ can replace 27% of a corn plant's nitrogen needs or if applied with the recommended nitrogen fertility program, increase corn yield between 5-13%. In this study, Envita™ was applied as a seed treatment. Anhydrous ammonia was applied at three rates, 100 lb N/ac, 150 lb N/ac, and 200 lb N/ac. At planting, the fertilizer plots were split such that half the planter had Envita™ and half did not. Yield, moisture, and net return were evaluated.

Results:

	Moisture (%)	Yield (bu/ac)†	Marginal Net Return‡ ($/ac)
100 lb/ac	16.6 A	235 B	786.23 AB
100 lb/ac + Envita	16.7 A	228 C	754.80 C
150 lb/ac	16.5 A	243 A	792.53 A
150 lb/ac + Envita	16.6 A	236 B	763.98 C
200 lb/ac	16.6 A	245 A	778.51 B
200 lb/ac + Envita	16.8 A	239 B	752.63 C
P-Value	0.317	<0.0001	<0.0001

*Values with the same letter are not significantly different at a 90% confidence level.
†Yield values are from cleaned yield monitor data. Bushels per acre corrected to 15.5% moisture.
‡Marginal net return based on $3.51/bu corn, $0.40/lb N, and $5/ac Envita™.

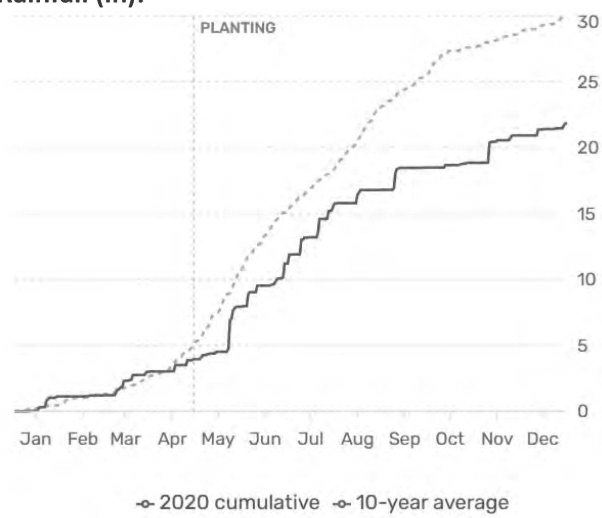
Summary:

- At each N rate, the use of Envita™ resulted in lower yields. Between the N rates tested, the 150 lb/ac rate was sufficient to maximize yield; applying 200 lb/ac did not result in additional yield over the 150 lb/ac rate.
- The use of Envita™ resulted in lower marginal net returns at each N rate evaluated. The 100 lb/ac and 150 lb/ac rates without Envita™ resulted in the greatest marginal net return.

Evaluating Spring Anhydrous Nitrogen Rate on Corn

Study ID: 1111185202002
County: York
Soil Type: Butler silt loam 0-1% slope; Hastings silt loam 0-1% slope; Hastings silt loam 3-7% slopes
Planting Date: 4/29/20
Harvest Date: 10/14/20
Seeding Rate: 27,500
Row Spacing (in): 36
Hybrid: Pioneer® P1639Q
Reps: 4
Previous Crop: Corn
Tillage: Stalk Chopping 4/20/20, Ridging 6/17/20
Herbicides: ***Post:*** Resicore®, Roundup®, atrazine, and crop oil on 5/2/20 as a post-plant burndown
Seed Treatment: PPST, Maxim® Quattro, Lumiflex™, Lumiante™, L-20012R, Lumivia™ 250, Lumisure™, and Lumialza™
Foliar Insecticides: None
Foliar Fungicides: Delaro® late August

Note: There was 3% green snap on July 9. Lots of the standing plants pollinated and grew small ears late.
Irrigation: Pivot, Total: 6.25"
Rainfall (in):



Soil Tests (December 2019, 0-8" depth):

pH	BpH	OM LOI %	Nitrate – N ppm N	Mehlich P-III ppm P	Ammonium Acetate (ppm) K	Ca	Mg	Na	CEC me/100g	% Base Saturation H	K	Ca	Mg	Na
6.5	6.8	3.0	6	50	352	2294	419	25	17.6	9	5	65	20	1
5.8	6.4	3.0	6.4	13	258	1456	205	16	16.0	39	4	45	11	0
6.9		3.0	6.6	12	298	2697	485	29	18.4	0	4	73	22	1
5.8	6.5	3.0	9.2	14	366	1766	276	20	16.9	28	6	51	14	1

Introduction: This study evaluated three different rates of nitrogen fertilizer. Nitrogen was applied as anhydrous ammonia the last week of March 2020. Three different rates were applied: 110 lb/ac N, 160 lb/ac N, and 210 lb/ac N. All treatments also received 25 lb/ac N as UAN with the burndown herbicide on May 1, 2020. This brings the total N rates for each treatment to 135 lb/ac, 185 lb/ac, and 235 lb/ac. For reference, the UNL nitrogen algorithm would recommend 171 lb/ac of N for this field using an expected yield of 225 bu/ac.

Results:

	Harvest Stand Count (plants/ac)	Stalk Rot (%)	Green snap (%)	lbs N/bu grain	Moisture (%)	Yield (bu/ac)†	Marginal Net Return‡ ($/ac)
135 lb/ac N	26,750 A*	2.50 A	0 A	0.73 C	17.1 B	184 A	599.14 A
185 lb/ac N	26,875 A	0.63 A	3 A	0.98 B	16.9 B	189 A	600.38 A
235 lb/ac N	27,125 A	2.50 A	1 A	1.23 A	17.9 A	191 A	594.88 A
P-Value	0.736	0.785	0.183	<0.0001	0.028	0.246	0.903

*Values with the same letter are not significantly different at a 90% confidence level.
†Bushels per acre corrected to 15.5% moisture.
‡Marginal net return based on $3.51/bu corn, $8/ac for the anhydrous application cost, $0.28/lb N as anhydrous, and $0.35/lb N as UAN.

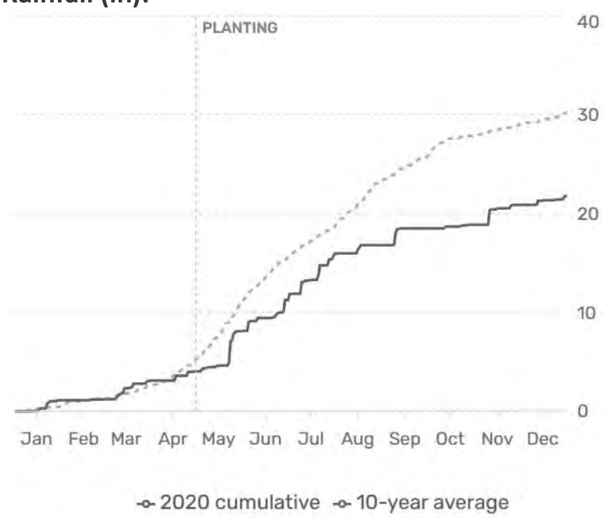
Summary:

- There were no statistically significant differences in stand count, stalk quality, yield, or marginal net return between the 3 nitrogen rates evaluated.
- The lowest nitrogen rate of 135 lb/ac resulted in the greatest nitrogen use efficiency, using approximately 0.7 lb of N to produce a bushel of grain.

Evaluating Nitrogen Rate and Timing on Corn

Study ID: 1111081202001
County: Hamilton
Soil Type: Hord silt loam rarely flooded; Hord silt loam 3-6% slopes
Planting Date: 4/30/20
Harvest Date: 10/24/20
Seeding Rate: 27,500
Row Spacing (in): 36
Hybrid: Pioneer® P1639Q
Reps: 3
Previous Crop: Corn
Tillage: Stalk Chopping 4/20/20, Ridging 6/17/20
Herbicides: Post: Resicore®, Roundup®, atrazine, and crop oil on 5/2/20 as a post plant burndown
Seed Treatment: PPST, Maxim® Quattro, Lumiflex™, Lumiante™, L-20012R, Lumivia™ 250, Lumisure™, and Lumialza™
Foliar Insecticides: None
Foliar Fungicides: Delaro® late August

Note: There was 10% green snap on this field July 9. Lots of the standing plants pollinated and grew small ears late.
Irrigation: Pivot, Total: 6.25"
Rainfall (in):



Soil Tests (December 2019, 0-8" depth): Nitrate only also sampled 8-40" (<0.1 ppm) and 40-72" (<0.1 ppm)

			Nitrate –	Mehlich P-	Sulfate-S	B	Ammonium Acetate (ppm)				CEC	% Base Saturation				
Soil pH 1:1	BpH	OM LOI %	N ppm N	III ppm P	ppm S	(ppm)	K	Ca	Mg	Na	me/100g	H	K	Ca	Mg	Na
6.6		3.5	7.5	120	17.3	0.94	485	2331	332	20	15.8	0	8	73	18	1
6.6		3.4	3.0	84	11.5	0.75	535	2217	325	18	15.2	0	9	72	18	1

Introduction: This study evaluated various rates and timings of nitrogen application. The treatments were as follows:

Fall 205 lb/ac: 180 lb/ac N as fall anhydrous ammonia and 25 lb/ac N with herbicide
Fall 255 lb/ac: 230 lb/ac N as fall anhydrous ammonia and 25 lb/ac N with herbicide
Spring 205 lb/ac: 180 lb/ac N as spring anhydrous ammonia and 25 lb/ac N with herbicide
Spring 255 lb/ac: 230 lb/ac N as spring anhydrous ammonia and 25 lb/ac N with herbicide
Split 205 lb/ac: 120 lb/ac N as spring anhydrous ammonia, 25 lb/ac N with herbicide, and 60 lb/ac N sidedressed at V8
Split 255 lb/ac: 170 lb/ac N as spring anhydrous ammonia, 25 lb/ac N with herbicide, and 60 lb/ac N sidedressed at V8

Fall anhydrous application was in early November 2019. Spring anhydrous application was the last week of March 2020. The N with herbicide was applied on May 2, 2020. The sidedress application at V8 was the second week of June. For reference, with a yield goalof 225 bu/ac, with the UNL economical N recommendation for this field was 232 lb/ac N if applied in the fall, 190 lb/ac N if applied in the spring, and 156 lb/ac N if applied with a split application.

There was 10% green snap from on July 9. Many of the standing plants were damaged and pollinated late and grew small ears. Soil samples were collected from the same area of the field throughout the season. Two soil cores were pulled from the anhydrous band in three rows for a total of 6 cores. For the split application treatments, additional samples were taken from the furrow where liquid fertilizer was applied and the results were averaged with the samples from the anhydrous band. The soil samples were not replicated.

Results:

	Stand Count (plants/ac)	Stalk Rot (%)	Green snap (%)	lbs N/bu grain	Moisture (%)	Yield (bu/ac)†	Marginal Net Return‡ ($/ac)
Fall 205 lb/ac	26,667 A*	0.01 A	6 A	1.03 B	16.2 A	199 A	629.85 A
Fall 255 lb/ac	26,500 A	0.00 A	2 A	1.27 A	16.3 A	201 A	625.49 A
Spring 205 lb/ac	25,833 A	0.00 A	7 A	1.02 B	16.5 A	201 A	638.30 A
Spring 255 lb/ac	26,000 A	0.00 A	6 A	1.24 A	16.5 A	206 A	641.70 A
Split 205 lb/ac	26,833 A	0.00 A	3 A	1.00 B	16.6 A	205 A	645.69 A
Split 255 lb/ac	26,833 A	0.00 A	5 A	1.24 A	16.6 A	206 A	633.50 A
P-Value	0.920	0.465	0.588	<0.0001	0.669	0.238	0.564

*Values with the same letter are not significantly different at a 90% confidence level.
†Bushels per acre corrected to 15.5% moisture.
‡Marginal net return based on $3.51/bu corn, $0.28/lb N as anhydrous ammonia, $8.00/ac for anhydrous ammonia application, $0.35/lb for UAN applied with herbicide or as sidedress, and $3/ac for sidedress UAN application.

Soil Samples:

Treatment	6/30/20 Nitrate – N ppm N	6/30/20 Nitrate-N lb N/ac	7/17/20 Nitrate-N ppm N	7/17/20 Nitrate-N lb N/ac	10/19/20 Nitrate-N ppm N	10/19/20 Nitrate-N lb N/ac
			0-12”			
Fall 205 lb/ac	48.4	174	21.3	77	3	13
Fall 255 lb/ac	32.2	116	8	29	3.2	12
Spring 205 lb/ac	56.5	203	16.5	59	5.8	19
Spring 255 lb/ac	35.2	127	12.8	46	3.3	12
Split 205 lb/ac	24.9	90	27.7	100	2.3	8
Split 255 lb/ac	22.1	80	23.3	84	6.4	0
			12-24”			
Fall 205 lb/ac	19.1	69	5.3	19	0.7	3
Fall 255 lb/ac	16	58	4.6	17	0.6	2
Spring 205 lb/ac	18.7	67	4.6	17	0.7	2
Spring 255 lb/ac	11.1	40	4.8	17	1.8	7
Split 205 lb/ac	13.6	49	3.9	14	0.4	1
Split 255 lb/ac	8.8	32	15.5	2.85	0.6	0
			24-36”			
Fall 205 lb/ac	3.3	12	3.3	12	0.2	1
Fall 255 lb/ac	4.5	16	5.1	18	0.4	1
Spring 205 lb/ac	7.5	27	3.3	12	0.1	0
Spring 255 lb/ac	3.8	14	4.6	17	0.2	1
Split 205 lb/ac	4.4	16	1.9	7	0.1	0
Split 255 lb/ac	0.6	2	1	11	0	0
			36-72”			
Fall 255 lb/ac	-	-	2.8	30	0.1	2
Split 255 lb/ac	-	-	1	11	<0.1	0

Summary:

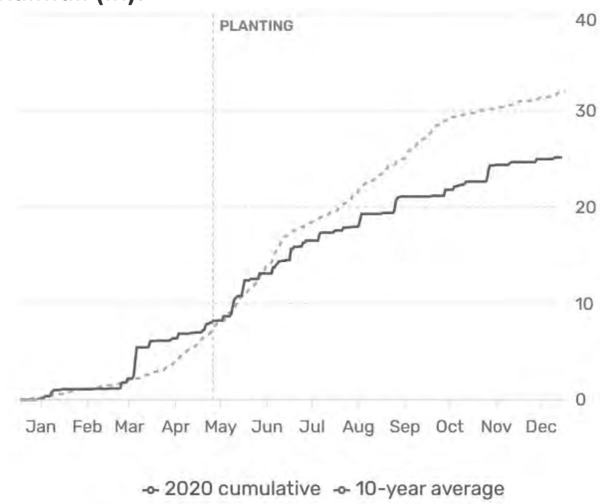
- There were no differences in stalk quality, yield, moisture, or net return for the nitrogen rates and timings evaluated. The 205 lb/ac N rate yielded as well as the higher N rate.
- The treatments with 205 lb/ac N resulted in better nitrogen use efficiency, using approximately 1 lb of N to produce a bushel of grain. In contrast, the treatments with 255 lb/ac N used approximately 1.2 lb of N to produce a bushel of grain.
- Across all treatments, in the mid-October soil sampling, the maximum amount of nitrate-N remaining in the soil was 19 lb/ac in the top 12” and 8 lb/ac from 12-72”.

CLICK TO WATCH A VIDEO ABOUT THIS STUDY https://go.unl.edu/psnt

PSNT-N Sidedress Rates in Corn Following Cover Crop

Study ID: 0996037202001
County: Colfax
Soil Type: Belfore silty clay loam 0-2% slope; Moody silty clay loam 2-6% slopes; Nora-Crofton 6-17% slopes
Planting Date: 5/10/20
Harvest Date: 11/2/20
Seeding Rate: 28,000
Row Spacing (in): 30
Hybrid: Pioneer® P1082AM
Reps: 5
Previous Crop: Soybean
Tillage: No-Till
Herbicides: ***Pre:*** 10.5 oz/ac 2,4-D LV6 and 8 oz/ac dicamba on 4/26/20; 96 oz/ac Trizar™ and 32 oz/ac glyphosate on 5/14/20 ***Post:*** 4 oz/ac Status® and 32 oz/ac Roundup PowerMAX® on 6/22/20

Seed Treatment: PPST 250
Foliar Insecticides and Fungicides: None
Irrigation: None
Rainfall (in):



Soil Tests (December 2019):

Soil pH 1:1	Soluble Salts 1:1 mmho/cm	OM LOI %	Nitrate lb N/A	Mehlich P-III ppm P	SO_4-S ppm	Ammonium Acetate (ppm) K	Ca	Mg	Na	Sum of Cations meq/100g	DPTA (ppm) Zn	Fe	Mn	Cu
5.9	0.3	2.9	30	31	9	258	3291	609	18	27	2.0	52	6	1.3
7.8	0.6	1.5	30	24	9	210	4490	645	16	28	1.9	21	2	1.4
8.3	0.5	1.1	30	15	8	180	4468	648	16	28	1.3	14	1	1.5

Introduction: The purpose of this study was to compare sidedress rates for a corn crop following a cover crop. Rates were determined using soil sampling and the pre-sidedress nitrogen test and compared the recommended rate to rates that would have been used in the past for a 215-bushel yield goal. A 5-way mix cover crop consisting of rye, winter peas, hairy vetch, crimson clover, and rapeseed was drilled in the fall of 2019 at a rate of 42 lbs. All but the rye winter killed, with the rye 8 inches tall when terminated at planting.

At planting, 65 lb of N was applied; 5 lb/ac N was applied as 10-34-0 in-furrow and 60 lb/ac N and 7 lb/ac S were applied from a 7.5:1 blend of 32% UAN and ammonium thiosulfate placed by a 360 BANDIT™. Sidedress rates were determined using the pre-sidedress nitrate test (PSNT). Sidedressing was done on June 24, 2020, at V7 using a bar with homemade Y-drops, which banded N on the soil surface. A 7.5:1 blend of UAN 32% and ammonium thiosulfate was used; therefore, S rates also varied between treatments. Additionally, approximately 0.5 lb/ac boron as Solubor® was applied with the sidedress application.

The PSNT indicated 18 ppm nitrate-N in the soil. Using the Iowa State University Extension and Outreach recommendation for PSNT (https://store.extension.iastate.edu/product/5259), the appropriate sidedress rate was 56 lb/ac N ([25 ppm – 18 ppm] * 8). The applicator over applied by 12 lb/ac for the PSNT strips, resulting in a treatment of PSNT rate + 12 lb/ac, but was close to the intended rate on the other strips. This was compared to additional N sidedress rates as follows:

- PSNT + 12: 68 lb/ac N and 7 lb/ac S sidedress; 133 lb/ac total N
- PSNT + 30: 83 lb/ac N and 9 lb/ac S sidedress; 148 lb/ac total N
- PSNT + 60: 114 lb/ac N and 12 lb/ac S sidedress; 179 lb/ac total N

Results:

	Nitrogen Tissue Test (%) June 12 (V4)	Nitrogen Tissue Test (%) July 17 (V14)	Nitrogen Tissue Test (%) August 20 (R4)	Stand Count (plants/ac)	Moisture (%)	Yield (bu/ac)†	Marginal Net Return‡ ($/ac)
PSNT + 12	4.25 (S-L)‖ §	3.41 (S)	1.85 (D)	25,950 A*	11.6 A	158 B	492.81 A
PSNT + 30	NA	3.51 (S)	2.10 (L-D)	25,475 A	11.6 A	162 AB	499.96 A
PSNT + 60	NA	3.58 (S)	2.29 (S-L)	24,950 A	11.8 A	166 A	503.09 A
P-Value	-	-	-	0.389	0.746	0.095	0.695

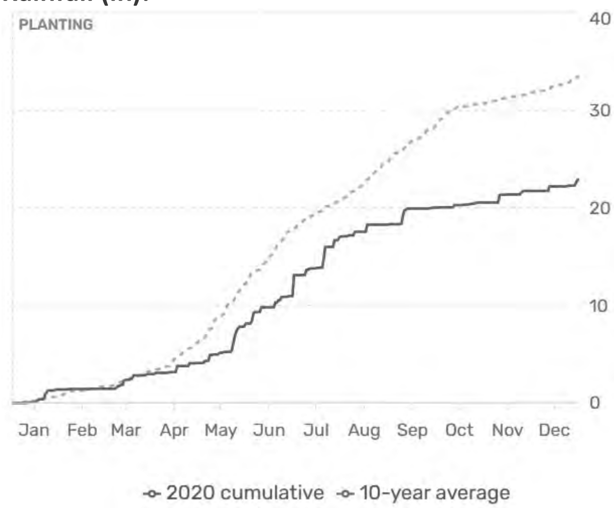
‖Only one tissue test for all treatments was taken at the June 12 date as this was before sidedress applications occurred.
§Sufficiency level as indicated by Midwest Laboratories. S indicates sufficient, L indicates L, D indicates deficient.
*Values with the same letter are not significantly different at a 90% confidence level.
†Bushels per acre corrected to 15.5% moisture.
‡Marginal net return based on $3.51/bu corn and $0.45/lb N.

Summary: There was no difference in harvest stand counts or moisture between the N rates. Yield for the PSNT + 60 treatment (total of 179 lb/ac N) was 8 bu/ac higher than the PSNT + 12 treatment (total of 133 lb/ac N). Dry conditions for the 7-10 days following sidedressing may have resulted in N loss. There was no difference in the net return between the three treatments. Drought conditions reduced yields compared to the 5-year average used to determine the yield goal.

Impact of MicroSource® DCD 25 Inhibitor with Anhydrous Ammonia Application

Study ID: 1137109202001
County: Lancaster
Soil Type: Judson silt loam 2-6% slopes; Aksarben silty clay loam 6-11% slopes; Zook silty clay loam occasionally flooded; Kennebec silt loam occasionally flooded
Planting Date: 4/29/20
Harvest Date: 10/12/20
Seeding Rate: 30,000
Row Spacing (in): 20
Hybrid: CROPLAN® 5335 VT2 PRO
Reps: 4
Previous Crop: Soybean
Tillage: Turbo-Till
Fertilizer: 4 ton/ac ag lime and 140 lb/ac N as anhydrous ammonia

Irrigation: None
Rainfall (in):



Introduction: MicroSource® DCD 25 contains dicyandiamide (DCD), a product with known efficacy for inhibiting nitrification. The chemical compound DCD temporarily inhibits populations of the bacteria that convert ammonium to nitrite *(Nitrosomonas)* and nitrite to nitrate *(Nitrobacter)*. These compounds protect against both denitrification and leaching by retaining fertilizer N in the ammonium form. Ammonium (NH_4+) is a positively charged ion (cation) that can be held on negatively charged exchange sites in soils (such as clays and organic matter); in comparison nitrate (NO_3-), which is negatively charged, can be converted to N_2O or N_2 gases in anerobic conditions, or can leach below the root zone with rain in well drained soils. You can learn more about nitrogen inhibitors at https://cropwatch.unl.edu/2019/nitrogen-inhibitors-improved-fertilizer-use-efficiency.

The purposes of this study were to evaluate the impact of MicroSource® DCD 25 applied with anhydrous ammonia on crop yield and soil ammonium and nitrate. Anhydrous was applied on November 9, 2019, at a rate of 140 lb/ac N. Soil samples were taken for ammonium-N and nitrate-N. Soil samples were collected across the inter-row area at 6" intervals (0", 6", 12", 18”, and 24" from the row). The first set of samples was taken on May 12, when corn was just spiking to a 1' depth. A second set of soil samples was taken on June 3, with V4-V5 corn, to 1', 2', and 3' sample depths.

Results:

	-- May 12 Soil Sample --			---------------------------- June 3 Soil Sample ----------------------------								
	1’			1’			2’			3’		
	NH_4-N	NO_3-N	Total	NH_4-N	NO_3-N	Total	NH_4-N	NO_3-N	Total	NH_4-N	NO_3-N	Total
	lb/ac											
Check	10.5 A	119.5 A	130.0 A	26.8 A	100.3 A	127.0 A	12.0 A	29.0 B	41.0 A	15.8 A	18.5 A	34.3 A
DCD	13.0 A	121.0 A	134.0 A	34.5 A	127.3 A	161.8 A	12.0 A	40.0 A	52.0 A	14.0 A	29.5 A	43.5 A
P-Value	0.801	0.894	0.849	0.347	0.14	0.164	1	0.046	0.151	0.831	0.239	0.530

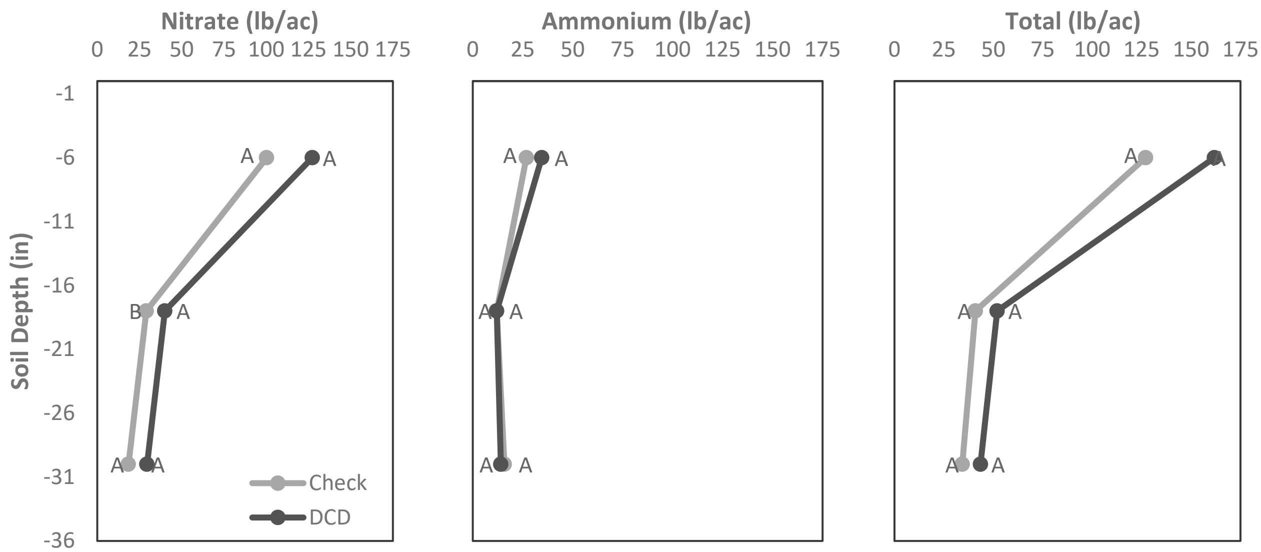


Figure 1. June 3 soil samples at 1’, 2’, and 3’ depths for ammonium (lb/ac), nitrate (lb/ac), and total N (lb/ac) for the treatments with and without inhibitor.

	Moisture (%)	Yield (bu/ac)†	Marginal Net Return‡
Check	14.2 A*	211 A	741.95 A
DCD	14.1 A	212 A	736.36 A
P-Value	0.521	0.841	0.602

*Values with the same letter are not significantly different at a 90% confidence level.

†Yield values are from cleaned yield monitor data. Bushels per acre corrected to 15.5% moisture.

‡Marginal net return based on $3.51/bu corn and $45/gal MicroSource® DCD 25 ($7.70/ac for MicroSource® DCD 25 at the 140 lb N/ac rate).

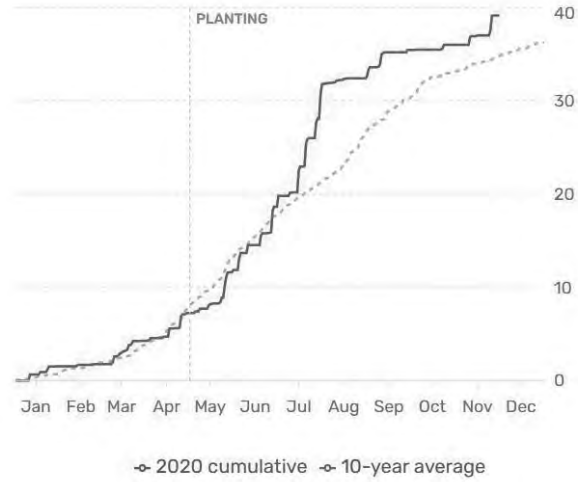
Summary:

- At the June 3 sample date, nitrate-N concentration was lower for the check in the 2nd foot sampled. There were no other statistical differences noted with soil samples between the treatments (Figure 1).
- The use of MicroSource® DCD 25 did not result in a statistical yield or marginal net return difference compared to the control.

Impact of CENTURO™ Inhibitor with Anhydrous Ammonia Application

Study ID: 0416147202001
County: Richardson
Soil Type: Monona silt loam 1-6% slopes
Planting Date: 5/1/20
Harvest Date: 10/17/20
Population: 33,000
Row Spacing (in): 30
Hybrid: Pioneer® P1870
Reps: 4
Previous Crop: Soybean
Tillage: Strip-Till
Fertilizer: Variable-rate 11-52-0 on 2/19/20; N contribution in the plot area ranged from 15-25 lb N/ac with an average of 21-22 lb N/ac in each treatment strip.

Irrigation: None
Rainfall (in):



Introduction: CENTURO™ by Koch™ Agronomic Services LLC contains a product with known efficacy for inhibiting nitrification (product information is provided below). The chemical compound pronitridine in CENTURO™ temporarily inhibits populations of the bacteria that convert ammonium to nitrite *(Nitrosomonas)* and nitrite to nitrate *(Nitrobacter)*. These compounds protect against both denitrification and leaching by retaining fertilizer N in the ammonium form. Ammonium (NH_4+) is a positively charged ion (cation) that can be held on negatively charged exchange sites in soils (such as in clays and organic matter); in comparison nitrate (NO_3-), which is negatively charged, can be converted to N_2O or N_2 gases in anerobic conditions, or can leach below the root zone with rain in well drained soils. You can learn more about nitrogen inhibitors at https://cropwatch.unl.edu/2019/nitrogen-inhibitors-improved-fertilizer-use-efficiency.

CENTURO

Active Ingredients:	
Pronitridine (CAS RN 1373256-33-7)	14%
Other ingredients:	86%
Total:	100%
Contains 1.495 pounds of active ingredient per gallon	

Product information from: https://kochagronomicservices.com/Solutions/agricultural-nutrient-efficiency/CENTURO/Documents/CENTURO-Specimen-Label.pdf?action=view

The purposes of this study were to evaluate the impact of CENTURO™ applied with anhydrous ammonia on crop yield and soil ammonium and nitrate. Anhydrous ammonia was applied at two rates: 150 lb N/ac and 180 lb N/ac on Dec. 4, 2019, at 7" depth with strip-till following a previous crop of soybeans. The study compared both N rates with no control of inhibitor versus with CENTURO™ inhibitor applied at 5 gal/ton of anhydrous ammonia (recommended rate). The field received variable-rate 11-52-0 fertilizer on Feb. 19, 2020; in the plot area N contribution from the 11-52-0 ranged from 15 lb N/ac to 25 lb N/ac with an average in each treatment strip of 21-22 lb N/ac. The field was planted on May 1 with corn rows on top of the anhydrous band.

Soil samples were taken for ammonium-N and nitrate-N. The first set of samples was taken on May 9, prior to corn emergence, to a 1' depth, and samples collected 2" from the band. A second set of soil samples was taken on June 9, with V6 corn, to 1', 2', and 3' sample depths and samples collected across the inter-row area at 6" intervals (0", 6", 12", 18", and 24" from the row). The sampling strategy was changed from 2" off the band to an inter-row transect in an attempt to better represent the actual N available in the field. Because of this, the soil sample results cannot be directly compared between dates.

Results:

	- May 9 Soil Sample -			June 9 Soil Sample								
	1’			1’			2’			3’		
	NH_4-N	NO_3-N	Total	NH_4-N	NO_3-N	Total	NH_4-N	NO_3-N	Total	NH_4-N	NO_3-N	Total
	lb/ac											
150 lb N/ac, no inhibitor	59 A*	217 A	276 A	6 A	42 A	48 A	4 A	62 A	65 A	3 A	34 A	37 A
150 lb N/ac, CENTURO™	17 B	150 A	167 A	9 A	43 A	52 A	3 A	65 A	68 A	5 A	34 A	38 A
180 lb N/ac, no inhibitor	47 A	222 A	269 A	3 A	40 A	44 A	2 A	53 A	55 A	8 A	42 A	50 A
180 lb N/ac, CENTURO™	32 A	201 A	234 A	8 A	42 A	50 A	4 A	53 A	57 A	4 A	26 A	29 A
P-Value	0.07	0.15	0.098	0.28	0.99	0.75	0.25	0.60	0.58	0.61	0.26	0.26

*Values with the same letter are not significantly different at a 90% confidence level.

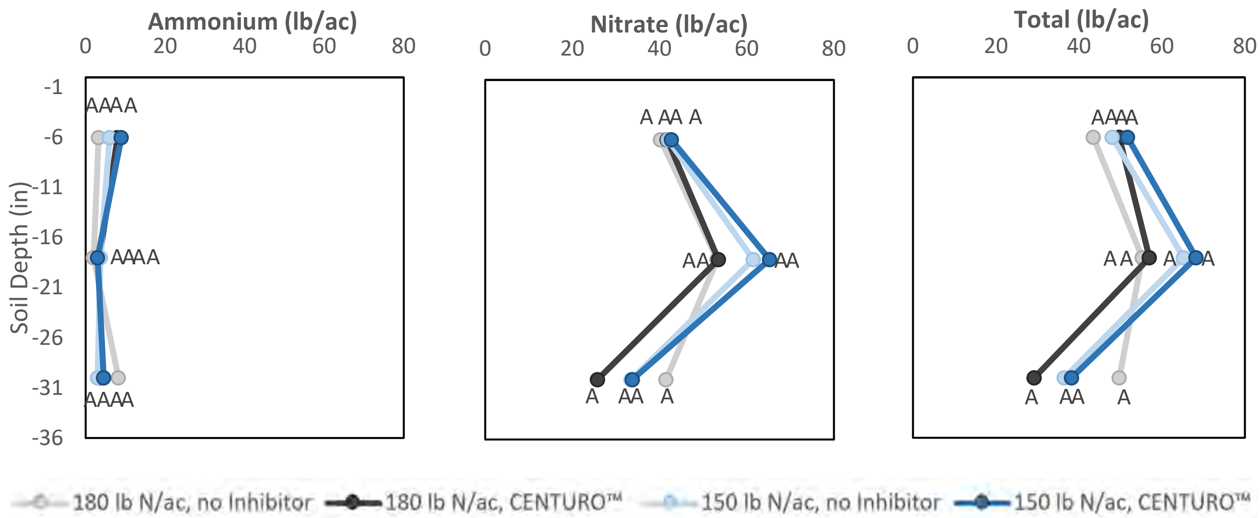


Figure 1. June 9 soil samples at 1’, 2’, and 3’ depths for ammonium (lb/ac), nitrate (lb/ac), and total N (lb/ac) for the 150 lb N/ac and 180 lb N/ac anhydrous rates with and without CENTURO™ inhibitor.

	Total N rate (lb/ac)	Stand Count (plants/ac)	Moisture (%)	Yield (bu/ac)†	Marginal Net Return‡ ($/ac)
150 lb N/ac, no inhibitor	172	30,750 A*	14.3 BC	229 B	759.59 AB
150 lb N/ac, CENTURO™	172	31,375 A	14.2 C	230 B	753.19 B
180 lb N/ac, no inhibitor	202	31,500 A	14.6 A	235 A	771.35 A
180 lb N/ac, CENTURO™	202	30,250 A	14.5 AB	236 A	761.55 AB
P-Value	-	0.691	0.015	0.006	0.064

*Values with the same letter are not significantly different at a 90% confidence level.
†Bushels per acre corrected to 15.5% moisture.
‡Marginal net return based on $3.51/bu corn, $0.30/lb N, and $21.12/gal CENTURO™ ($9.66/ac for CENTURO™ at the 150 lb N/ac rate and $11.59/ac for CENTURO™ at the 180 lb N/ac rate).

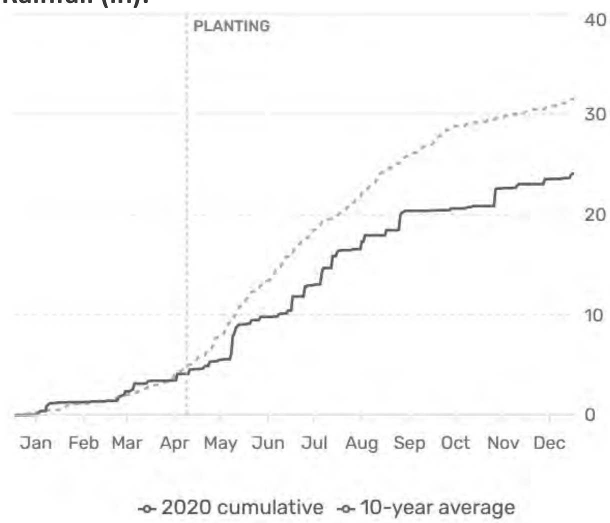
Summary:

- At the May 9 soil sampling date, the NH_4-N concentration was lower for the 150 lb N/ac rate with CENTURO™. There were no other significant differences in N at the 1’ depth for the May 9 sampling date.
- At the June 9 sampling date, there were no significant differences in NH_4-N concentration, NO_3-N concentration, or total N. The sampling strategy was changed between the two sample dates; therefore, no comparisons can be made across sampling dates.
- The use of CENTURO™ did not increase yield at the 150 lb N/ac or 180 lb N/ac rate. Yield was significantly higher for the 180 lb N/ac anhydrous rate, regardless of whether or not CENTURO™ was used.

Impact of CENTURO™ Inhibitor with Fall and Spring Anhydrous Ammonia Application

Study ID: 0118185202001
County: York
Soil Type: Hastings silt loam 0-1% slope; Hastings silt loam 1-3% slope; Hastings silt loam 3-7% slopes
Planting Date: 4/23/20
Harvest Date: 10/19/20
Seeding Rate: 32,500
Row Spacing (in): 30
Hybrid: CROPLAN® 5335 VT2 PRO
Reps: 4
Previous Crop: Soybean
Tillage: No-Till
Herbicides: 3 qt/ac Lexar
Seed Treatment: None
Foliar Insecticides: None
Foliar Fungicides: None
Irrigation: Pivot, Total: 5.5"

Rainfall (in):



Introduction: CENTURO™ by Koch™ Agronomic Services LLC contains a product with known efficacy for inhibiting nitrification (product information is provided below). The chemical compound pronitridine in CENTURO™ temporarily inhibits populations of the bacteria that convert ammonium to nitrite *(Nitrosomonas)* and nitrite to nitrate *(Nitrobacter)*. These compounds protect against both denitrification and leaching by retaining fertilizer N in the ammonium form. Ammonium (NH_4+) is a positively charged ion (cation) that can be held on negatively charged exchange sites in soils (such as in clays and organic matter); in comparison nitrate (NO_3-), which is negatively charged, can be converted to N_2O or N_2 gases in waterlogged conditions, or can leach below the root zone with rain in well drained soils. You can learn more about nitrogen inhibitors at https://cropwatch.unl.edu/2019/nitrogen-inhibitors-improved-fertilizer-use-efficiency.

CENTURO

Active Ingredients:	
Pronitridine (CAS RN 1373256-33-7)	14%
Other ingredients:	86%
Total:	100%
Contains 1.495 pounds of active ingredient per gallon	

Product information from: https://kochagronomicservices.com/Solutions/agricultural-nutrient-efficiency/CENTURO/Documents/CENTURO-Specimen-Label.pdf?action=view

The purposes of this study were to evaluate the impact of CENTURO™ applied with anhydrous ammonia on crop yield and soil ammonium and nitrate. This study was conducted in silt loam soils. Anhydrous ammonia was applied at 150 lb/ac N at two different times; the fall application date was November 15, 2019, and the spring application date was March 7, 2020. The study compared both application timings with no inhibitor versus with CENTURO™ applied at 10 gal/ton of anhydrous ammonia. The field also received 5 gal/ac N from 10-34-0 at planting and 30 lb/ac N as 32% UAN through fertigation. The field was planted on April 23, 2020.

Soil samples were taken for ammonium-N and nitrate-N. The first set of samples was taken on May 12 to a 1' depth. A second set of soil samples was taken on June 5 to 1', 2', and 3' sample depths. Samples were collected 2" from the anhydrous band. Ear leaf tissue samples were collected at R2 on July 22, 2020, and analyzed for N%. Stand count, stalk quality, yield, and net return were evaluated.

Results:

	May 12 Soil Sample			---------------------------- June 5 Soil Sample ----------------------------								
	1’			1’			2’			3’		
	NH_4-N	NO_3-N	Total	NH_4-N	NO_3-N	Total	NH_4-N	NO_3-N	Total	NH_4-N	NO_3-N	Total
	----------	----------	----------	----------	----------	----------	*lb/ac*	----------	----------	----------	----------	----------
Fall, no inhibitor	2.3 A*	112.0 A	114.3 A	6.0 B	62.3 A	68.3 A	8.3 A	82.0 A	90.3 A	12.0 A	27.0 A	39.0 A
Fall, CENTURO™	5.0 A	111.0 A	116.0 A	4.7 B	49.0 A	53.7 A	7.7 A	66.3 A	74.0 A	7.3 AB	24.3 A	31.7 AB
Spring, no inhibitor	45.7 A	201.7 A	247.3 A	12.7 A	61.7 A	74.3 A	6.3 A	38.7 A	45.0 A	6.3 B	18.3 A	24.7 AB
Spring, CENTURO™	11.7 A	108.0 A	119.7 A	5.0 B	74.3 A	79.3 A	8.3 A	54.7 A	63.0 A	10.1 AB	10.7 A	20.8 B
P-Value	0.175	0.310	0.233	0.013	0.894	0.880	0.921	0.283	0.241	0.056	0.128	0.065

*Values with the same letter are not significantly different at a 90% confidence level.

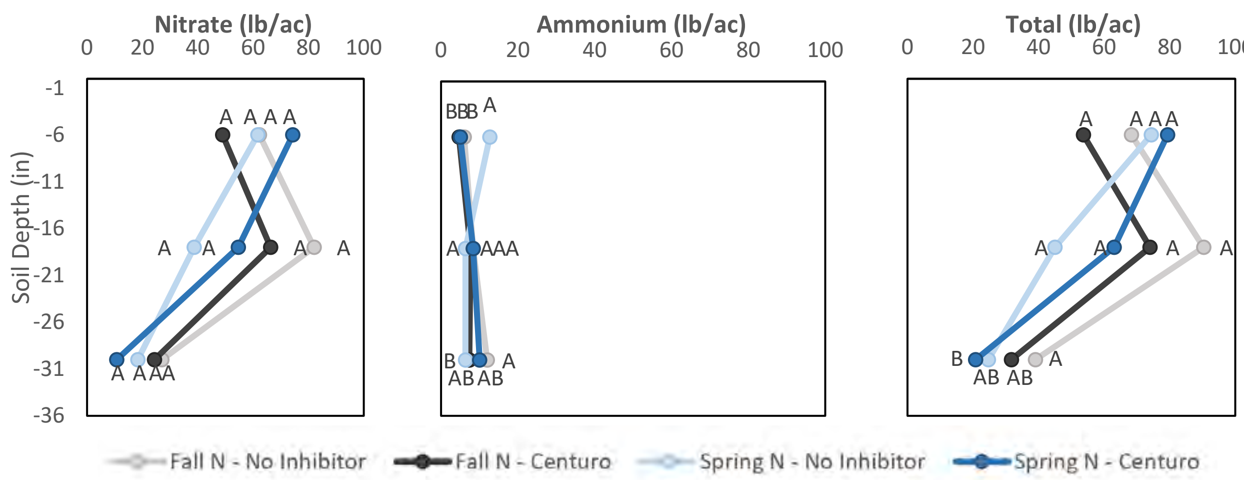


Figure 1. June 5 soil samples at 1’, 2’, and 3’ depths for ammonium (lb/ac), nitrate (lb/ac), and total N (lb/ac) for the fall and spring anhydrous applications and with and without the CENTURO™ inhibitor.

	Stand Count (plants/ac)	Stalk Rot (%)	Green snap (%)	R2 Foliar N (%)†	Moisture (%)	Yield (bu/ac)††	Marginal Net Return‡ ($/ac)
Fall, no inhibitor	30,167 A*	10.00 A	5 A	2.71 A	16.3 A	269 A	902.61 A
Fall, CENTURO™	33,167 A	8.33 A	1 A	2.78 A	16.4 A	267 A	876.77 B
Spring, no inhibitor	31,500 A	7.50 A	1 A	2.74 A	16.4 A	269 A	903.49 A
Spring, CENTURO™	31,333 A	7.50 A	3 A	2.77 A	16.4 A	270 A	885.54 B
P-Value	0.151	0.892	0.191	0.151	0.560	0.269	0.0003

*Values with the same letter are not significantly different at a 90% confidence level.
†Midwest Laboratories sufficient level for in tissue sample is 3.4; Ward Laboratories sufficiency level is 2.71.
††Bushels per acre corrected to 15.5% moisture.
‡Marginal net return based on $3.51/bu corn, $445/ton anhydrous ammonia ($40.70/ac for the without inhibitor treatment), and $22.50/gal for CENTURO™ ($61.28/ac for the with inhibitor treatment).

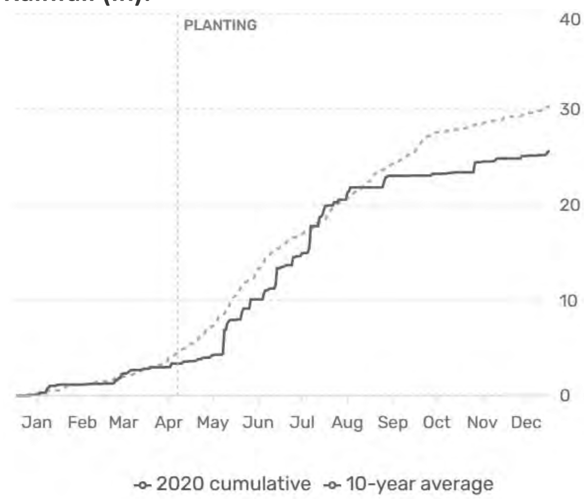
Summary:

- The timing of anhydrous and the use of CENTURO™ did not impact soil nitrate or ammonium at the 1’ depth on the May 12 sampling dates. At the June 5 sampling date, in the top 1', the spring applied anhydrous with no inhibitor had higher ammonium concentrations. In the 3' depth, the fall applied anhydrous without inhibitor had higher ammonium than the spring anhydrous without CENTRO™.
- There were no differences in stand count, stalk rot, or green snap between the treatments evaluated.
- Yield was not different between the treatments. Due to the additional cost for the treatments with CENTURO™, there was a lower net return for the applications with inhibitor. There was no yield or net return difference between the fall and spring application timings.

This study is sponsored in part by the Upper Big Blue NRD.

Impact of Instinct® II Inhibitor with UAN Applications

Study ID: 0620059202001
County: Fillmore
Soil Type: Butler silt loam 0-1% slope; Crete silt loam 0-1% slope
Planting Date: 4/21/20
Harvest Date: 9/30/20
Seeding Rate: 33,000
Row Spacing (in): 30
Hybrid: Mycogen® 12G38 RA
Reps: 11
Previous Crop: Corn
Tillage: Ridge-Till
Herbicides: ***Pre:*** 1 qt/ac atrazine and 1 qt/ac TripleFLEX® on 4/9/20 ***Post:*** 1 pt/ac atrazine and 3.6 pts/ac Halex® GT on 6/4/20
Seed Treatment: None
Foliar Insecticides: None
Foliar Fungicides: 8 oz/ac Delaro® on 8/11/20
Irrigation: Pivot, Total: 4.5"
Rainfall (in):



Introduction: The goal of this study was to evaluate Instinct® II nitrification inhibitor applied with UAN to increase nitrogen availability and decrease nitrogen loss to the environment.

Check: 115 lbs/ac N applied as 32% UAN on April 1, 2020.

Instinct® II: 115 lb/ac N applied as 32% UAN with 32 oz/ac Instinct® II. Instinct® II is a nitrapyrin inhibitor by Corteva Agriscience™ with known efficacy in inhibiting nitrification.

Both treatments also received 70 lb/ac N applied as 32% UAN on June 10, 2020, with no inhibitor.

Soil samples were taken for ammonium-N and nitrate-N. The first set of samples was taken on May 11, 2020, to a 1' depth. A second set of soil samples was taken on June 8, 2020, a 1', 2', and 3' sample depths. Samples were collected from within the fertilizer band. Ear leaf tissue samples were collected at VT on July 13, 2020, and analyzed for N%. Stand count, yield, and net return were evaluated.

roduct information from: https://s3-us-west-.amazonaws.com/agrian-cg-fs1-roduction/pdfs/Instinct_II_Label1i.pdf

Results:

	May 11 Soil Sample			---------------------------- June 8 Soil Sample ----------------------------								
	1’			1’			2’			3’		
	NH_4-N	NO_3-N	Total	NH_4-N	NO_3-N	Total	NH_4-N	NO_3-N	Total	NH_4-N	NO_3-N	Total
	-- *lb/ac* --											
Check	66.8 A*	159.3 A	226.0 A	22.5 A	165.3 A	187.8 A	32.8 A	62.0 A	94.8 A	22.3 A	72.8 A	95.0 A
Instinct® II	10.5 B	53.5 B	63.9 B	20.0 A	61.5 B	81.5 A	12.8 A	15.8 B	28.5 B	15.5 A	15.8 B	31.3 B
P-Value	0.038	0.016	0.010	0.873	0.065	0.117	0.241	0.042	0.083	0.296	0.016	0.032

*Values with the same letter are not significantly different at a 90% confidence level.

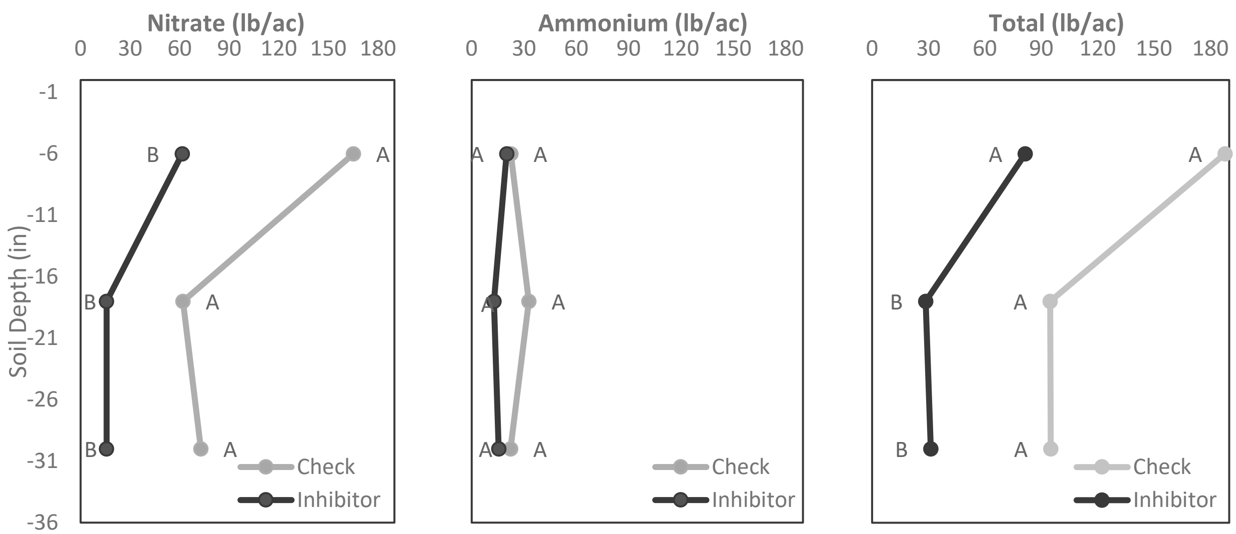


Figure 1. June 8 soil samples at 1’, 2’, and 3’ depths for ammonium (lb/ac), nitrate (lb/ac), and total N (lb/ac) for the check and inhibitor products.

	Stand Count (plants/ac)	VT Foliar N (%)†	Moisture (%)	Yield (bu/ac)††	Marginal Net Return‡ ($/ac)
Check	33,214 A*	3.22 A	19.0 A	213 A	746.24 A
Instinct® II	32,500 A	3.21 A	19.0 A	213 A	739.43 A
P-Value	0.211	0.923	0.530	0.679	0.259

*Values with the same letter are not significantly different at a 90% confidence level.
†Midwest Laboratories sufficient level for in tissue sample is 3.4; Ward Laboratories sufficiency level is 2.71.
††Yield values are from cleaned yield monitor data. Bushels per acre corrected to 15.5% moisture.
‡Marginal net return based on $3.51/bu corn and $9.23/ac for Instinct® II.

Summary:

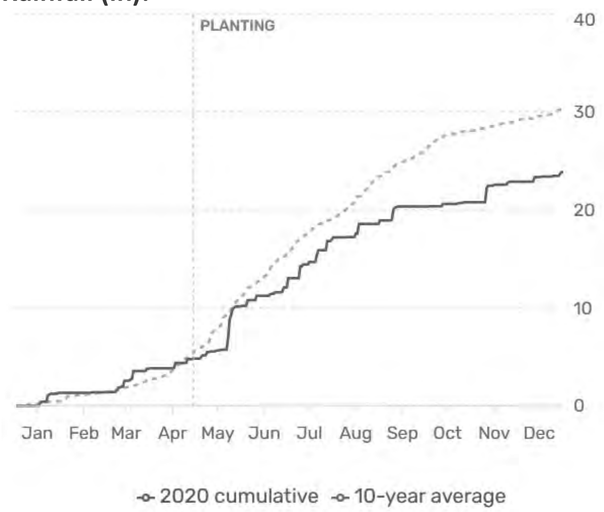
- The use of the Instinct® II resulted in less soil nitrate and ammonium at the May 11 sampling date. At the June 8 sampling date, Instinct® II resulted in less nitrate at the 1', 2', and 3' depth. There was no difference in ammonium between the two treatments.
- There were no differences in stand count, foliar nitrogen, moisture, yield, or net return between the check and the treatment with Instinct® II.

This study is sponsored in part by the Upper Big Blue NRD.

Impact of Inhibitors with UAN Application

Study ID: 1067185202001
County: York
Soil Type: Hastings silt loam
Planting Date: 4/29/20
Harvest Date: 10/20/20
Seeding Rate: 32,500
Row Spacing (in): 36
Hybrid: DEKALB® DKC7027
Reps: 6
Previous Crop: Corn
Tillage: Ridge-Till
Herbicides: ***Post:*** 84 oz/ac Stalwart® 3W on 5/11/20
Seed Treatment: None
Foliar Insecticides: None
Foliar Fungicides: None

Irrigation: Pivot, Total: 6"
Rainfall (in):



Introduction: The goal of this study was to evaluate various products applied with UAN to increase nitrogen availability and decrease nitrogen loss to the environment. Three different products were evaluated as well as an untreated check.

Check: 44 gal/ac UAN applied in a band on April 1, 2020

ATS: 44 gal/ac UAN with 4.4 gal/ac ATS (ATS contributed 12.7 lb/ac S and 5.8 lb/ac N). ATS has been shown to be a nitrification and urease inhibitor (Goos, 1985).

Biovante™: 44 gal/ac UAN with 21 oz/ac BioRed™ and 0.8 oz/gal Assist™. BioRed™ is a microbial product that claims to improve carbon cycling, nitrogen cycling, and mineralization. It also claims to hold, convert, stabilize, and increase nitrogen in soil. Assist™ is fulvic and humic acid derived from mushroom compost said to help catalyze enzyme reactions and naturally extend the life of nitrogen due to higher amounts of caboxyl groups in fulvic acid.

Instinct® II: 44 gal/ac UAN with 37 oz/ac, Instinct® II, is a nitrapyrin inhibitor by Corteva Agriscience™ with known efficacy in inhibiting nitrification.

Soil samples were taken for ammonium-N and nitrate-N. The first set of samples was taken on May 12, 2020, to a 1' depth. A second set of soil samples was taken on June 8, 2020, to 1', 2', and 3' sample depths. Samples were collected half from the fertilizer band and half from outside of the streamed band. Ear leaf tissue samples were collected at V14 on July 13, 2020, and analyzed for N%. Stand count, stalk quality, yield, and net return were evaluated. A wind storm on July 9 resulted in 37% green snap.

Results:

	- May 12 Soil Sample -			---------------------------- June 11 Soil Sample -----------------------------								
	1’			1’			2’			3’		
	NH_4-N	NO_3-N	Total	NH_4-N	NO_3-N	Total	NH_4-N	NO_3-N	Total	NH_4-N	NO_3-N	Total
	lb/ac											
Check	176.4 A*	147.3 A	323.7 A	86.4 A	187.3 A	273.7 A	14.4 A	139.0 A	153.4 A	18 A	69.7 AB	87.7 AB
ATS	150.0 A	174.3 A	324.3 A	133.2 A	237.7 A	370.9 A	10.8 A	146.7 A	157.5 A	21.6 A	86.3 AB	107.9 AB
Biovante™	120.0 A	164.3 A	284.3 A	67.2 A	198.0 A	265.2 A	28.8 A	146.0 A	174.8 A	28.8 A	92.7 A	121.5 A
Instinct® II	96.0 A	165.7 A	261.7 A	82.8 A	202.7 A	285.5 A	15.6 A	138.0 A	153.6 A	14.4 A	62 B	76.4 B
P-Value	0.272	0.694	0.661	0.629	0.727	0.582	0.232	0.980	0.881	0.185	0.07	0.075

*Values with the same letter are not significantly different at a 90% confidence level.

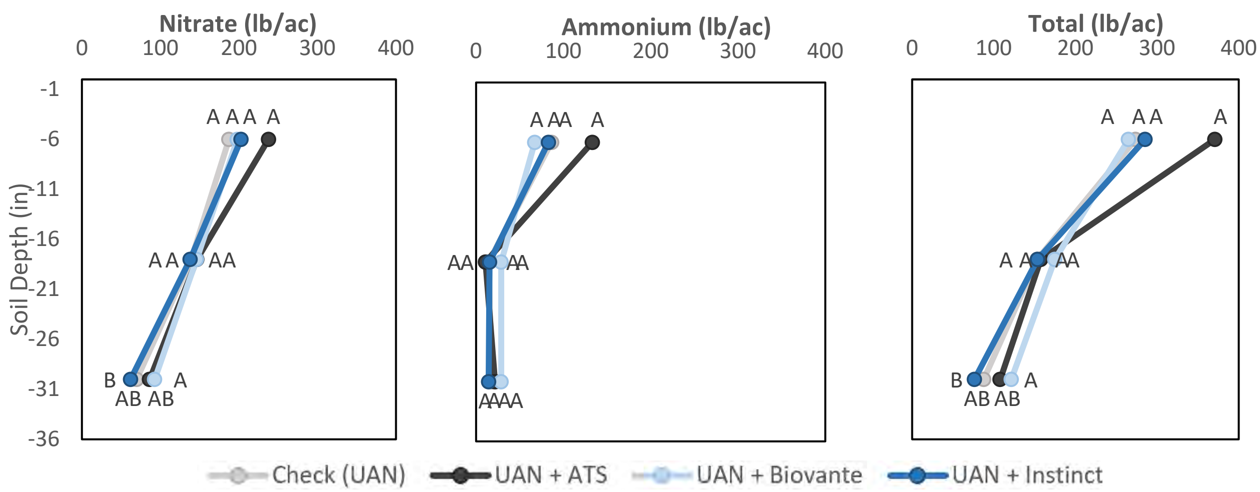


Figure 1. June 8 soil samples at 1', 2', and 3' depths for ammonium (lb/ac), nitrate (lb/ac), and total N (lb/ac) for the check and inhibitor products.

	Stand Count (plants/ac)	Stalk Rot (%)	Green snap (%)	V14 Foliar N (%)†	Moisture (%)	Yield (bu/ac)††	Marginal Net Return‡ ($/ac)
Check	28,875 A*	2.50 A	15 A	2.99	18.2 A	209 B	734.76 AB
ATS	25,500 A	0.00 A	23 A	3.21	18.3 A	215 A	745.62 A
Biovante™	26,125 A	0.00 A	21 A	2.97	18.2 A	212 AB	725.64 B
Instinct® II	28,750 A	0.63 A	16 A	3.13	18.2 A	212 AB	730.65 AB
P-Value	0.105	0.524	0.448	N/A	0.635	0.104	0.064

*Values with the same letter are not significantly different at a 90% confidence level.
†Samples were submitted to Midwest Laboratories. Midwest Laboratories' normal level for %N in tissue sample is 3.4; therefore, all the samples were considered low or sufficient-low. Ward Laboratories' sufficiency level is 2.71; therefore, by Ward Laboratories' standard, all foliar N tissue samples are sufficient.
††Bushels per acre corrected to 15.5% moisture.
‡Marginal net return based on $3.51/bu corn, $7.86/ac for ATS, $17.31/ac for Biovante™ BioRed™ and Assist™, and $12.30/ac for Instinct® II.

Summary:

- The use of the ATS, Biovante™, and Instinct® II did not impact soil nitrate or ammonium at the 1' and 2' depths. At the 3' depth, Biovante™ had higher nitrate concentrations than the Instinct® II treatment; however, neither Instinct® II nor Biovante™ had a statistically different nitrate concentration than the check.
- There were no differences in stand count, stalk rot, or green snap between the treatments evaluated.
- Yield was higher for the ATS treatment than for the check. Biovante™ and Instinct® II did not result in any yield differences compared to the check.
- Net return was higher for the ATS treatment than for the Biovante™ treatment.

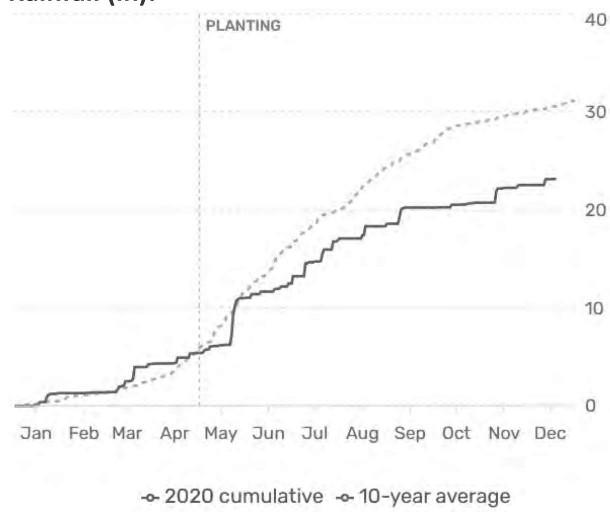
Goos, R. J. 1985. Identification of Ammonium Thiosulfate as a Nitrification and Urease Inhibitor. Soil Science Society of America Journal 49:232-235

This study is sponsored in part by the Upper Big Blue NRD.

Evaluating Inhibitor Concoction with UAN

Study ID: 0916185202001
County: York
Soil Type: Hastings silty clay loam; Hastings silt loam
Planting Date: 5/1/20
Harvest Date: 10/19/20
Row Spacing (in): 36
Hybrid: Big Cob B15-H64
Reps: 4
Previous Crop: Corn
Tillage: No-Till
Herbicides: ***Pre:*** 32 oz/ac Roundup PowerMAX® on 5/5/20, ***Post:*** 3 qt/ac Stalwart® 3W at VE-V1
Insecticides: 7 oz/ac bifenthrin in-furrow at planting
Foliar Fungicides: 10.5 oz/ac Propaz applied R3

Irrigation: Pivot, Total: 9"
Rainfall (in):



Introduction: The goal of this study was to concoction the ability of a producer-developed inhibitor concoction (ATS, Nano Humic Acid from Nano Ag Technologies LLC™ and Nano Brown Sugar SK from Nano Ag Technologies LLC™, to reduce nitrogen loss from UAN. The producer's goal with the concoction was to convert the nitrogen from ammonium and nitrate into amino acids for the microbial food cycle and therefore reduce leaching. The concept for this study came from John Kempf's webinar "Preventing Nitrogen and Phosphorus Leaching" (https://www.youtube.com/watch?v=vyHEof7LVk0).

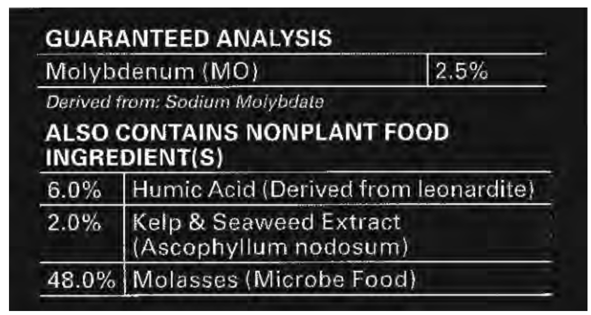


Figure 1. Nano Brown Sugar SK (Nano Ag Technologies LLC™)

There were two treatments:

Check: 45 gal/ac 32% UAN (160 lb/ac N)

Inhibitor Concoction: 40 gal/ac 32% UAN (142 lb/ac N) with 4.5 gal/ac ATS (6 lb/ac N and 12.6 lb/ac S), 24 oz/ac Nano Humic Acid (45% humic acid), and 16 oz/ac Nano Brown Sugar SK (6% humic acid, 2.5% molybdenum, and 48% brown sugar, Figure 1).

Both treatments were applied on April 11, 2020, with streaming nozzles into standing rye cover crop. Both treatments also received 8 gal/ac of 32% UAN (28 lb/ac N) by fertigation.

Soil samples were taken for ammonium-N and nitrate-N. The first set of samples was taken on May 12, 2020, to a 1' depth. A second set of soil samples was taken on June 11, 2020, to 1', 2', and 3' sample depths. Samples were collected 3" from the streamed band. Ear leaf tissue samples were collected at VT on July 22, 2020, and analyzed for N%. Stand count, stalk quality, yield, and net return were evaluated. A wind storm on July 9 resulted in 5% green snap. Many plants bent, but didn't break, impacting ear formation.

Results:

	- May 12 Soil Sample -			June 11 Soil Sample								
	1'			1'			2'			3'		
	NH_4-N	NO_3-N	Total	NH_4-N	NO_3-N	Total	NH_4-N	NO_3-N	Total	NH_4-N	NO_3-N	Total
	lb/ac											
Check	40.8 A*	53.8 A	94.5 A	19.8 A	62.3 A	80.0 A	19.3 A	16.0 A	35.3 A	12.8 B	15.3 B	28.0 B
Inhibitor	33.3 A	50.3 A	83.5 A	20.5 A	99.3 A	119.8 A	18.0 A	22.5 A	40.5 A	19.0 A	23.8 A	42.8 A
P-Value	0.783	0.715	0.737	0.801	0.439	0.488	0.830	0.406	0.635	0.080	0.067	0.024

*Values with the same letter are not significantly different at a 90% confidence level.

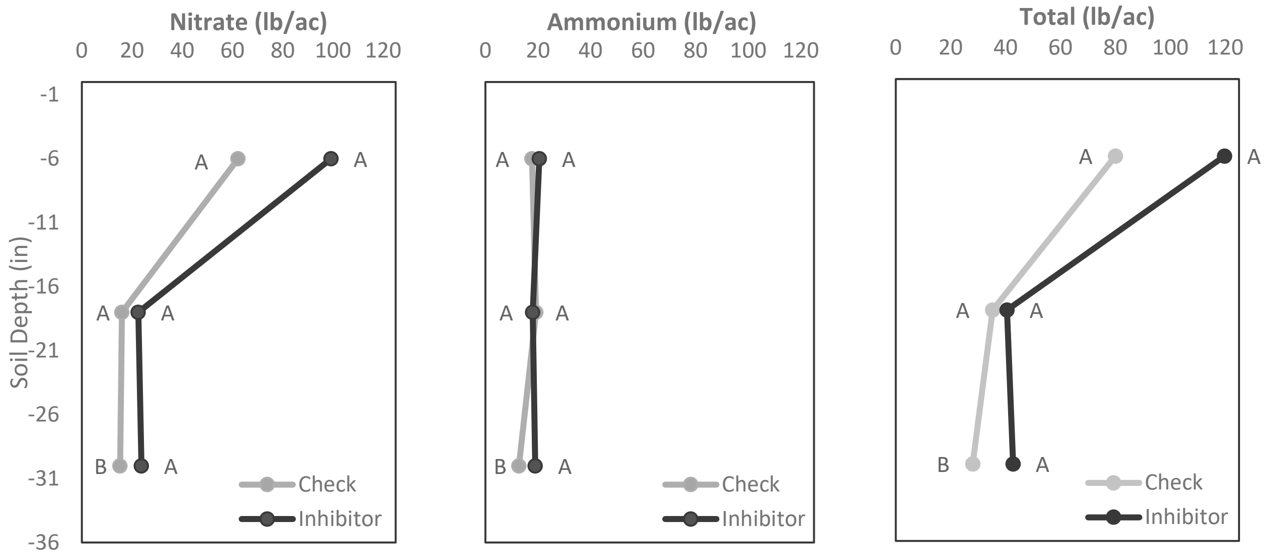


Figure 1. June 11 soil samples at 1', 2', and 3' depths for ammonium (lb/ac), nitrate (lb/ac), and total N (lb/ac) for the check and inhibitor concoction.

	Stand Count (plants/ac)	Stalk Rot (%)	VT Foliar N (%)†	Moisture (%)	Yield (bu/ac)† †	Marginal Net Return‡ ($/ac)
Check	29,750 A*	0.63	3.10 A	16.1 A	220 A	711.55 A
Inhibitor Concoction	29,375 A	0.63	3.05 A	15.9 B	221 A	705.68 A
P-Value	0.681	N/A	0.647	0.060	0.797	0.695

*Values with the same letter are not significantly different at a 90% confidence level.
†Midwest Laboratories sufficient level for in tissue sample is 3.4; Ward Laboratories sufficiency level is 2.71.
††Yield values are from cleaned yield monitor data. Bushels per acre corrected to 15.5% moisture.
‡Marginal net return based on $3.51/bu corn, UAN cost of $58.75/ac for the check treatment with 45 gal/ac of UAN, UAN cost of $52.22/ac for the inhibitor treatment with 40 gal/ac UAN, $7.47/ac for 4.5 gal/ac ATS, $4.75/ac for Nano Humic Acid, and $4/ac for Nano Brown Sugar.

Summary: The use of ATS, Nano Humic Acid, and Nano Brown Sugar SK did not impact soil nitrate or ammonium at the 1' and 2' depth. At the 3' depth, the ATS, Nano Humic Acid, and Nano Brown Sugar SK treatment had higher nitrate and ammonium concentrations. There were no differences between the control and the inhibitor concoction in tissue N% concentration, corn stand, yield, or marginal net return.

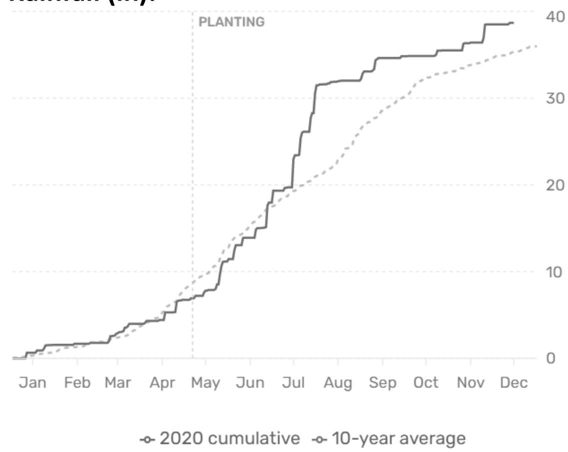
This study is sponsored in part by the Upper Big Blue NRD.

CLICK TO WATCH A VIDEO ABOUT THIS STUDY https://go.unl.edu/nratestudy

Determining Economically Optimum Nitrogen Rate on Corn

Study ID: 0416147202003
County: Richardson
Soil Type: Kennebec silt loam rarely flooded
Planting Date: 5/6/20
Harvest Date: 10/8/20
Seeding Rate: 32,000-34,000
Row Spacing (in): 30
Hybrid: Pioneer® P1197
Reps: 6
Previous Crop: Soybean
Tillage: No-Till / Strip-Till

Irrigation: None
Rainfall (in):



Soil Samples (2017, minimum, maximum, and average values from grid sample in the plot area):

	pH	BpH	OM LOI %	Bray P1 ppm P	Sulfate-S ppm S	Zn (DPTA)	Ammonium Acetate (ppm) K	Ca	Mg	Na	CEC me/100g	% Base Saturation H	Ca	Mg	K	Na
Min	6.2	0.0	2.8	32	2	2.8	169	1835	159	15	11.4	3	72	12	3	0.0
Max	6.8	6.8	3.2	61	9	3.4	231	2373	230	21	15.9	12	80	13	4	1.0
Avg	6.5	4.5	3.1	44	6	3.0	202	2055	194	17	13.4	7	77	12	4	0.5

Introduction: The objective of this study was to utilize precision ag technology to determine the most economical rate of nitrogen. A variable-rate nitrogen prescription was developed to apply six blocks of five nitrogen rates on-the-go as anhydrous ammonia was being applied (Figure 1). Plots were approximately 300' long by 30' wide. The field received anhydrous ammonia on November 20, 2019, at 7" depth with strip-till following a previous crop of soybeans. As-applied fertilizing maps were used to evaluate the accuracy of fertilizer application. The field also received a variable-rate application of 11-52-0 on February 20, 2020, with N contribution in the research blocks averaging 23 lb N/ac. Two of the treatments received a sidedress application of 30 lb/ac N with 32% UAN stabilized with N-Fixx® XLR at V5 on June 2, 2020. Values in the results table and graph reflect the total N applications. Corn was planted on May 6.

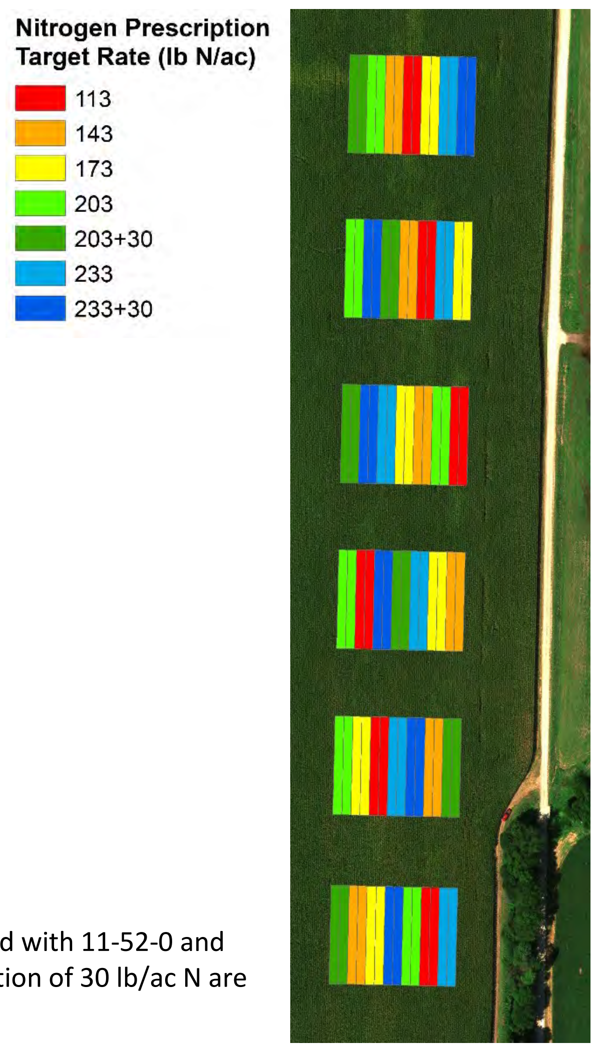


Figure 1. Nitrogen treatment map showing N rate applied with 11-52-0 and anhydrous ammonia. Treatments with sidedress application of 30 lb/ac N are indicated with “+30”.

Throughout the growing season, multispectral imagery was collected using a DJI™ Inspire 2 drone equipped with a MicaSense® RedEdge™ five-band sensor. Imagery was obtained on eight dates (Figure 2). The normalized difference red edge (NDRE) index was calculated for each flight date. The objective of collecting drone imagery was to: 1) evaluate the potential of using imagery of varying nitrogen rate blocks to direct in-season N management, 2) determine how low the lowest N rate needs to be to detect differences soon enough to make a timely in-season application, and 3) relate NDRE values for varying nitrogen rates to crop yield at the end of the season.

Yield monitor data were collected at the end of the growing season and post-processed to remove errors with Yield Editor software from the USDA. Additionally, yield data points that correspond to areas where the fertilizer application rate was more than 15% above or below the target rate were eliminated. Yield response to nitrogen and the economic optimum N rate (EONR) were calculated (Figure 3).

Results:

	NDRE							
	6/19/20	**6/24/20**	**7/1/20**	**7/8/20**	**7/19/20**	**7/31/20**	**8/18/20**	**9/4/20**
113 lb N/ac	0.612 C	0.642 C	0.722 C	0.742 B	0.726 C	0.734 C	0.682 C	0.457 C
143 lb N/ac	0.619 BC	0.647 BC	0.727 B	0.744 AB	0.728 BC	0.737 BC	0.686 BC	0.485 BC
173 lb N/ac	0.625 AB	0.651 AB	0.727 B	0.745 AB	0.730 AB	0.738 ABC	0.688 AB	0.511 AB
203 lb N/ac	0.622 AB	0.652 AB	0.728 AB	0.746 AB	0.731 AB	0.740AB	0.691 A	0.516 AB
203+30 lb N/ac	0.625 AB	0.654 A	0.731 A	0.748 A	0.730 AB	0.740 AB	0.691 AB	0.522 A
233 lb N/ac	0.630 A	0.655 A	0.729 AB	0.745 AB	0.731 A	0.739 AB	0.688 AB	0.516 AB
233+30 lb N/ac	0.628 A	0.657 A	0.729 AB	0.747 A	0.731 A	0.740 A	0.691 AB	0.524 A
P-Value	<0.0001	<0.0001	<0.0001	0.0132	0.0001	0.0002	0.0003	<0.0001

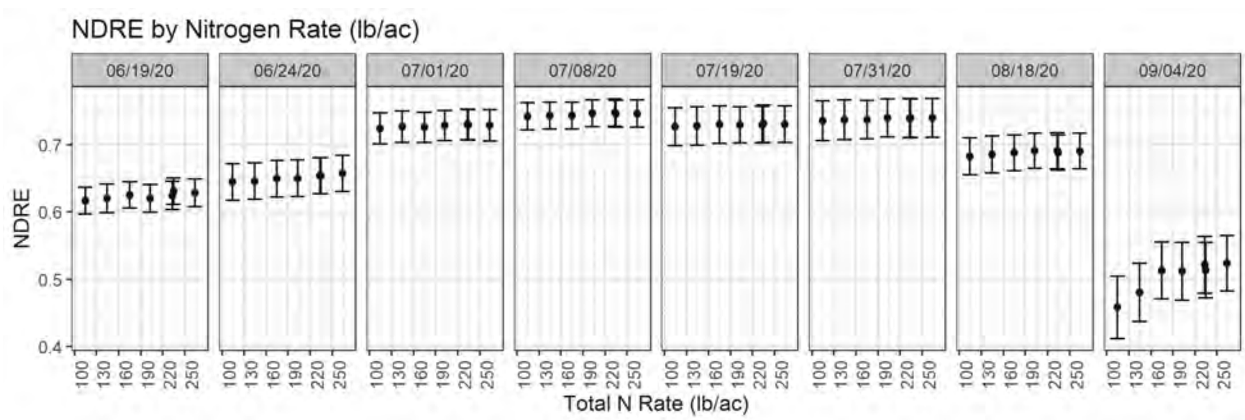


Figure 2: NDRE mean and standard deviation bars by total N applied for eight imagery dates.

	Yield (bu/ac)†	Partial Factor Productivity of N (lb grain/lb N)	lbs N/bu grain	Marginal Net Return‡ ($/ac)
113 lb N/ac	238 B*	117 A	0.48 F	790.03 A
143 lb N/ac	244 AB	95 B	0.59 E	799.74 A
173 lb N/ac	246 A	79 C	0.71 D	794.49 A
203 lb N/ac	248 A	68 D	0.82 C	788.90 A
203+30 lb N/ac	250 A	60 E	0.93 B	775.25 AB
233 lb N/ac	249 A	60 E	0.94 B	781.45 AB
233+30 lb N/ac	249 A	53 F	1.06 A	760.89 B
P-Value	0.0004	<0.0001	<0.0001	0.0019

*Values with the same letter are not significantly different at a 90% confidence level.
†Yield values are from cleaned yield monitor data. Bushels per acre corrected to 15.5% moisture.
‡Marginal net return based on $3.51/bu corn, $0.40/lb N, and $8.74/ac for sidedress N application.

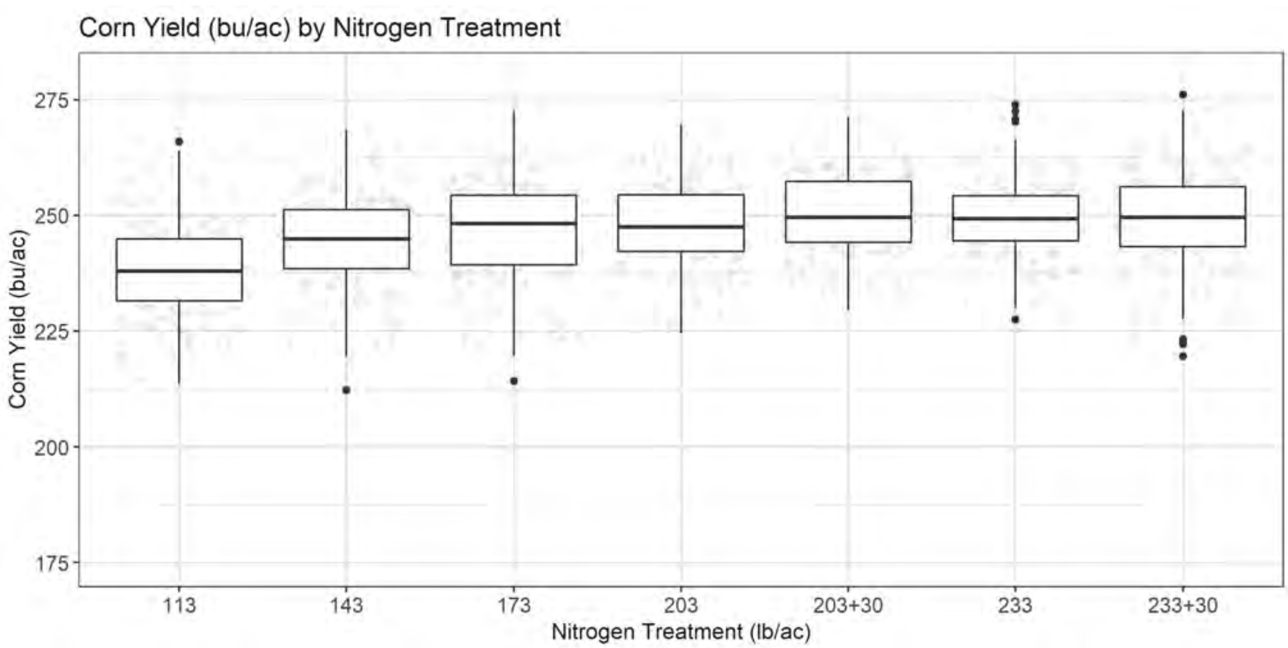


Figure 3: Corn yield by nitrogen rates. Nitrogen rates include N from 11-52-0 and from anhydrous ammonia. Treatments with sidedress application of 30 lb/ac N are indicated with "+30". The economic optimum N rate (EONR) was 157 lb/ac. In the plot, the midline is the median of the data, with the upper and lower limits of the box being the third and first quartile (75th and 25th percentile), respectively. Whiskers extend up to 1.5 times the interquartile range. Outliers are represented as individual points.

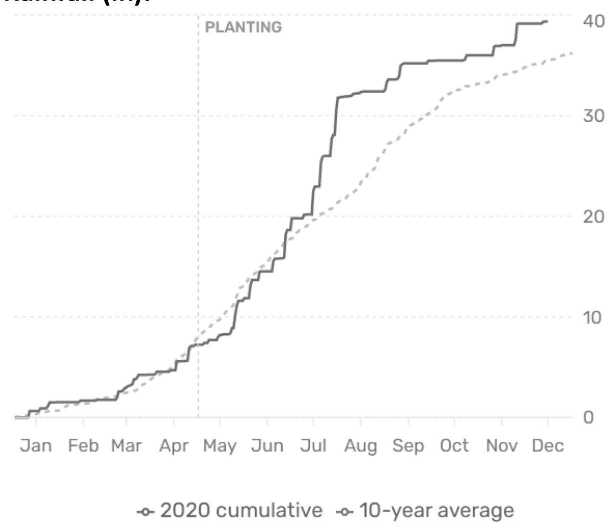
Summary:

- Analysis of NDRE imagery showed the overall trend of increasing NDRE values for all treatments until tasseling on July 11. After tasseling, NDRE values for all treatments decreased. Differences in NDRE values between treatments were apparent throughout the season with the lowest N rate consistently having a lower NDRE value than higher N rates.
- The EONR was 157 lb/ac resulting in a yield of 245 bu/ac. NUE at the EONR was 0.64 lb N/bu grain.
- Yields with the sidedress application of 30 lb/ac were not higher than the corresponding rate with no sidedress application.

Determining Economically Optimum Nitrogen Rate on Corn

Study ID: 0416147202004
County: Richardson
Soil Type: Monona silt loam 1-6% slopes; Judson silt loam 2-6% slopes
Planting Date: 5/1/20
Harvest Date: 10/19/20
Seeding Rate: 32,500
Row Spacing (in): 30
Hybrid: Pioneer® P1870
Reps: 5
Previous Crop: Soybean
Tillage: No-Till / Strip-Till

Irrigation: None
Rainfall (in):



Soil Samples (2017, minimum, maximum, and average values from grid sample in the plot area):

	pH	BpH	OM LOI %	Bray P1 ppm P	Sulfate-S ppm S	Zn (DPTA)	Ammonium Acetate (ppm) K	Ca	Mg	Na	CEC me/100g	% Base Saturation H	Ca	Mg	K	Na
Min	6.4	0.0	2.5	35	2	2	204	2038	180	13	13.1	0	76	10	3	0.0
Max	7.0	6.9	5.1	70	9	4	448	3234	274	35	20.1	9	83	13	7	1.0
Avg	6.8	3.4	4.3	48	5	3	288	2736	231	22	17.1	4	80	11	4	0.4

Introduction: The objective of this study was to utilize precision ag technology to determine the most economical rate of nitrogen on a field with contour farming and terraces. A variable-rate nitrogen prescription was developed to apply five blocks of four nitrogen rates on-the-go as anhydrous ammonia was being applied (Figure 1). Plots were approximately 300' long by 30' wide. The field received anhydrous ammonia on December 5, 2019, at 7" depth with strip-till following a previous crop of soybeans. As-applied fertilizing maps were used to evaluate the accuracy of fertilizer application. The field also received a variable-rate application of 11-52-0 on February 19, 2020, with N contribution in the research blocks averaging 16 lb N/ac. One of the treatments received a sidedress application of 60 lb/ac N as 32% UAN stabilized with N-Fixx® XLR at V5 on June 2, 2020. Values in the results table and graph, reflect the total N applications. Corn was planted on May 1, 2020.

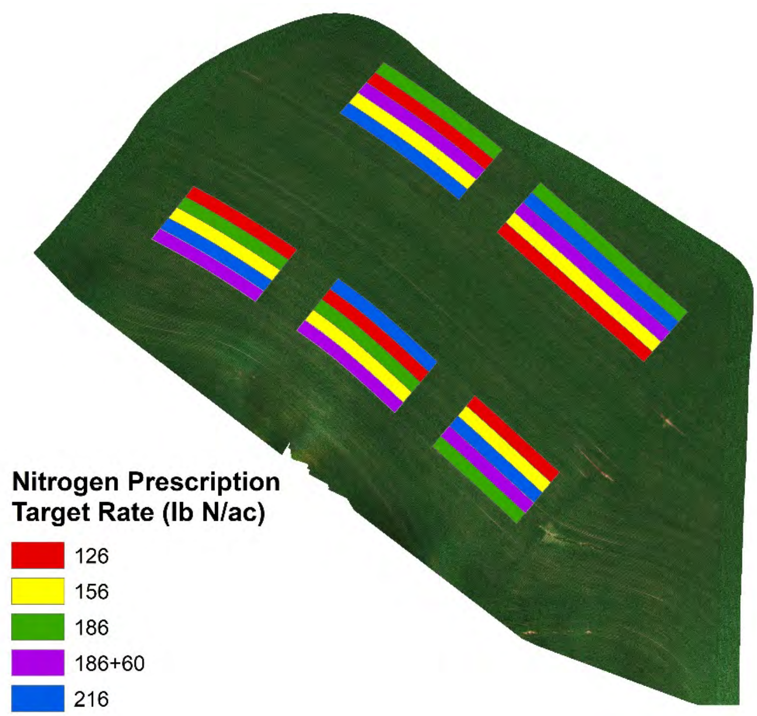


Figure 1. Nitrogen treatment map showing N rate applied with 11-52-0 and anhydrous ammonia. The treatments with sidedress application of 60 lb/ac N is indicated with "+60".

Throughout the growing season, multispectral imagery was collected using a DJI™ Inspire 2 drone equipped with a MicaSense® RedEdge™ five-band sensor. Imagery was obtained on eight dates (Figure 2). The normalized difference red edge (NDRE) index was calculated for each flight date. The objective of collecting drone imagery was to: 1) evaluate the potential of using imagery of varying nitrogen rate blocks to direct in-season N management, 2) determine how low the lowest N rate needs to be to detect differences soon enough to make a timely in-season application, and 3) relate NDRE values for varying nitrogen rates to crop yield at the end of the season.

Yield monitor data were collected at the end of the growing season and post-processed to remove errors with Yield Editor software from the USDA. Additionally, yield data points that correspond to areas where the fertilizer application rate was more than 15% above or below the target rate were eliminated. Yield response to nitrogen and the economic optimum N rate (EONR) were calculated (Figure 3).

Results:

	NDRE							
	6/20/20	**6/24/20**	**7/1/20**	**7/8/20**	**7/19/20**	**7/31/20**	**8/18/20**	**9/4/20**
126 lb N/ac	0.569 B	0.610 C	0.694 D	0.757 D	0.711 C	0.693 D	0.616 D	0.282 C
156 lb N/ac	0.574 B	0.618 C	0.699 C	0.763 C	0.716 B	0.702 C	0.635 C	0.334 B
186 lb N/ac	0.582 A	0.624 B	0.703 B	0.766 BC	0.721 AB	0.708 BC	0.644 BC	0.361 B
216 lb N/ac	0.585 A	0.628 AB	0.705 AB	0.767 B	0.724 A	0.712 AB	0.654 AB	0.405 A
186+60 lb N/ac	0.585 A	0.631 A	0.708 A	0.772 A	0.726 A	0.715 A	0.659 A	0.423 A
P-Value	<0.0001	<0.0001	<0.0001	<0.0001	0.0001	<0.0001	<0.0001	<0.0001

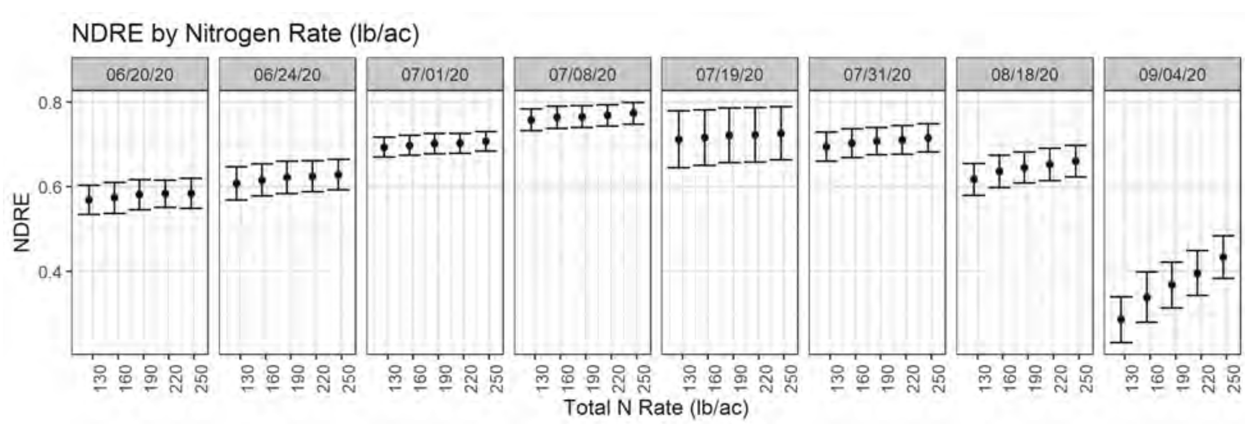


Figure 2. NDRE mean and standard deviation bars by total N applied for eight imagery dates.

	Yield (bu/ac)†	Partial Factor Productivity of N (lb grain/lb N)	lbs N/bu grain	Marginal Net Return‡ ($/ac)
126 lb N/ac	217 C*	97 A	0.58 E	709.94 B
156 lb N/ac	228 B	82 B	0.69 D	736.90 A
186 lb N/ac	232 B	70 C	0.80 C	740.46 A
216 lb N/ac	242 A	63 D	0.89 B	762.58 A
186+60 lb N/ac	243 A	55 E	1.01 A	745.62 A
P-Value	<0.0001	<0.0001	<0.0001	0.0011

†Yield values are from cleaned yield monitor data. Bushels per acre corrected to 15.5% moisture.
*Values with the same letter are not significantly different at a 90% confidence level.
‡Marginal net return based on $3.51/bu corn, $0.40/lb N, and $8.74/ac for sidedress N application.

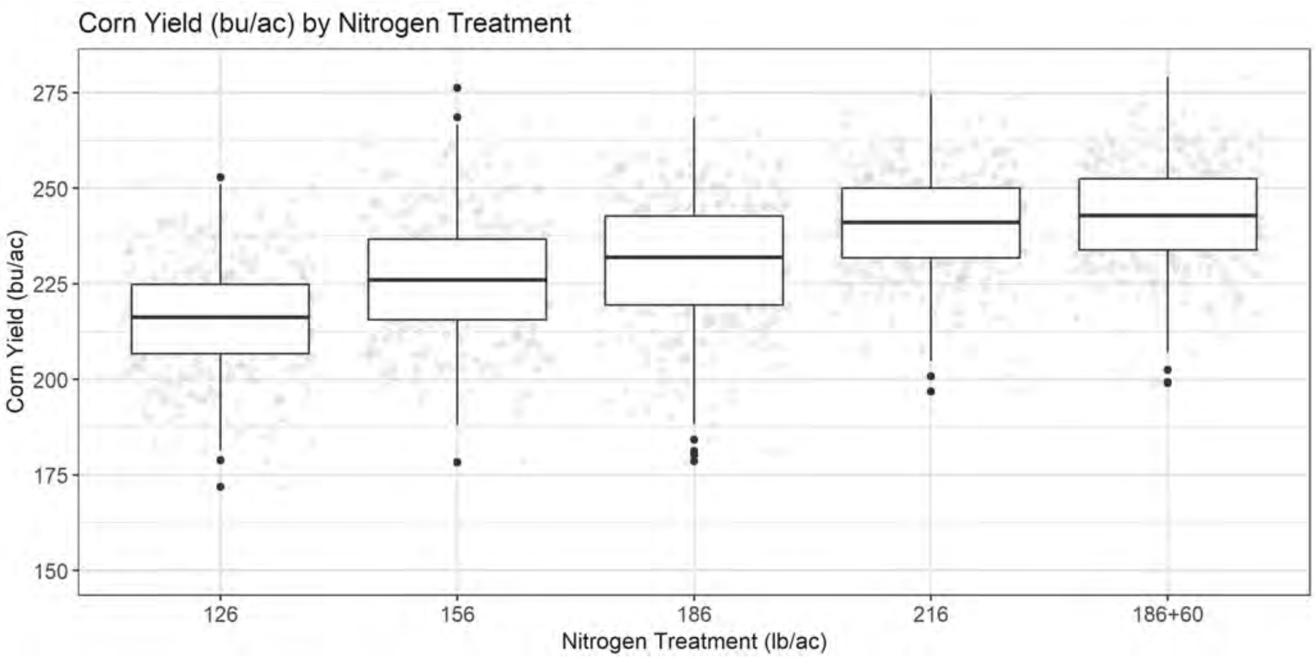


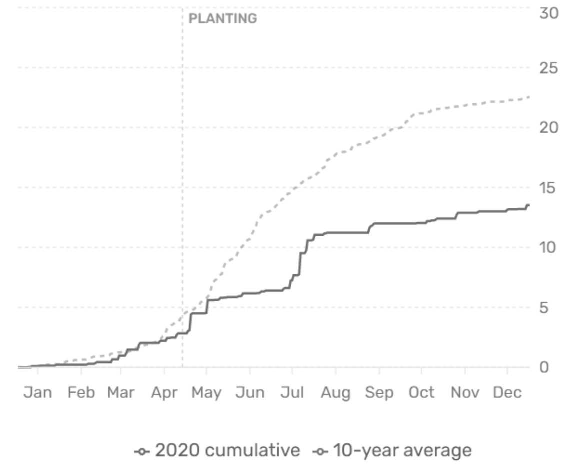
Figure 3. Box and whisker plot of corn yield by nitrogen rates. Nitrogen rates include N from 11-52-0 and from anhydrous ammonia. The treatment with sidedress application of 60 lb/ac N is indicated with “+60”. The economic optimum N rate (EONR) was 232 lb/ac N. In the plot, the midline is the median of the data, with the upper and lower limits of the box being the third and first quartile (75th and 25th percentile), respectively. Whiskers extend up to 1.5 times the interquartile range. Outliers are represented as individual points.

Summary:

- Analysis of NDRE imagery showed the overall trend of increasing NDRE values for all treatments until tasseling on July 11. After tasseling, NDRE values for all treatments decreased. Differences in NDRE values between treatments were apparent throughout the season with the lower N rates consistently having a lower NDRE value than higher N rates. The impact of the sidedress application is apparent in the imagery on July 8, where the 186+60 lb/ac treatment has the highest NDRE value.
- The EONR was 232 lb/ac resulting in a yield of 242 bu/ac. NUE at the EONR was 0.96 lb N/bu grain.
- Yields with the 186 lb/ac base rate and 60 lb/ac sidedress were statistically higher than the treatment with only 186 lb/ac and no sidedress application. However, yields with the 186 lb/ac base rate and 60 lb/ac sidedress application were not higher than the 216 lb/ac rate.

Granular vs Adapt-N for In-Season Nitrogen Management on Non-Irrigated Popcorn

Study ID: 0678111202001
County: Lincoln
Soil Type: Hord fine sandy loam 1-3% slope; Hersh fine sandy loam 3-5% slopes; Holdrege silt loam 3-7% slopes, eroded; Hord silt loam 1-3% slope; Hersh-Valentine soils 6-11% slopes; Uly-Coly silt loam 6-11% slopes; Hersh fine sandy loam 6-11% slopes
Planting Date: 4/28/20
Harvest Date: 10/7/20
Seeding Rate: 15,000-18,000
Row Spacing (in): 30
Hybrid: AP4002LR
Reps: 5
Previous Crop: Wheat
Tillage: Strip-till
Foliar Fungicides: None
Irrigation: None
Rainfall (in):



Introduction: This study evaluated two commercially available crop models, Granular by Corteva Agriscience™ and Adapt-N by Yara International, by comparing the in-season N rate recommendations produced by each. Nitrogen applications to the field included:

1) Variable-rate strip-till application of 10-34-0 on April 23, 2020, resulting in an average of 4 lb/ac N.
2) 10 gal/ac of 6-24-6 starter fertilizer resulting in 7 lb/ac N.
3) Variable-rate sidedress application with a dual coulter applicator applying 32% UAN using either Adapt-N or Granular prescriptions on June 8, 2020. Across the entire field, the Granular in-season N prescription recommended an average of 89 lb N/ac, whereas the Adapt-N in-season N prescription recommended an average of 34 lb N/ac. Prescriptions for each are shown in Figure 1.

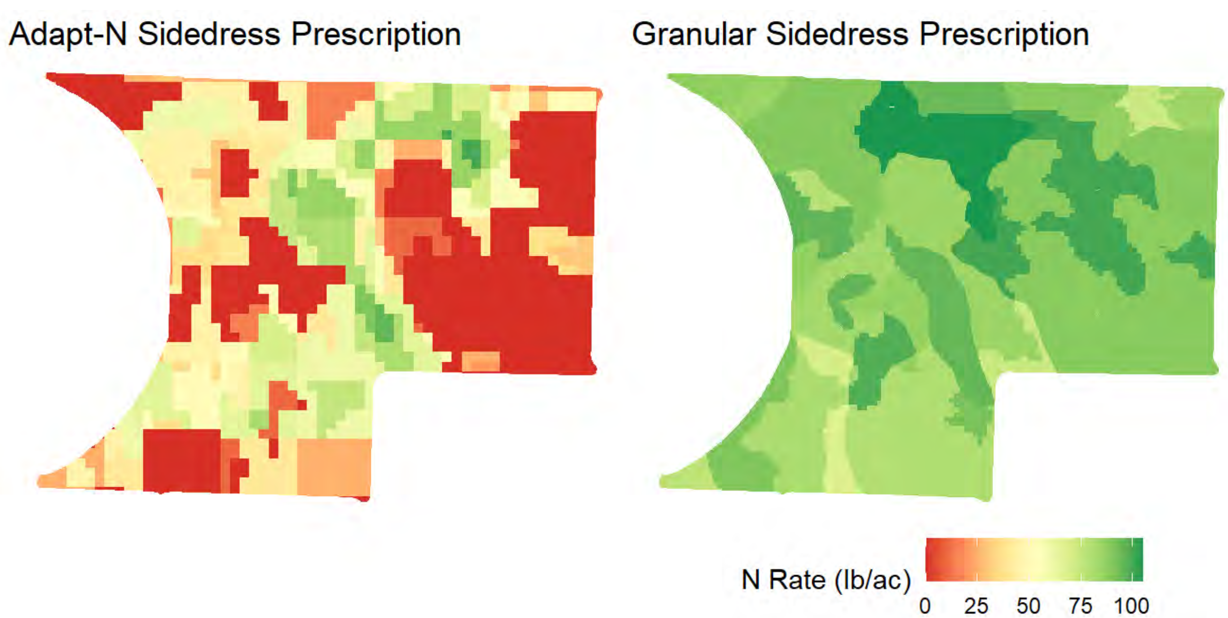


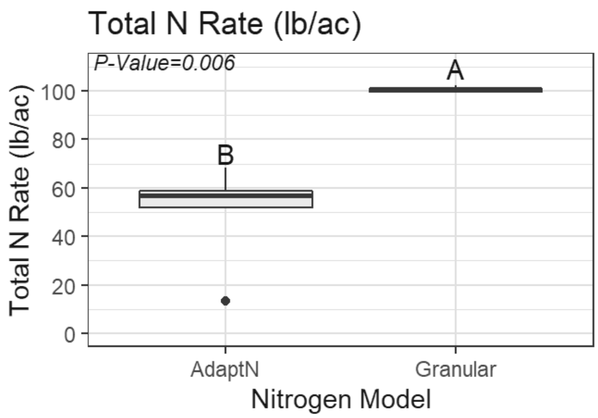
Figure 1. Adapt-N and Granular N recommendation prescriptions for in-season application.

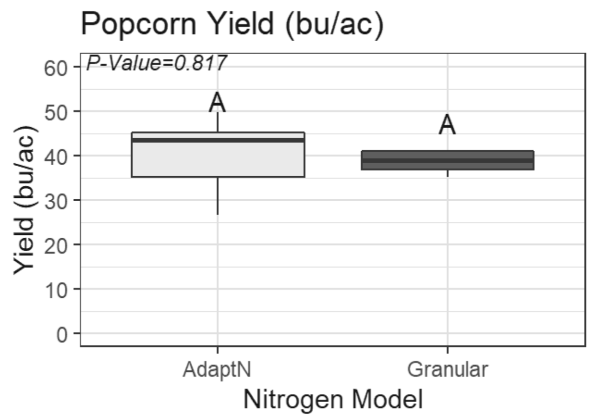
Geospatial yield monitor data were collected at the end of the growing season and post-processed to remove errors with Yield Editor software from the USDA. The as-applied sidedress data were evaluated, and only areas that achieved N application rates within 10% of the target rate were included for yield analysis.

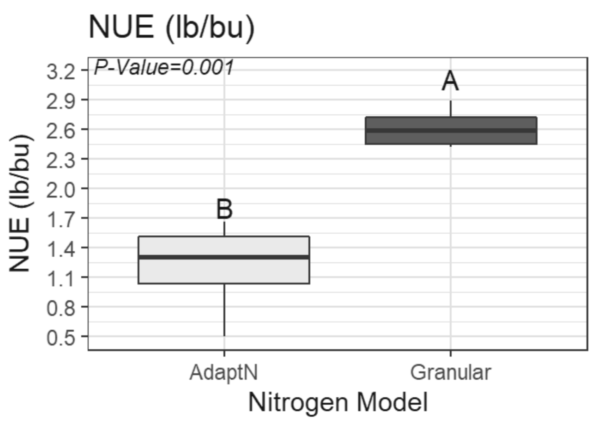
Results:

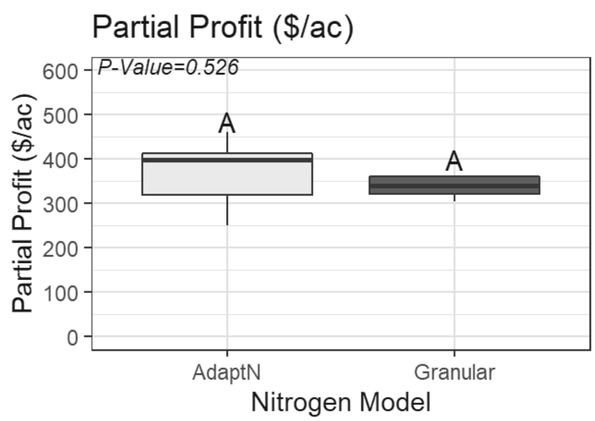
	Total N rate (lb/ac)	Moisture (%)	Yield (bu/ac)†	Partial Factor Productivity of N (lb grain/lb N)	lbs N/bu grain	Marginal Net Return‡ ($/ac)
Adapt-N	50 B*	13.1 A	40 A	60 A	1.21 B	368.49 A
Granular	101 A	13.6 A	39 A	23 B	2.59 A	342.20 A
P-Value	0.06	0.34	0.817	0.072	0.001	0.526

*Values with the same letter are not significantly different at a 90% confidence level.
†Yield values are from cleaned yield monitor data. Bushels per acre corrected to 15.5% moisture.
‡Marginal net return based on $9.60/bu popcorn ($0.16/lb at 60 lb/bu) and $0.32/lb N.









Summary:

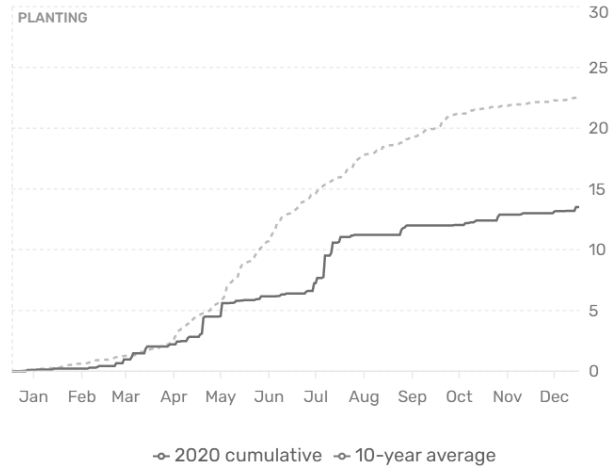
- The total N rate using Granular was 51 lb/ac higher than the N rate using Adapt-N.
- The yield target for the field was around 100 bu/ac; however, lower than normal rainfall and strong winds resulted in lower yields. There was no yield difference between the two models evaluated.
- Adapt-N had better nitrogen use efficiency; Adapt-N used 1.4 lb/ac less N to produce a bushel of grain than Granular.
- Marginal net return was not statistically different between the two models evaluated.

This research was supported in part by an award from the USDA-NRCS Conservation and Innovation Grants, On-Farm Conservation Innovation Trials, award number NR203A750013G014.

Granular vs Adapt-N for In-Season Nitrogen Management on Irrigated Corn

Study ID: 0678111202002
County: Lincoln
Soil Type: Hord fine sandy loam 1-3% slope; Holdrege silt loam 3-7% slopes, eroded; Hersh-Valentine soils 6-11% slopes; Uly-Coly loam 6-11% slopes; Hersh fine sandy loam 3-6% slopes; Anselmo fine sandy loam 1-3% slope
Planting Date: 5/6/20
Harvest Date: 10/28/20
Seeding Rate: 32,600
Row Spacing (in): 30
Hybrid: Golden Harvest® G13Z50-5222 EZ
Reps: 6
Previous Crop: Popcorn
Tillage: Strip-till

Irrigation: Pivot
Rainfall (in):



Introduction: This study evaluated two commercially available crop models, Granular by Corteva Agriscience™ and Adapt-N by Yara International, comparing the in-season N rate recommendations produced by each. Nitrogen applications to the field include:

1) Variable-rate strip-till application of 10-34-0 on April 1, 2020, resulting in an average of 22 lb/ac N.
2) 10 gal/ac of 6-24-6 starter fertilizer resulting in 7 lb/ac N.
3) Variable-rate sidedress application with a dual coulter applicator applying 32% UAN using either Adapt-N or Granular prescriptions on June 11 and 12, 2020. Across the entire field, the Granular in-season N prescription recommended an average of 95 lb/ac N, whereas the Adapt-N in-season N prescription recommended an average of 82 lb/ac N. Prescriptions for each are shown in Figure 1.
4) 35 lb/ac N fertigated with 28-0-0-5S on June 5, 2020.
5) 35 lb/ac N fertigated with 28-0-0-5S on July 17, 2020.

Both the Granular and Adapt-N model recommendations were accounting for the 70 lb/ac N that would be applied through fertigation. Geospatial yield monitor data were collected at the end of the growing season and post-processed to remove errors with Yield Editor software from the USDA. The as-applied sidedress data were evaluated and only areas that achieved N application rates within 10% of the target rate were included for yield analysis.

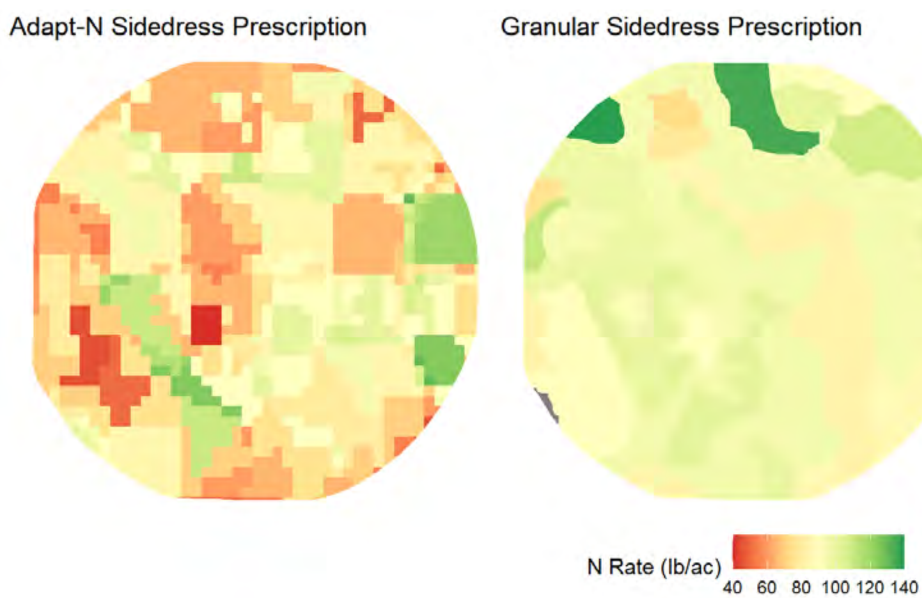


Figure 1. Adapt-N and Granular N recommendation prescriptions for in-season application.

Results:

	Total N rate (lb/ac)	Moisture (%)	Yield (bu/ac)†	Partial Factor Productivity of N (lb grain/lb N)	lbs N/bu grain	Marginal Net Return‡ ($/ac)
Adapt-N	188 A*	17.0 A	229 A	68 A	0.82 A	728.21 A
Granular	194 A	17.1 A	225 A	65 A	0.86 A	713.20 A
P-Value	0.129	0.974	0.482	0.201	0.202	0.425

*Values with the same letter are not significantly different at a 90% confidence level.
†Yield values are from cleaned yield monitor data. Bushels per acre corrected to 15.5% moisture.
‡Marginal net return based on $3.51/bu corn and $0.40/lb N.

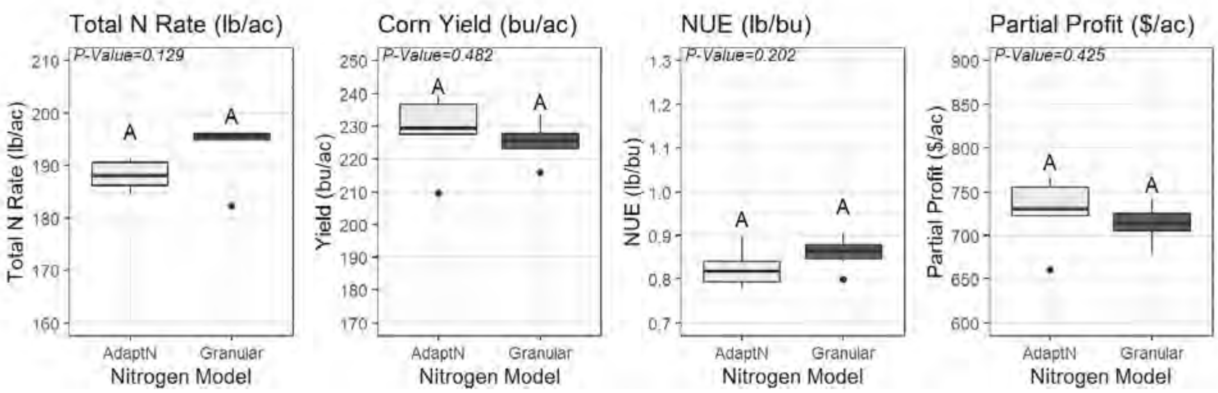


Figure 1. Total N rate, irrigated corn yield, nitrogen use efficiency, and partial profit for the Adapt N model and Granular model. Boxplots with the same letter are not significantly different at a 90% confidence level.

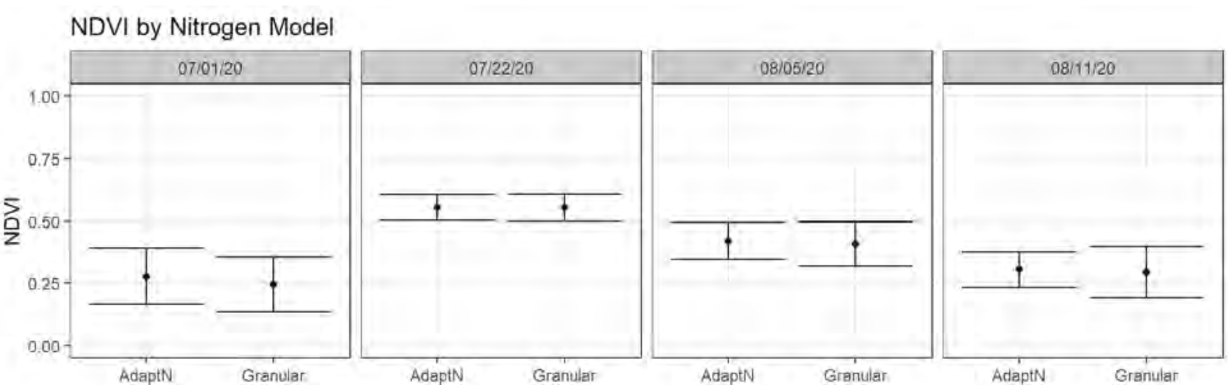


Figure 2. Normalized difference vegetation index (NDVI) mean and standard deviation values from aerial imagery for corn in Adapt N and Granular strips from July 1 to August 11. There were no statistical differences in NDVI between the treatments within dates.

Summary:

- The total N rates for the Granular and Adapt-N recommendations were not statistically different.
- Yields were not different between the two nitrogen models evaluated.
- Nitrogen use efficiency was not statistically different between the two models evaluated, with nitrogen use around 0.82 to 0.86 lbs of N per bushel of corn.
- Marginal net return was not statistically different between the two treatments.

This research was supported in part by an award from the USDA-NRCS Conservation and Innovation Grants, On-Farm Conservation Innovation Trials, award number NR203A750013G014.

CLICK TO WATCH A VIDEO ABOUT THIS STUDY https://go.unl.edu/fertigation

Sensor-based Nitrogen Fertigation

In 2019 and 2020, growers participating in the Nebraska On-Farm Research Network experimented with using imagery to direct responsive nitrogen (N) application to corn through fertigation. The adoption of technology such as sensors mounted on an aerial platform may be used to improve nitrogen use efficiency (NUE) by responding to actual plant N need. There were five sites in 2019 and 2020, one of which was repeated both years (Figure 1).

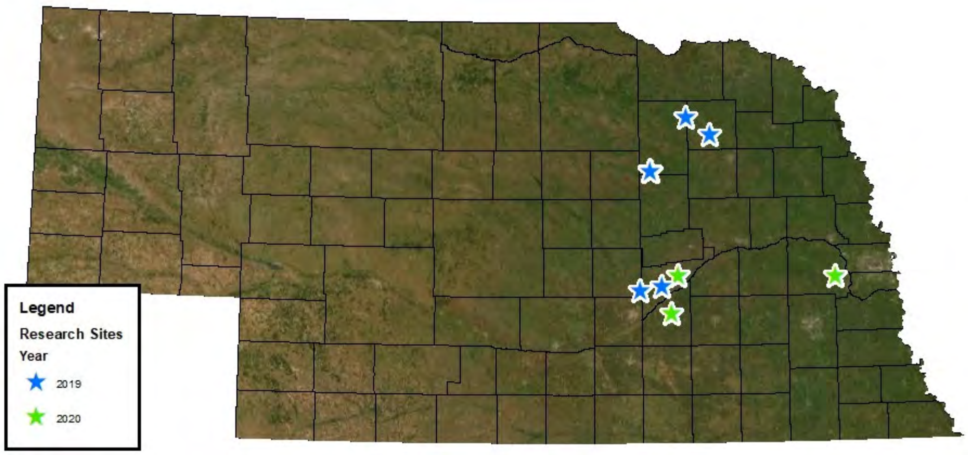


Figure 1. Sensor-based nitrogen fertigation research site locations. Duplicate and close-proximity site locations are non-distinguishable.

Managing Variability with Drone-based Sensors

Nitrogen need varies spatially within a field and from year to year. This study utilized a Parrot Sequoia multispectral sensor, which captures imagery in four bands: green, red, red edge, and near-infrared. These bands allow the normalized difference vegetation index (NDVI) and the normalized difference red edge (NDRE) index to be calculated. These vegetation indices are correlated with crop biomass and nitrogen status, and therefore can inform growers about the crop’s N need. The Parrot Sequoia was mounted on a senseFly eBee fixed-wing drone (Figure 2). Pre-programmed flight paths were developed and autonomously flown on a weekly basis.

Figure 2. senseFly eBee fixed-wing drone (left) and Parrot Sequoia sensor (top right).

Study Design

The experiments were arranged in a randomized complete block design with four replications of three treatments. In 2019, treatments were the grower’s traditional N management, a risk-averse sensor-based fertigation approach, and a risk-tolerant fertigation approach (Figure 3). The risk-averse and risk-tolerant approaches differed in the amount of indicated N deficiency required to trigger a fertigation application, with the risk-tolerant approach requiring more deficiency than the risk-averse approach to trigger an application. Risk-averse and risk-tolerant language was used to describe the two treatments, because risk-averse approach was designed to emphasize protecting yield potential over reducing applied N, whereas the risk-tolerant approach was designed to emphasize saving N over protecting yield potential. In 2020, treatments included the grower's traditional N management, a constrained sensor-based management approach, and a full-season sensor-based management approach (Figure 4). The constrained sensor-based management approach followed the risk-averse approach from 2019, but was only implemented once the applied N for the season was within 60 lb/ac of the grower's intended total applied N. Full-season sensor-based management followed the risk-averse approach from 2019 for the entire growing season beginning at V6 or 10 days after indicator establishment, whichever was later. The treatments were applied in 15° sectors on half of a quarter section under pivot irrigation. By the V7 growth stage, *indicator blocks* were established in the field using traditional ground-based application equipment (e.g., high-clearance applicator) or via center pivot fertigation. Indicator blocks included at least two plots – an indicator plot and a reference plot – of two different N rates. Indicator plots received 30 lb/ac less N than the bulk sector rate and reference plots received at least 30 lb/ac more N than the bulk sector rate. Four indicator blocks were established in each sector in 2019, while indicator blocks were established in each management zone represented in a sector in 2020.

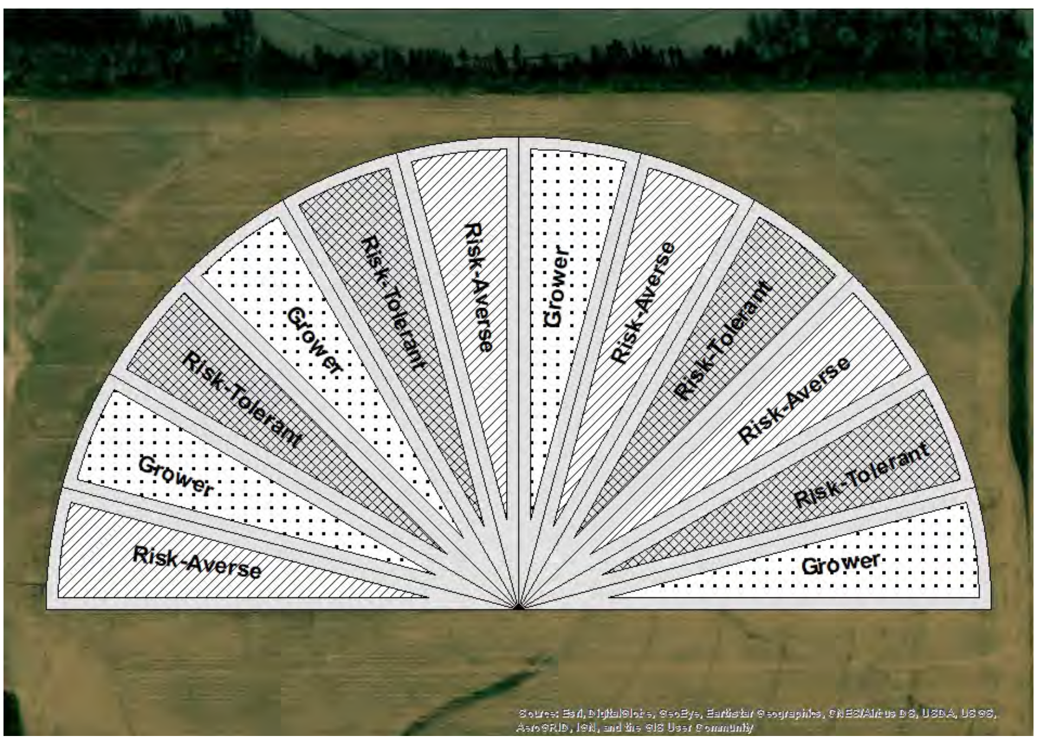


Figure 3. Experiment design with four replications of three treatments (grower's traditional management and the risk-tolerant and risk-averse sensor-based fertigation approaches) arranged in sectors.

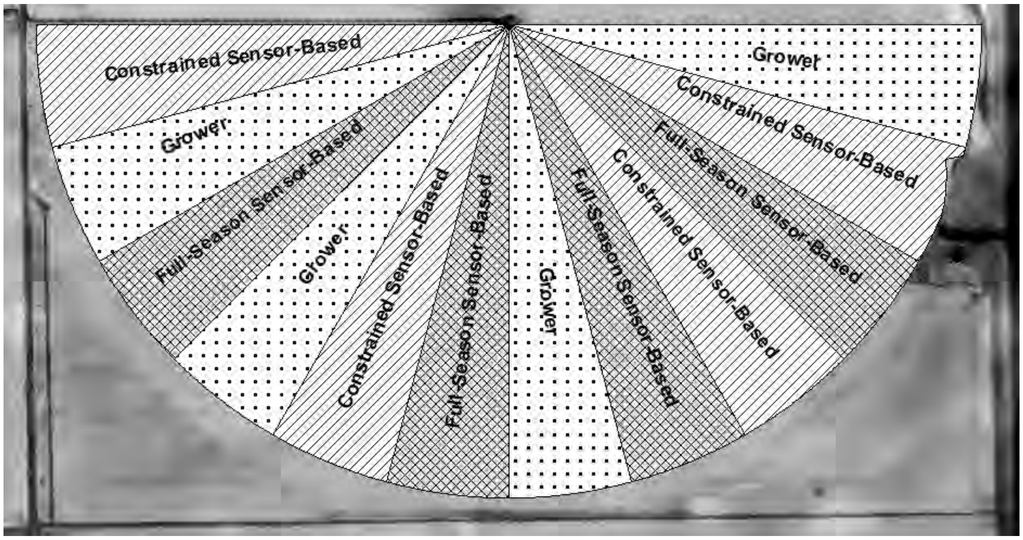


Figure 4. Experiment design in 2020 with four replications of three treatments (grower's traditional management and the constrained and full-season sensor-based management approaches) arranged in sectors.

Figure 5. Center pivot system equipped with a variable injection rate fertilizer pump.

Following indicator block establishment, each field site was flown weekly with the drone to collect multispectral imagery. Collected imagery was then analyzed, fertigation decisions were made for each treatment sector, and a fertigation prescription was generated. If indicator blocks in a given sector suggested that an N application was needed, fertigation was initiated at a rate of 30 lb N/ac. Only the sectors that indicated N application was needed received fertilizer; therefore, on a given fertigation date, it was possible for only one of the sectors in a given treatment to receive N, or for all four sectors of a given treatment to receive N. Each field site was equipped with a variable injection rate fertilizer pump on the center pivot system that injected liquid fertilizer into the irrigation water in order to *fertigate* the corn (Figure 5). This allowed each sector to be managed independently using variable-rate fertigation applications. Fertigation applications were not allowed to occur in consecutive weeks to allow the crop enough time to take up and incorporate applied nitrogen and therefore reduce the risk of excess fertilizer applications. Fertigation applications were allowed to occur up to the R3 growth stage as observed at the time of flight. The grower management was determined by the grower. Ultimately, this method sought to improve fertigation application timing and make only necessary fertigation applications. Successfully accomplishing this goal would match applied N to the N uptake dynamics of corn and reduce the total N applied when possible, optimizing N management. A visual summary of method implementation is given in Figure 6.

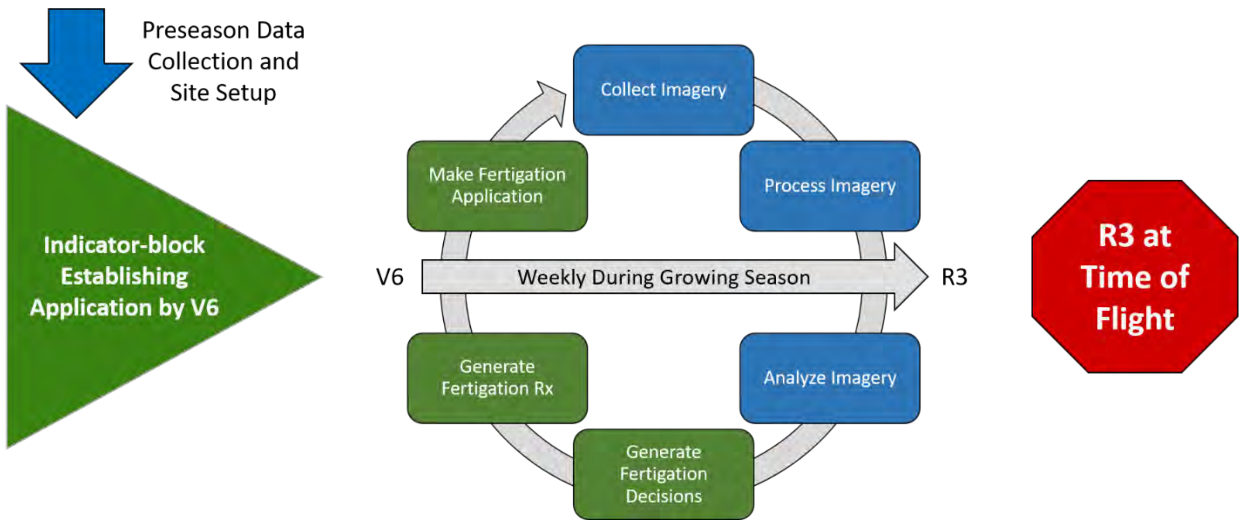


Figure 6. Visual summary of sensor-based fertigation method implementation.

Data Analysis

Yield for the plots was recorded with calibrated yield monitors. Following harvest, yield data were post-processed using the USDA Yield Editor software (USDA) to remove erroneous data points, then the average yield from each sector was extracted. Yield from indicator plots was included in the analysis as they are a necessary element of this N fertilization method. Because the indicator plots occurred in all three treatments, they impacted yield equally. Statistical analysis and Tukey's HSD mean separation were completed with R (R Core Team, 2019).

Comprehensive Data

Data from all sites in 2019 and 2020 have been compiled and analyzed. Summary information is presented in this section. Primarily, sensor-based fertigation management treatments are compared versus typical grower management in terms of marginal net return (MNR, $/ac) and partial factor productivity (PFP, lb grain/lb N). Figure 6 shows the distribution of all sites' partial factor productivity differences versus marginal net return differences compared with typical grower management at that site. Values to the right of the y-axis indicate that the sensor-based management treatment was more efficient than typical grower management, whereas values left of the y-axis indicate that sensor-based management was less efficient than typical grower management. Similarly, points above the x-axis indicate that sensor-based fertigation management was more profitable than typical grower management, whereas points below the x-axis indicate that sensor-based fertigation management was less profitable than typical grower management. If sensor-based management was both more profitable and more efficient than typical grower management at a particular site, the point for that treatment at that site lies in the upper right-hand quadrant.

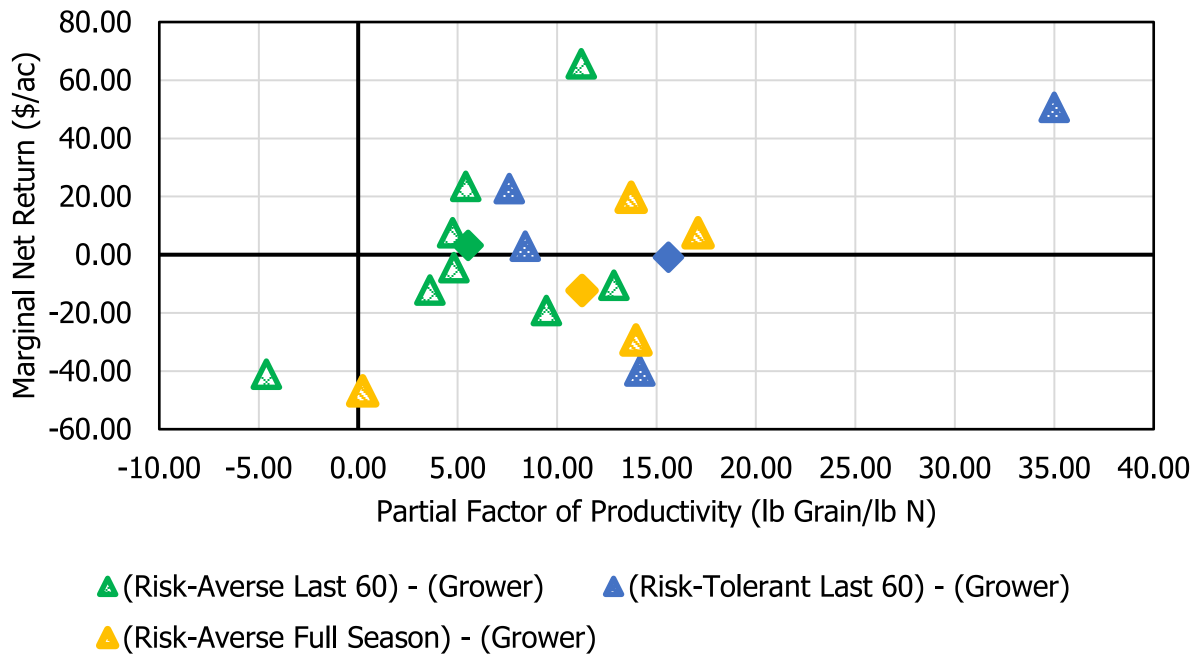


Figure 6. Profitability (y-axis) versus efficiency (x-axis) differences by site for sensor-based fertigation management treatments compared with traditional grower management. Diamonds indicate treatment averages, only sites with a grower management treatment are included.

This distribution shows that approximately 94% of sensor-based fertigation treatment instances across all sites were more efficient than typical grower management. Only 53% of sensor-based fertigation treatment instances across sites were more profitable than typical grower management. Average treatment outcome differences versus traditional grower management are directly quantified in Figure 6.

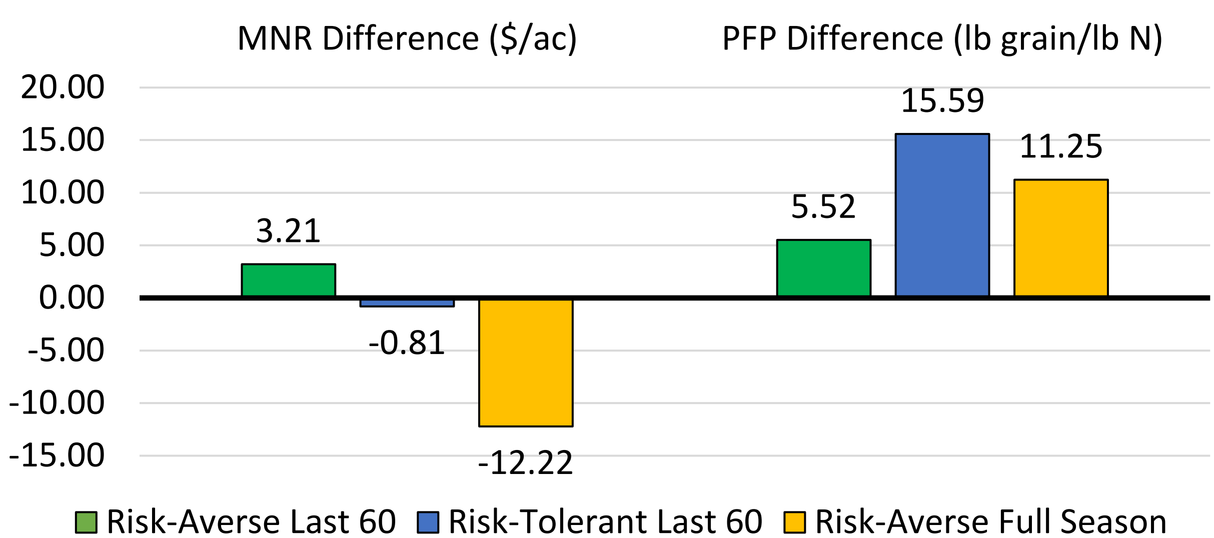


Figure 6. Average profitability and efficiency differences between sensor-based management approaches and traditional grower management across all sites with a grower management treatment.

On average, the risk-averse approach implemented for the last 60 lb/ac of intended applied N increased profitability by $3.21/ac versus typical grower management, while also increasing efficiency by 5.5 lb grain per lb of N applied. All sensor-based fertigation management treatments improved efficiency on average, with the risk-tolerant approach implemented for the last 60 lb/ac of intended applied N realizing the most substantial gains at 15.6 lb grain/lb N. With only one year of data, the risk-averse approach implemented for the entire season appears to offer significant improvements in efficiency, but also appears to be very risky from a profit perspective with an average profit loss of $12.22/ac. This apparent profit risk is strongly influenced by two sites where profit losses were substantial, though the other two sites showed profit increases versus typical grower management.

Conclusions

A couple conclusions can be drawn from the comprehensive dataset compiled over the past two years. First, sensor-based fertigation management is likely to substantially improve NUE versus typical grower management if implemented. It is important to note that the efficiency improvements observed in these trials are relative to grower management strategies following recommended best management practices, such as multiple fertigation applications of small amounts throughout the growing season. Improvements in efficiency may be even more substantial compared with growers not following best practices. Second, implementing the risk-averse sensor-based management approach for only the last 60 lb/ac of intended applied N appears to offer the best combination of profitability and efficiency outcomes. Additional tuning of risk-averse implementation over the entire growing season and risk-tolerant implementation for the last 60 lb/ac of intended applied N may help to solve the profit inconsistency issue.

Continued Development

This study will continue in 2021 on as many as 6 sites, and plans are being made to continue into 2022. A software decision support tool automating the sensor-based fertigation management process is in the late stages of development and will be used to facilitate management on research sites beginning in the 2021 growing season. Additional agronomic analysis is being undertaken to determine the potential for adjusting fertigation application rates during critical application windows and extending the application window for sensor-based fertigation past the R2 growth stage. Future iterations of the project will continue to tune the approaches currently being implemented, integrate scalable imagery sources, and quantify nitrate losses. Updates regarding this research will be provided through UNL Extension media and at field days (restrictions permitting) in 2021.

The sensor-based fertigation project is made possible through support from:

Nebraska CornBoard

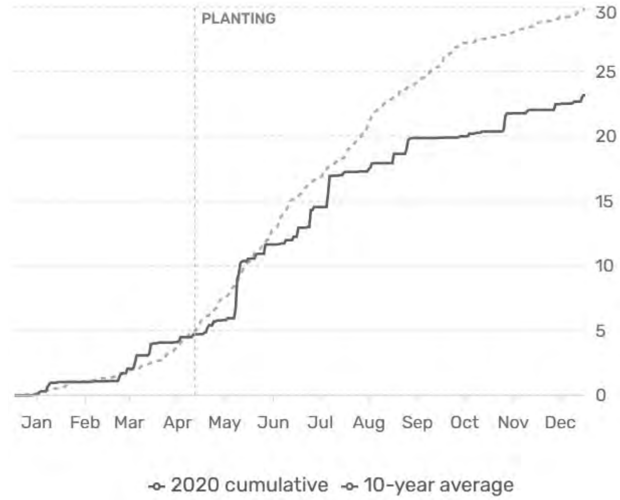
USDA

Water for Food DAUGHERTY GLOBAL INSTITUTE at the University of Nebraska

Sensor-Based Nitrogen Fertigation Management

Study ID: 0207121202001
County: Merrick
Soil Type: Janude sandy loam rarely flooded; Alda loam occasionally flooded; Fonner loam rarely flooded
Planting Date: 4/26/20
Harvest Date: 10/2/20
Seeding Rate: 31,700
Row Spacing (in): 30
Hybrid: Pioneer® 1366Q
Reps: 4
Previous Crop: Soybean
Tillage: No-Till
Herbicides: ***Pre:*** 2.5 qt/ac Acuron®, 1 pt/ac atrazine, and 28 oz/ac glyphosate
Foliar Insecticides: 6 oz/ac Brigade® 2EC
Foliar Fungicides: 10.5 oz/ac Gold Rush® Duo

Irrigation: Pivot, Total: 6.95"
Rainfall (in):



Soil Test (April 2020, soil tests are averages of four replications of each of two treatments):

	pH	BpH	OM LOI %	Nitrate – N ppm N	Mehlich P-III ppm P	Sulfate-S ppm S	Ammonium Acetate (ppm) K	Ca	Mg	Na	CEC me/100g	% Base Saturation H	K	Ca	Mg	Na
Grower	7.0	7.2	2.1	4.1	14	10	162	1585	180	11	10	0	5	78	17	0.5
Full-Season	7.2	7.2	2.2	4.5	15	11	148	1873	183	12	11	0	4	80	16	0.5

Introduction: Corn nitrogen management may be improved by using sensors or imagery to detect and respond to corn nitrogen need during the growing season. This study used weekly aerial imagery obtained with a multispectral sensor on a fixed-wing drone to monitor indicator plots that had lower N rates. If indicator plots demonstrated nitrogen deficiency, a fertigation application of 30 lb/ac was triggered. Originally, this study was intended to compare the grower's standard N management with two reactive, sensor-based fertigation approaches. Due to miscommunication regarding the rate of starter fertilizer applied (10 lb/ac N more than actual), this site only evaluated the full-season sensor-based management versus the grower management as follows:

Grower Management: The grower's standard N management plan involved applying 18 lb/ac N as 13 gal/ac of 10-34-0 and 4 gal/ac 6-24-6 on April 26 with planting, 52 lb/ac N as 28-0-0-5S on June 3 with a high-clearance applicator, 20 lb/ac N as 28-0-0-5S through fertigation on June 25, July 10, and July 16, and 10 lb/ac N as 28-0-0-5S through fertigation on July 28. Total N application was 140 lb/ac.

Full-Season Sensor-Based Management: The sensor-based method is used to recommend N applications from V6 to R3 growth stages. Fertigation application decisions were made based on a decision logic applied to aerial imagery. The base rate of N was 70 lb/ac N (from planting and high-clearance applications). All sensor-based fertigation applications were made at a rate of 30 lb/ac N. Sensor-based fertigation with 28-0-0-5S was triggered on three dates: one of four replications received N on June 25, all four replications received N on July 20, and two replications received N on July 24. The total N application was 122 lb/ac N.

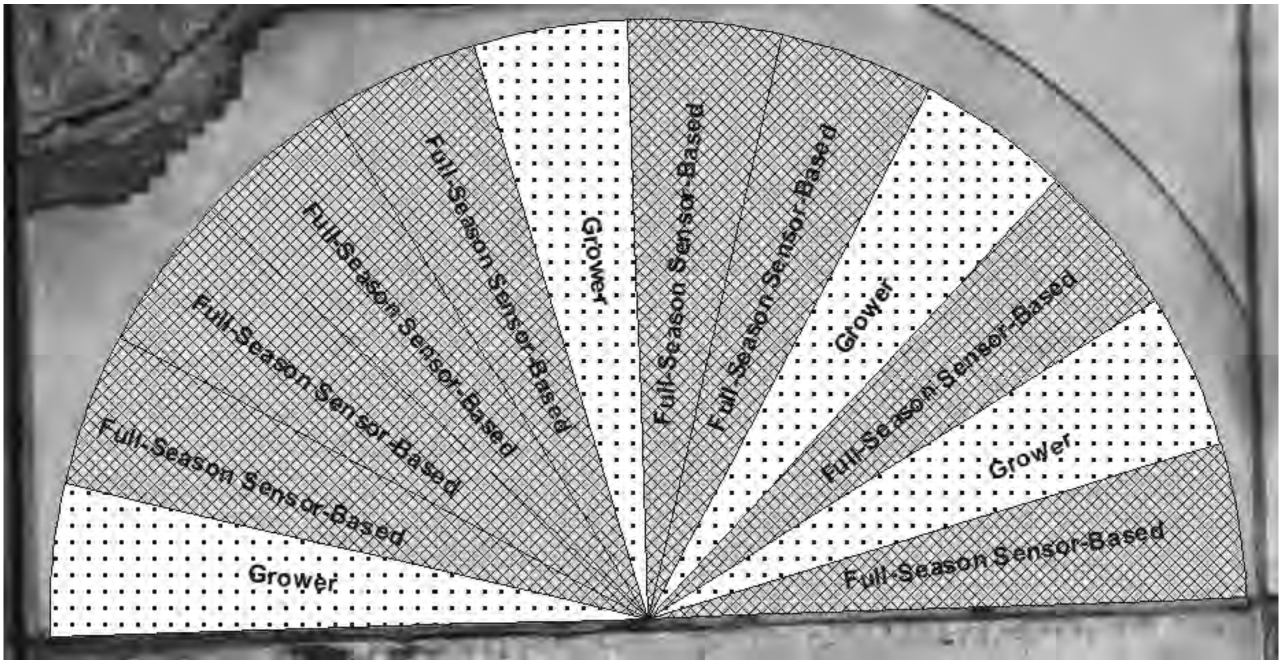


Figure 1. Experiment layout showing four replications of two treatments arranged in sectors.

Results:

	Total N rate (lb/ac)	Moisture (%)	Yield (bu/ac)†	Partial Factor Productivity of N (lb grain/lb N)	lbs N/bu grain	Marginal Net Return‡ ($/ac)	NO_3-N ppm N[Ψ] 0-8"	NO_3-N ppm N 8-24"
Grower	140 A*	15.8 A	233 A	93 B	0.60 A	760.02 A	5.5 A	2.0 A
Full-Season	122 B	16.1 A	236 A	109 A	0.51 B	779.77 A	5.0 A	1.7 A
P-Value	0.041	0.372	0.676	0.032	0.019	0.496	0.541	0.409

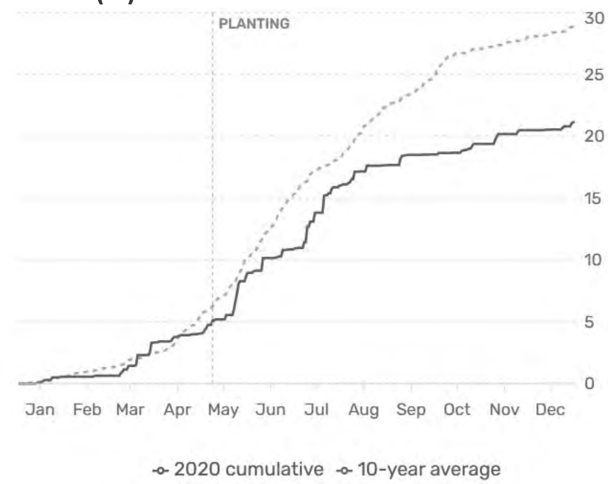
*Values with the same letter are not significantly different at a 90% confidence level.
†Yield values are from cleaned yield monitor data. Bushels per acre corrected to 15.5% moisture.
‡Marginal net return based on $3.51/bu corn and $0.41/lb N.
ΨSoil samples collected after harvest in November 2020.

Summary:

- At this site, the full-season sensor-based management approach applied 18 lb/ac less N than the grower's management.
- Yield was not statistically different between the sensor-based management and the grower's N management.
- The sensor-based approach resulted in greater nitrogen use efficiency as measured by lb of N per bu of grain; the sensor-based approach used 0.09 fewer lb of N to produce a bushel of grain.
- There was no statistical difference in marginal net return between the sensor-based approach and the grower's N management.
- Results at this site suggest that full-season sensor-based nitrogen management can significantly increase N use efficiency without significantly impacting yields, even compared with intensive grower management.
- There were no statistically significant differences in residual soil nitrate between treatments or relative change in soil nitrate from spring to fall.

Sensor-Based Nitrogen Fertigation Management

Study ID: 0568003202001
County: Antelope
Soil Type: Doger loamy fine sand 0-2% slope; Thurman loamy fine sand 2-6% slopes
Planting Date: 5/8/20
Harvest Date: 10/28/20
Seeding Rate: 33,500
Row Spacing (in): 20
Hybrid: Channel® 209-51 VT2P RIB, 211-66STX, and 213-19 VT2P RIB
Reps: 4
Previous Crop: Soybean
Tillage: No-Till
Herbicides: ***Pre:*** 30 oz/ac Durango®, 2 oz/ac Explorer™, 1.6 pt/ac Staunch® II on 5/14/20 ***Post:*** 0.4 gal/ac atrazine 4L, 30 oz/ac Durango®, Explorer™, 0.1 gal/ac Me-Too-Lachlor™ on 6/11/20
Seed Treatment: None
Foliar Insecticides: 4 oz/ac Brigade® 2 EC on 7/22/20
Foliar Fungicides: 10.5 oz/ac Cover XL on 7/22/20
Irrigation: Pivot, Total: 11.7"
Rainfall (in):



Soil Test (March 2020, soil tests are averages of four replications of each of three treatments):

	pH	BpH	OM LOI %	Nitrate – N ppm N	Mehlich P-III ppm P	Sulfate-S ppm S	Ammonium Acetate (ppm) K	Ca	Mg	Na	CEC me/100g	% Base Saturation H	K	Ca	Mg	Na
Grower	7.2	7.2	2.0	3.7	21	8.5	112	852	82	9	5.3	0	6	80	13	1
Full-Season	7.2	7.2	2.0	3.5	28	7.7	126	853	85	9	5.3	0	6	80	13	1
Constrained	7.2	7.2	1.8	3.0	23	8.1	98	780	77	9	4.8	0	5	81	13	1

Introduction: Corn nitrogen management may be improved by using sensors or imagery to detect and respond to corn nitrogen need during the growing season. This study used weekly aerial imagery obtained with a multispectral sensor on a fixed-wing drone to monitor indicator plots that had lower N rates. If indicator plots demonstrated nitrogen deficiency, a fertigation application of 30 lb/ac was triggered. This study compared the grower's standard N management with two reactive, sensor-based fertigation approaches as follows:

Grower Management: The grower's standard N management plan involved applying 42 lb/ac N as 15-15-0-7S on May 8 with planting, 40 lb/ac N as 28-0-0-5S through fertigation on June 13, 25 lb/ac N as 28-0-0-5S through fertigation on June 19, 60 lb/ac N as 32% UAN through fertigation on June 27, 35.5 lb/ac N as 32% UAN through fertigation on July 10, and 30 lb/ac N as 32% UAN through fertigation on July 25. Total N application was 233 lb/ac.

Full-Season Sensor-Based Management: The sensor-based method is used to recommend N applications from V6 to R3 growth stages. Fertigation application decisions were made based on a decision logic applied to aerial imagery.
The base rate of N was 107 lb/ac N (from 42 lb/ac N as 15-15-0-7S on May 8 with planting, 40 lb/ac N as 28-0-

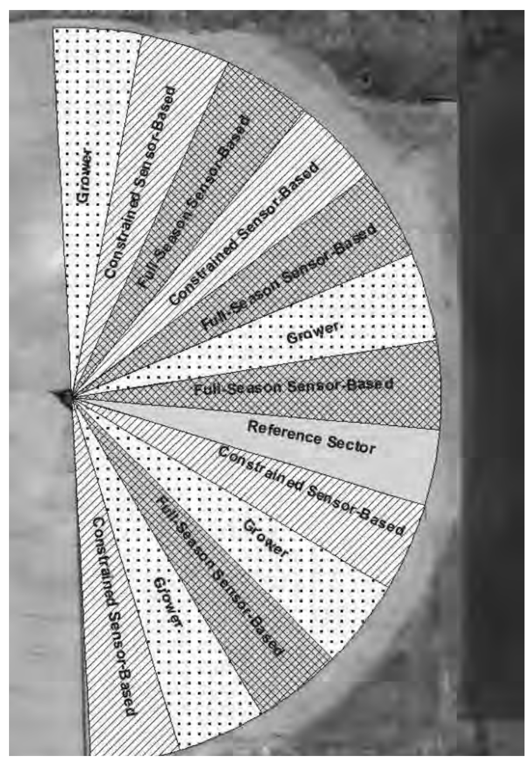


Figure 1. Experiment layout showing four replications of three treatments arranged in sectors.

0-5S through fertigation on June 13, and 25 lb/ac N as 28-0-0-5S through fertigation on June 19). All sensor-based fertigation applications were made at a rate of 30 lb/ac N and began after the June 19 application. Sensor-based fertigation with 32% UAN was triggered on six dates: three of four replications received N on June 27, one of four replications received N on July 3, two of four replications received N on July 10, one of four replications received N on July 18, two of four replications received N on July 25, and one of four replications received N on July 30. The total N application was 182 lb/ac N.

Constrained Sensor-Based Management: The sensor-based method is used to recommend N applications for the last 60 lb/ac of applied N. Prior to the last 60 lb/ac N, fertigation applications were managed identically to the grower management. The base rate of N was 107 lb/ac N (from 42 lb/ac N as 15-15-0-7S on May 8 with planting, 40 lb/ac N as 28-0-0-5S through fertigation on June 13, and 25 lb/ac N as 28-0-0-5S through fertigation on June 19). The grower's management was followed to apply 60 lb/ac N as 32% UAN through fertigation on June 27. After this time, the sensor-based fertigation method was used; the sensor-based method triggered applications on two dates: all four replications received N on July 10 and two of four replications received N on July 25. The total N applied to this treatment was 217 lb/ac N.

Results:

	Total N rate (lb/ac)	Moisture (%)	Yield (bu/ac)†	Partial Factor Productivity of N (lb grain/lb N)	lbs N/bu grain	Marginal Net Return‡ ($/ac)
Grower	233 A*	19.2 A	266 A	64 B	0.88 A	837.31 A
Constrained	217 A	18.8 A	260 A	68 B	0.84 A	825.18 A
Full-Season	182 B	19.1 A	262 A	81 A	0.69 B	844.87 A
P-Value	0.0005	0.696	0.539	0.001	0.001	0.534

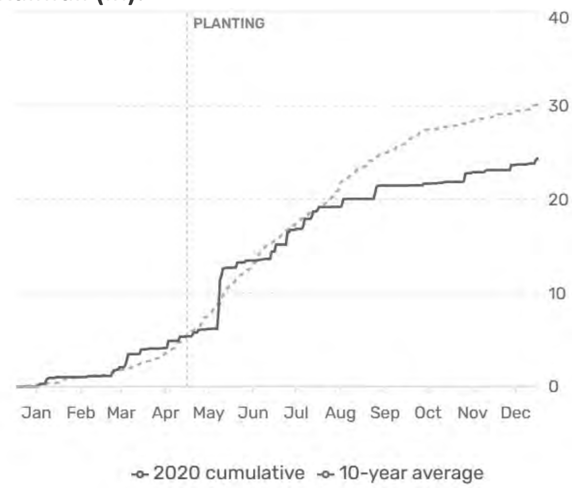
*Values with the same letter are not significantly different at a 90% confidence level.
†Yield values are from cleaned yield monitor data. Bushels per acre corrected to 15.5% moisture.
‡Marginal net return based on $3.15/bu corn and $0.41/lb N.

Summary:

- At this site, the constrained sensor-based management approach applied 16 lb/ac less N than the grower's N management, whereas the full-season sensor-based management approach applied 51 lb/ac less N than the grower's management.
- Yield was not statistically different between the treatments. There were three hybrids in the treatment area. Within the individual sectors the hybrids responded differently to the N treatment strategies evaluated; however, the hybrid effect did not influence the yield response to N treatment when considering all replications together.
- The full-season sensor-based management resulted in greater nitrogen use efficiency as measured by lb of N per bu of grain than the grower's management and the constrained sensor-based management.
- There was no statistical difference in marginal net return between the sensor-based approaches and the grower's N management.
- A spring-grazed rye cover crop preceded the corn crop on this field, and decomposition of residual cover crop biomass may have contributed available N later in the growing season.
- Results from this site indicate that full-season sensor-based fertigation management can significantly increase N use efficiency without impacting yield, primarily by reducing excessive pre-V9 applications.
- This site used the indicator sector establishment approach, covered more thoroughly in study 0934155202002, with embedded indicator sectors in the sensor-based treatments and a separate reference sector.
- An implementation error at this site resulted in a 5-day error in applied N timing for the last fertigation application of the season; however, that error likely did not affect the efficacy of the treatments, especially because it occurred at a growth stage with slower N uptake (R2).

Sensor-Based Nitrogen Fertigation Management

Study ID: 0817081202001
County: Hamilton
Soil Type: Crete silt loam 0-1% slope; Hastings silt loam 0-1% slope; Hastings silt loam 1-3% slope
Planting Date: 4/30/20
Harvest Date: 11/2/20
Seeding Rate: 32,000
Row Spacing (in): 30
Hybrid: Pioneer® P1370Q
Reps: 4
Previous Crop: Corn
Tillage: Ridge-Till
Herbicides: ***Pre:*** 12 oz/ac Verdict®, 0.50 pt/ac Talus™ HC, 1 qt/ac ALTRA-V™ 4L, and 24 oz/ac Mountaineer® 6 MAX on 4/21/20 ***Post:*** 16 oz/ac Armezon® PRO, 1 qt/ac ALTRA-V™ 4L, and 32 oz/ac Mountaineer® 6 MAX on 6/11/20
Seed Treatment: Maxim® Quattro, Lumiflex™, Lumiante™, L-2012R, Lumivia™, Lumisure™, Lumialza™
Foliar Insecticides: 5 oz/ac Hero® on 7/18/20
Foliar Fungicides: 6.8 oz/ac Aproach® Prima, 4 oz/ac Spire™ 500 EC on 7/18/20
Note: Hail on 6/3 when corn was at V3. High winds on 7/8 led to stalk snap. Adjustment was 33.8% loss. Generally less damage in the study area.
Irrigation: Pivot, Total: 10.3"
Rainfall (in):



Soil Test (April 2020, soil tests are averages of four replications of each of three treatments):

	pH	BpH	OM LOI %	Nitrate – N ppm N	Mehlich P-III ppm P	Sulfate-S ppm S	Ammonium Acetate (ppm) K	Ca	Mg	Na	CEC me/100g	% Base Saturation H	K	Ca	Mg	Na
Grower	6.5	7.0	3.9	5.9	11	11	286	2239	351	36	16	7	5	70	17	1
Full-Season	6.5	6.9	3.8	6.0	15	11	296	2304	339	31	17	11	5	68	16	1
Constrained	6.5	6.9	3.7	5.6	11	9	277	2225	337	34	17	10	4	68	17	1

Introduction: Corn nitrogen management may be improved by using sensors or imagery to detect and respond to corn nitrogen need during the growing season. This study used weekly aerial imagery obtained with a multispectral sensor on a fixed-wing drone to monitor indicator plots that had lower N rates. If indicator plots demonstrated nitrogen deficiency, a fertigation application of 30 lb/ac was triggered. This study compared the grower's standard N management with two reactive, sensor-based fertigation approaches as follows:

Grower Management: The grower's standard N management plan involved applying 64 lb/ac N as 11-52-0 on April 9, 35.5 lb/ac N as 32% UAN on April 22 with a high-clearance applicator, 5.8 lb/ac N as 10-34-0 on April 30 with planting, and 35.5 lb/ac N as 32% UAN through each fertigation on June 17, June 24, and July 8. Total N application was 212 lb/ac.

Full-Season Sensor-Based Management: The sensor-based method is used to recommend N applications from V6 to R3 growth stages. Fertigation application decisions were made based on a decision logic applied to aerial imagery. The base rate of N was 105 lb/ac N (from pre-plant and at planting applications). All sensor-based fertigation applications were made at a rate of 30 lb/ac N. Sensor-based fertigation with 32% UAN was triggered on five dates: three of four replications received N on June 24, one replication received N on July 8, one replication received N on July 13, two replications received N on July 22, and one replication received N on July 28. The total N application was 165 lb/ac N.

Constrained Sensor-Based Management: The sensor-based method is used to recommend N applications for the last 60 lb/ac of applied N. Prior to the last 60 lb/ac N, fertigation applications were managed identically to the grower management. The base rate of N was 105 lb/ac N (from pre-plant and at planting applications). The grower's management was followed to apply 35.5 lb/ac N through each fertigation on June 17 and June 24. After this time, the sensor-based fertigation method was used; the sensor-based method did not trigger any N applications. The total N applied to this treatment was 176 lb/ac N.

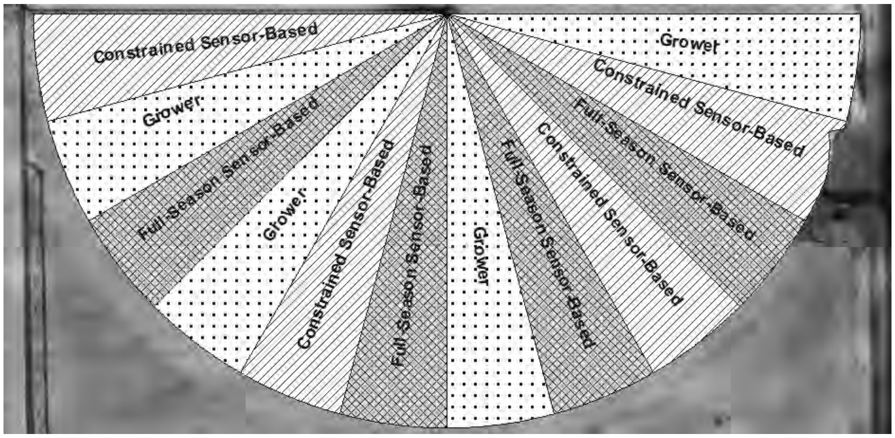


Figure 1. Experiment layout showing four replications of three treatments arranged in sectors.

Results:

	Total N rate (lb/ac)	Moisture (%)	Yield (bu/ac)†	Partial Factor Productivity of N (lb grain/lb N)	lbs N/ bu grain	Marginal Net Return‡ ($/ac)	NO_3-N ppm N$^{\Psi}$ 0-8"	NO_3-N ppm N 8-24"
Grower	212 A*	15.5 A	235 A	62 B	0.90 A	738.66 A	3.3 A	8.0 A
Constrained	176 B	15.4 A	226 B	72 AB	0.78 B	719.43 A	3.7 A	8.9 A
Full-Season	165 B	15.0 A	221 B	76 A	0.75 B	709.31 A	3.2 A	7.9 A
P-Value	0.004	0.256	0.020	0.028	0.014	0.117	0.687	0.955

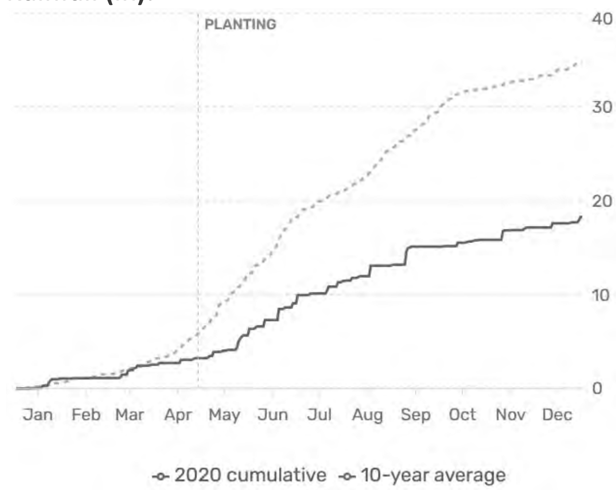
*Values with the same letter are not significantly different at a 90% confidence level.
†Yield values are from cleaned yield monitor data. Bushels per acre corrected to 15.5% moisture.
‡Marginal net return based on $3.51/bu corn and $0.41/lb N.
ΨSoil samples were collected after harvest in November 2020.

Summary:

- At this site, the constrained sensor-based management approach applied 36 lb/ac less N than the grower's N management, whereas the full-season sensor-based management approach applied 47 lb/ac less N than the grower's management.
- Yield was 10-14 bu/ac lower for the sensor-based approaches compared to the grower's N management approach.
- Both sensor-based approaches resulted in greater nitrogen use efficiency as measured by lb of N per bu of grain.
- There was no statistical difference in marginal net return between the sensor-based approaches and the grower's N management.
- Imagery collected from this site did not appear to show insufficiency until the reproductive growth stages, indicating that yield loss may have occurred during grain fill and also suggesting that fertigation applications past R2 might be beneficial.
- Satellite imagery with only the NDVI index available was used to direct the first fertigation of the year on this site due to high winds, which inhibited UAV flight. This only impacted the full-season sensor-based management treatment, which had no sectors receive N, while all treatment sectors for the grower and constrained sensor-based management received 30 lb N.
- A significant rain event in early May could have caused significant N leaching that would have compounded the effects of a delayed early season fertigation.
- In general, results from this site further indicate the yield risk associated with full-season sensor-based fertigation management in its current form.
- Results from this site further indicate that sensor-based fertigation management leads to improved N use efficiency versus typical grower management.
- There were no statistically significant differences in residual soil nitrate or change in soil nitrate from fall to spring between the three treatments, though the two sensor-based treatments led to larger numerical reductions in soil nitrate from spring to fall.

Sensor-Based Nitrogen Fertigation Management

Study ID: 0934155202002
County: Saunders
Soil Type: Yutan silty clay loam terrace, 2-6% slopes, eroded; Filbert silt loam 0-1% slope; Tomek silt loam 0-2% slope
Planting Date: 4/28/20
Harvest Date: 10/20/20
Seeding Rate: 32,000
Row Spacing (in): 30
Hybrid: Pioneer® P1563AM
Reps: 4
Previous Crop: Soybean
Tillage: No-Till
Herbicides: ***Pre:*** 1 qt/ac atrazine 4L, 3.5 oz/ac Corvus®, 36 oz/ac Roundup PowerMAX® with 2 lb/ac AMS and 16 oz/ac COC on 4/28/20 ***Post:*** 1 pt/ac atrazine 4L, 3 oz/ac Laudis®, 40 oz/ac Roundup PowerMAX® with 2 lb/ac AMS and 18 oz/ac MSO on 6/4/20
Foliar Insecticides: None
Foliar Fungicides: None
Irrigation: Pivot, Total: 8.35"
Rainfall (in):



Soil Test (March 2020, soil tests are averages of four replications of each of three treatments):

	pH	BpH	OM LOI %	Nitrate – N ppm N	Mehlich P-III ppm P	Sulfate-S ppm S	Ammonium Acetate (ppm) K	Ca	Mg	Na	CEC me/100g	% Base Saturation H	K	Ca	Mg	Na
Strip	5.9	6.5	4.3	7.4	47	7.7	321	1833	294	22	17.9	30	5	51	13	0.5
Sector	6.0	6.5	4.2	6.3	26	7.5	272	1882	305	24	17.8	29	4	52	14	1.0
Virtual	6.0	6.5	4.3	7.8	44	7.5	341	1997	334	22	18.6	27	5	53	15	0.4

Introduction: Corn nitrogen management may be improved by using sensors or imagery to detect and respond to corn nitrogen need during the growing season. This study used weekly aerial imagery obtained with a multispectral sensor on a fixed-wing drone to monitor indicator plots that had lower N rates. If indicator plots demonstrated nitrogen deficiency, a fertigation application of 30 lb/ac was triggered. This study compared three different methods of determining whether or not to trigger a sensor-based application: indicator strip full-season sensor-based management, indicator sector full-season sensor-based management, and virtual reference full-season sensor-based management. The indicator strip and indicator sector methods both used physical indicator (low-N) and reference (high-N) plots to make weekly fertigation decisions. In the indicator strip method, indicator and reference plots were established in rectangular strips during the anhydrous application, whereas in the indicator sector method, indicator plots were established as pie-shaped sectors embedded within the treatment sectors using fertigation through the center pivot. The virtual reference method included no physical reference. Instead the N sufficient reference value was determined using the 95th percentile NDRE for the managed area and used to make weekly fertigation decisions. The indicator strip method has been the establishment method used in sensor-based fertigation management on-farm trials until 2020, and the goal of this trial was to determine if more efficient establishment alternatives have similar efficacy for implementation on-farm.

Indicator Strip Full-Season Sensor-Based Management: 70 lb/ac N was applied as anhydrous ammonia on March 30, 7 lb/ac N was applied as ATS via fertigation on June 5, and 30 lb/ac N was applied as 28% UAN through fertigation on June 6. Sensor-based fertigation began at this point with all sensor-based fertigations at a rate of 30 lb/ac N. Sensor-based fertigation was triggered on one date: one of four replications received N as 28% UAN on June 24. Total N application was 115 lb/ac.

Indicator Sector Full-Season Sensor-Based Management: 70 lb/ac N was applied as anhydrous ammonia on March 30, 7 lb/ac N was applied as ATS via fertigation on June 5, and 30 lb/ac N was applied as 28% UAN through fertigation on June 6. Sensor-based fertigation began at this point with all sensor-based fertigations at a rate of 30 lb/ac N. Sensor-based fertigation was triggered on two dates: one of four replications received N as 28% UAN on July 8 and one of four replications received N as 28% UAN on July 14. Total N application was 122 lb/ac.

Virtual Reference Full-Season Sensor-Based Management: 70 lb/ac N was applied as anhydrous ammonia on March 30, 7 lb/ac N was applied as ATS via fertigation on June 5, and 30 lb/ac N was applied as 28% UAN through fertigation on June 6. Sensor-based fertigation began at this point with all sensor-based fertigations at a rate of 30 lb/ac N. Sensor-based fertigation was triggered on three dates: three of four replications received N as 28% UAN on June 24, all four replications received N as 28% UAN on July 8, and all four replications received N as 28% UAN on July 23. Total N application was 190 lb/ac.

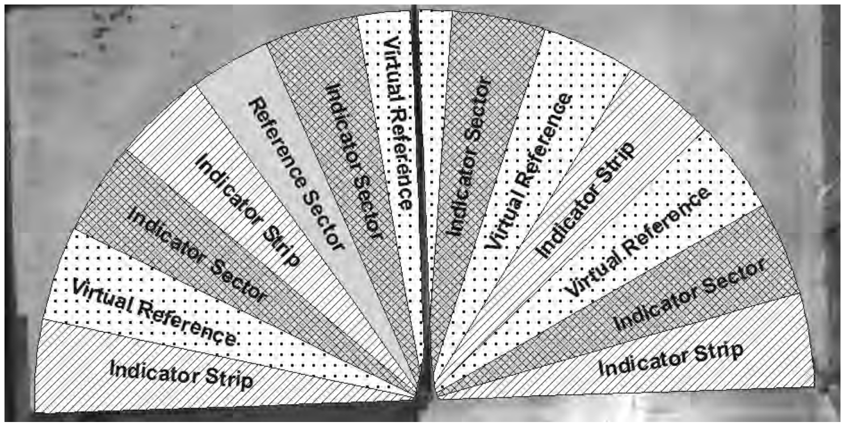


Figure 1. Experiment layout showing four replications of three treatments arranged in sectors.

Results:

	Total N rate (lb/ac)	Moisture (%)	Yield (bu/ac)†	Partial Factor Productivity of N (lb grain/lb N)	lbs N/ bu grain	Marginal Net Return‡ ($/ac)	NO_3-N ppm N$^{\psi}$ 0-8"	NO_3-N ppm N 8-24"
Indicator Strip	115 B*	14.3 A	234 A	116 A	0.49 B	774.47 A	7.4 B	3.1 B
Indicator Sector	122 B	14.3 A	233 A	108 A	0.52 B	768.44 A	4.7 B	2.6 B
Virtual Reference	190 A	13.8 A	241 A	72 B	0.79 A	767.05 A	12.2 A	8.1 A
P-Value	0.0005	0.241	0.459	0.004	0.001	0.843	<0.001	<0.001

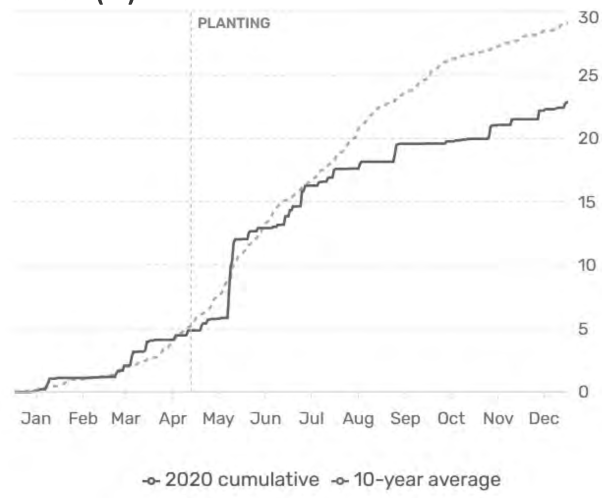
*Values with the same letter are not significantly different at a 90% confidence level.
†Yield values are from cleaned yield monitor data. Bushels per acre corrected to 15.5% moisture.
‡Marginal net return based on $3.51/bu corn and $0.41/lb N.
ΨSoil samples were collected after harvest in October 2020.

Summary:

- At this site, the virtual reference method resulted in a higher total N rate than the indicator strip or sector method.
- There was no yield difference between the three approaches evaluated.
- The indicator strip and sector methods had greater nitrogen use efficiency than the virtual reference method.
- There was no statistical difference in marginal net return between the sensor-based approaches and the grower's N management.
- Results from this site suggest that the indicator sector establishment method has similar performance to the indicator strip establishment method and should be efficacious in on-farm implementation. This means it is possible to execute this method without any variable-rate equipment other than a pivot capable of pie-shaped VRI applications.
- While the virtual reference method had slightly higher numerical yield, the method appears to overapply N compared with physical indicator establishment methods.
- The virtual reference method resulted in significantly more residual soil nitrate than the other two treatments, and was the only treatment to increase the amount of soil nitrate from spring to fall.

Sensor-Based Nitrogen Fertigation Management

Study ID: 0815093202001
County: Howard
Soil Type: Libory-Boelus loamy fine sand; Valentine-Thurman Choose Soil Texture 0-17% slopes; Thurman loamy fine sand
Planting Date: 4/27/20
Harvest Date: 10/21/20
Seeding Rate: 33,000
Row Spacing (in): 30
Hybrid: Pioneer® P1108Q
Reps: 4
Previous Crop: Corn
Tillage: No-Till
Herbicides: ***Pre:*** 64 oz/ac Lexar, 32 oz/ac Roundup®, and 1 oz/ac Sharpen®, with 6 oz/ac Liquid AMS and 16 oz/ac MSO on 5/1/20 ***Post:*** 32 oz/ac Lexar, 32 oz/ac Roundup®, and 4 oz/ac Status® on 6/5/20; 32 oz/ac Roundup®, 32 oz/ac Liberty® and 2 oz/ac Direct Hit on 7/6/20; 12 oz/ac 2,4-D on 7/25/20
Seed Treatment: LumiGEN™
Foliar Insecticides: 6.6 oz/ac bifenthrin on 4/27/20; 2 oz/ac bifenthrin and 2 oz/ac lambda-cyhalothrin on 7/20/20
Foliar Fungicides: 10 oz/ac Trivapro® on 7/20/20
Note: Hail at V3, moderate leaf damage, all plants standing. High winds on night of 7/8 led to significant stalk snap in spots of this field.
Irrigation: Pivot, Total: 12.3"
Rainfall (in):



Soil Test (April 2020, soil tests are averages of four replications of each of three treatments):

	pH	BpH	OM LOI %	Nitrate – N ppm N	Mehlich P-III ppm P	Sulfate-S ppm S	Ammonium Acetate (ppm) K	Ca	Mg	Na	CEC me/100g	% Base Saturation H	K	Ca	Mg	Na
Grower	5.7	6.8	2.0	6.5	42	9.0	181	672	99	7	7.2	37	6	46	11	0.1
Full-Season	5.6	6.7	1.8	7.2	27	5.8	145	579	86	8	7.2	44	5	40	10	0.3
Constrained	5.6	6.8	1.7	7.0	32	6.3	130	539	78	7	6.4	42	5	42	10	0.3

Introduction: Corn nitrogen management may be improved by using sensors or imagery to detect and respond to corn nitrogen need during the growing season. This study used weekly aerial imagery obtained with a multispectral sensor on a fixed-wing drone to monitor indicator plots that had lower N rates. If indicator plots demonstrated nitrogen deficiency, a fertigation application of 30 lb/ac was triggered. This study compared the grower's standard N management with two reactive, sensor-based fertigation approaches as follows:

Grower Management: The grower's standard N management plan involved applying 17 lb/ac N as 11-52-0 on April 19, 5.8 lb/ac N as 10-34-0 and 60 lb/ac N as 28% UAN with planting on April 27, 60 lb/ac N as 28% UAN on May 30 with a coulter applicator, 30 lb/ac N as 28% UAN on June 11 with a high-clearance applicator, 20 lb/ac N as 28-0-0-5S through fertigation on June 24 and July 3, and 37 lb/ac N as 28-0-0-5S through fertigation on July 28. Total N application was 250 lb/ac.

Full-Season Sensor-Based Management: The sensor-based method is used to recommend N applications from V6 to R3 growth stages. Fertigation application decisions were made based on a decision logic applied to aerial imagery. The base rate of N was 173 lb/ac N (from 17 lb/ac N as 11-52-0 on April 19, 5.8 lb/ac N as 10-34-0 and 60 lb/ac N as 28% UAN with planting on April 27, 60 lb/ac N as 28% UAN on May 30 with a coulter applicator, and 30 lb/ac N as 28% UAN on June 11 with a high-clearance applicator). All sensor-based fertigation applications were made at a rate of 30 lb/ac N. Sensor-based fertigation with 28-0-0-5S was triggered on three dates: two of four replications received N on June 24, three of four replications received N on July 14, and three of four replications received N on July 28. The total N application was 233 lb/ac N.

Constrained Sensor-Based Management: The sensor-based method is used to recommend N applications for the last 60 lb/ac of applied N. Prior to the last 60 lb/ac N, fertigation applications were managed identically to the grower management. The base rate of N was 173 lb/ac N (from 17 lb/ac N as 11-52-0 on April 19, 5.8 lb/ac N as 10-34-0 and 60 lb/ac N as 28% UAN with planting on April 27, 60 lb/ac N as 28% UAN on May 30 with a coulter applicator, and 30 lb/ac N as 28% UAN on June 11 with a high-clearance applicator). The grower's management was followed to apply 20 lb/ac N through fertigation on June 24. After this time, the sensor-based fertigation method was used; the sensor-based method did not trigger any N applications. The total N applied to this treatment was 193 lb/ac N.

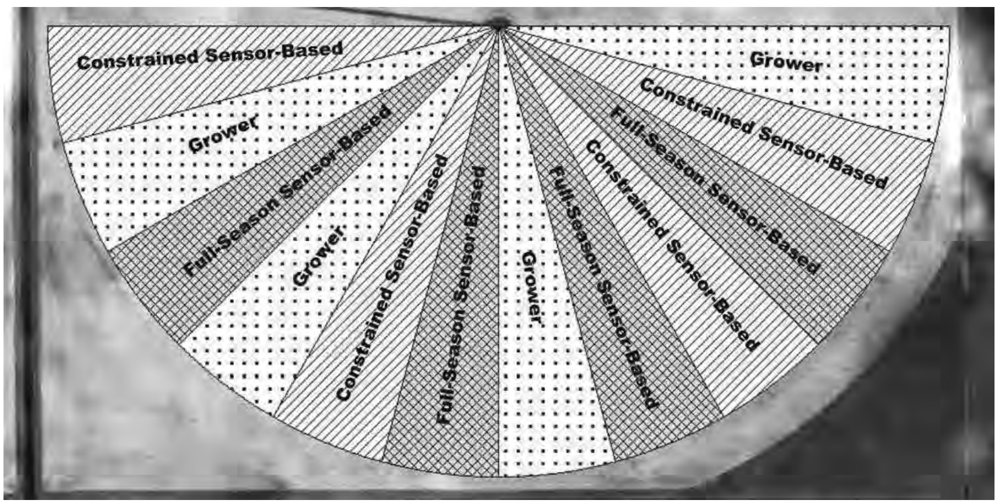


Figure 1. Experiment layout showing four replications of three treatments arranged in sectors.

Results:

	Total N rate (lb/ac)	Moisture (%)	Yield (bu/ac)†	Partial Factor Productivity of N (lb grain/lb N)	lbs N/bu grain	Marginal Net Return‡ ($/ac)	NO_3-N ppm N[Ψ] 0-8"	NO_3-N ppm N 8-24"
Grower	250 A*	16.0 A	236 A	53 B	1.06 A	727.39 A	4.1 A	1.9 A
Constrained	193 B	15.3 A	227 A	66 A	0.85 B	716.86 A	5.1 A	1.6 A
Full-Season	233 A	15.3 A	221 A	53 B	1.06 A	680.56 A	3.5 A	1.6 A
P-Value	0.001	0.206	0.465	0.002	0.004	0.503	0.373	0.897

*Values with the same letter are not significantly different at a 90% confidence level.
†Yield values are from cleaned yield monitor data. Bushels per acre corrected to 15.5% moisture.
‡Marginal net return based on $3.51/bu corn and $0.41/lb N.
ΨSoil samples collected after harvest in November 2020.

Summary:

- At this site, the constrained sensor-based management approach applied 57 lb/ac less N than the grower's N management, whereas the full-season sensor-based management approach applied 17 lb/ac less N than the grower's management.
- Yield was not statistically different between the treatments. The lack of significant yield difference at this site, despite drastic numerical differences in yield, is indicative of significant yield variability within all three treatments. This suggests the experimental design may not adequately control for variability in

measuring the impact of these treatments. Historical yield data (shown below) suggest underlying productivity patterns may have influenced the outcome of the trial.

- The constrained sensor-based approach resulted in the greatest nitrogen use efficiency; the constrained sensor-based approach used 0.21 fewer lb of N to produce a bushel of grain than the full-season sensor-based approach or the grower's approach.
- There was no statistical difference in marginal net return between the sensor-based approaches and the grower's N management.
- Significant wind damage, and associated weed pressure, on the higher-elevation and drastically sloping southeast portion of the field likely limited yield potential in this area. Wind damage may have also been present in other areas of the field.
- This site was the only site at which a sensor-based management treatment sector received more N than the grower treatment.
- Despite the factors that may have influenced results at this site, results from this site suggest that the constrained sensor-based management maintains efficacy for increasing N use efficiency.
- Results further suggest that full-season sensor-based management may in fact be a higher-risk implementation.
- There were no statistically significant differences in residual soil nitrate or change in soil nitrate from spring to fall between the three treatments.

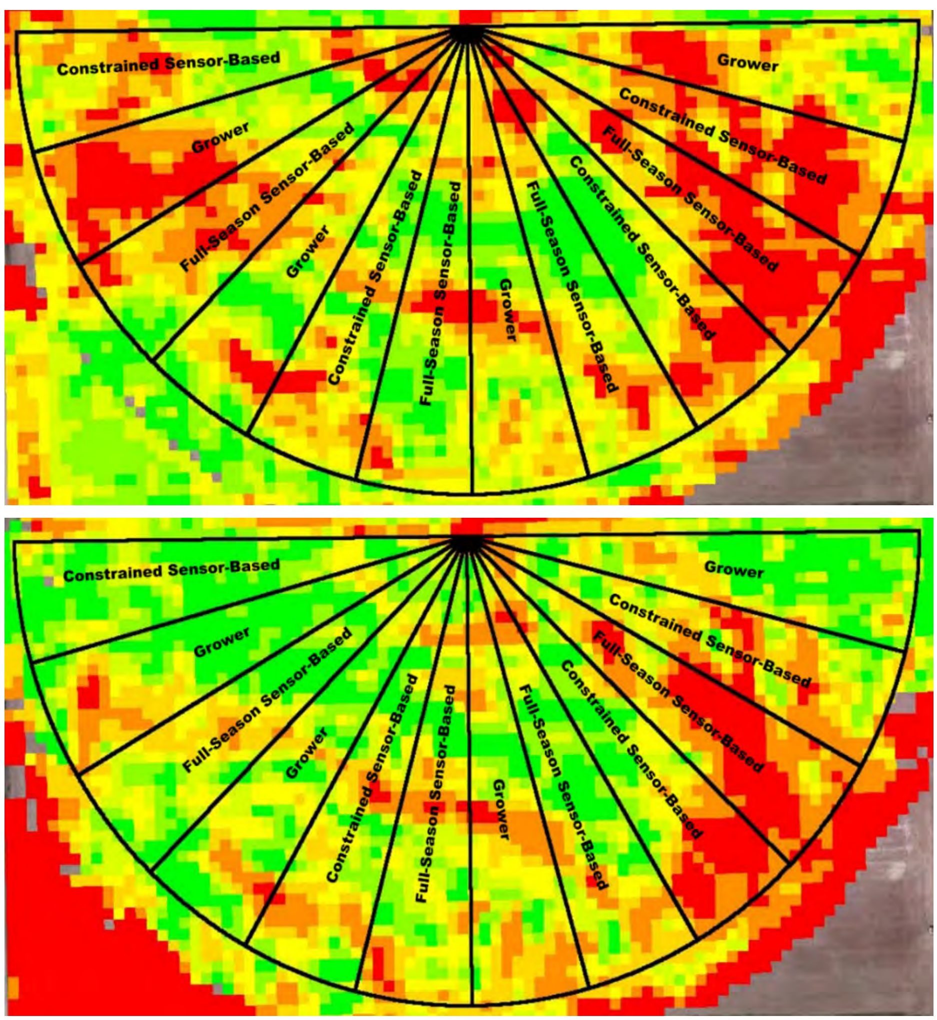


Figure 2. Gridded 2019 yield data (top) and 2020 yield data (bottom).

CLICK TO WATCH A VIDEO ABOUT THIS STUDY https://go.unl.edu/projectsense

Project SENSE – 2020 Research and 6-Year Summary Report

Sensors for Efficient Nitrogen Use and Stewardship of the Environment

The Nebraska On-Farm Research Network launched a project in 2015 focused on improving the efficiency of nitrogen fertilizer use. Project SENSE (Sensors for Efficient Nitrogen Use and Stewardship of the Environment) compares crop canopy sensors to fixed-rate, in-season nitrogen application in corn. From 2015 to 2020, 58 site-studies were conducted, with five partnering Natural Resources Districts (NRDs): Central Platte, Little Blue, Lower Loup, Lower Platte North, and Upper Big Blue. Since 2018, the project has been conducted at fewer sites each year; however, sites were not constrained to a specific NRD or to irrigated fields. The 2020 study-site results are reported individually following this summary.

Nitrogen Management Challenges

Since 1988, the nitrate concentration in groundwater in Nebraska's Central Platte river valley has been steadily declining, largely due to the conversion from furrow to center-pivot irrigation. However, over the last 25 years, fertilizer nitrogen use efficiency has remained static. This trend points to the need for adoption of available technologies such as crop canopy sensors for further improvement in nitrogen use efficiency. Strategies that direct crop nitrogen status at early growth stages are promising to improve nitrogen fertilizer efficiency.

Managing Variability with Sensors

It is difficult to determine the optimum amount of nitrogen to apply in a field; nitrogen needs in a field vary spatially and from year to year. Because crop canopy sensors are designed to be responsive to nitrogen needs, they can help account for this variability. Active sensors work by emitting light onto the crop canopy and then measuring reflectance from the canopy with photodetectors (*Figure 1*). When used to detect plant health, light in both the visible (VIS; 400-700 nm) and near-infrared (NIR; 700-1000 nm) portions of the electromagnetic spectrum are generally measured. These wavelengths are combined to create various vegetation indices (VI). In this study, the normalized difference red edge (NDRE) index was used in the algorithm to prescribe an in-season nitrogen recommendation rate.

Study Design

A high-clearance applicator was equipped with an Ag Leader® Integra in-cab monitor and four OptRx® sensors *(Figure 1)*. A master module enables connection between the OptRx® sensors, which are capturing the normalized difference red edge (NDRE) index, and Ag Leader® in-cab monitor, which is computing the recommended N rate. An application rate module communicates the target rate from the Ag Leader® monitor to the rate controller. The applicator was equipped with straight stream drop nozzles in order to apply UAN fertilizer to the crop as it was sensed *(Figure 2)*. This configuration of active sensors with a high-clearance machine has several benefits. Nitrogen rates are prescribed in real-time by the system and account for spatial variability across the field, application can occur up until the V12 growth stage, and sensing does not rely on sunlight, as the active sensors provide their own light source.

Figure 1: Active crop canopy sensor (left) positioned over the corn canopy and high-clearance applicator (right) equipped with OptRx® crop canopy sensors, GPS, and drop nozzles.

Project SENSE plots were arranged in a randomized complete block design with six replications *(Figure 2).* The grower's normal N management was compared with the Project SENSE N Management. For the Project SENSE strips, a base rate (75 lb N/ac for most sites) was applied at planting or very early in the growing season.

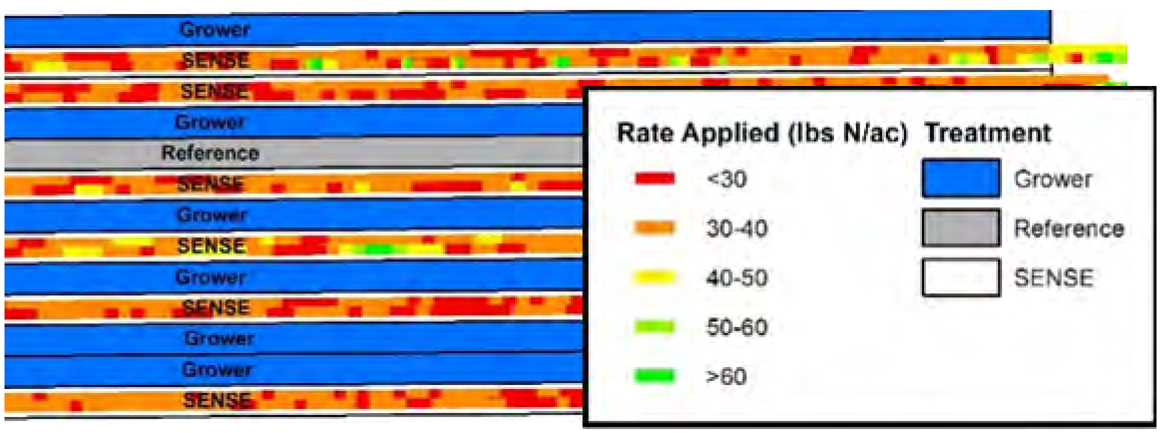


Figure 2: Layout of Project SENSE field trials with grower, SENSE, and reference strips.

Between V8 and V12, corn was sensed with the crop canopy sensors and variable-rate N was applied on-the-go *(NDRE values shown in Figure 3)*. The collected data consisted of grower N rates, Project SENSE in-season N rates, and yield, which were averaged by treatment strip. For each site, the average difference in N applied (lb/acre) and the average difference in yield (bu/acre) were calculated. Nitrogen use efficiency (NUE) was also calculated as partial factor productivity of N (PFP_N) (lb grain/lb N fertilizer) and as lb N applied per bushel of grain produced.

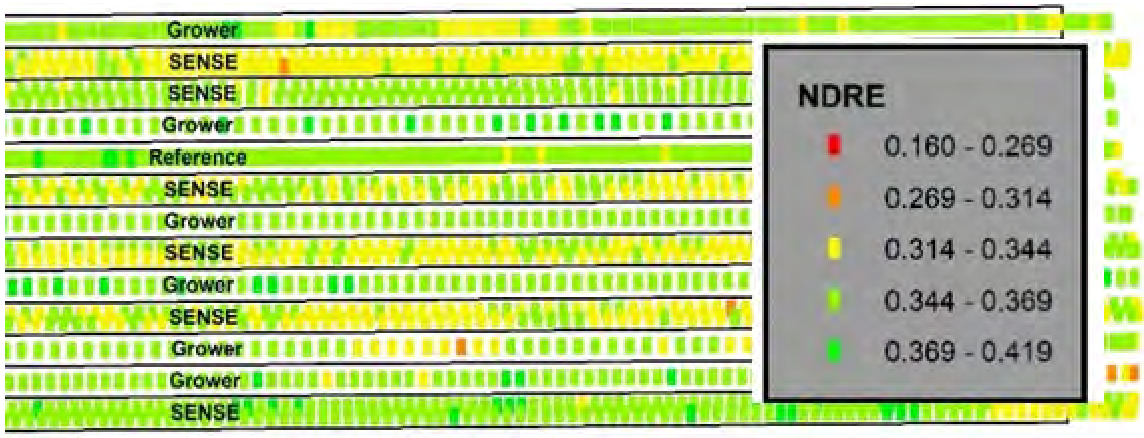


Figure 3: NDRE values recorded during sensing/application through grower, SENSE, and reference strips.

2015-2020 Irrigated Site Results

Data were analyzed using the GLIMMIX procedure in SAS 9.4 (SAS Institute Inc., Cary, NC). Mean separation was performed with Fisher's LSD. Across the 58 sites (Table 1), ***the sensor-based approach used 33 lb-N/ac less*** than the cooperating growers' approaches; the result was an ***average of 1.1 bu/ac less corn produced using the sensor-based method***. In terms of productivity and NUE, the sensor-based approach produced an additional 15.5 lb-grain/lb-N compared to the cooperator approaches. The sensor-based approach resulted in an average increase in profit compared to the grower approaches.

At higher N and corn prices ($0.65/lb-N and $3.65/bu) noted during the study, ***the sensor-based approach was $16.70/ac more profitable.*** At lower N and corn prices ($0.41/lb-N and $3.15/bu), ***the sensors were $9.40/ac more profitable compared to the grower approaches***. Input costs and crop revenues are important considerations regarding decisions about technology adoption; however, the sensors were a viable option for improving economic returns based on this study.

Table 1. Summary of 58 sites from 2015 to 2020 comparing sensor-based N management to the grower's traditional method.

Six-Year Average	SENSE	Grower
Total N rate (lb-N/ac)	159.3 B*	190.8 A
Yield (bu/ac)	216.9 B	218.0 A
Partial Factor Productivity of N (lb grain/lb-N)	81.4 A	65.9 B
Nitrogen Use Efficiency (lb-N/bu grain)	0.75 B	0.92 A
Partial Profitability ($/ac) [@3.65/bu and $0.65/lb-N]	$693.17 A	$676.44 B
Partial Profitability ($/ac) [@3.15/bu and $0.41/lb-N]	$622.20 A	$612.82 B

*Values with the same letter are not significantly different at a 95% confidence interval (SENSE vs. Grower).

Further analysis found the active crop canopy sensor treatments often performed better in sandy soil types due to high N application rates by growers compared to the optimal nitrogen rate. In addition, fields where the base nitrogen rate was lower had greater nitrogen use efficiencies in the sensor-based system. Summaries for each site from 2015 to 2019 can be found at https://cropwatch.unl.edu/on-farm-research 2020 summaries follow this section.

Figure 4 shows the overall distribution of the 58 irrigated field sites in terms of profitability and partial factor productivity of N (PFP_N). Since 2015, 64% of field sites benefitted in terms of both profit (+$28/ac) and productivity (+22 lb-grain/lb-N) from using the sensor-based approach. Another 22% of field sites showed increased productivity (+13 lb-grain/lb-N); however, profit was negatively impacted (- $14/ac). About 10% of sites exhibited less profitability (-$25/ac) coupled with less productivity (-12 lb-grain/lb-N). In irrigated production, these data indicate there is high potential for improving productivity and profitability if growers could utilize a sensor-based, in-season approach to N management.

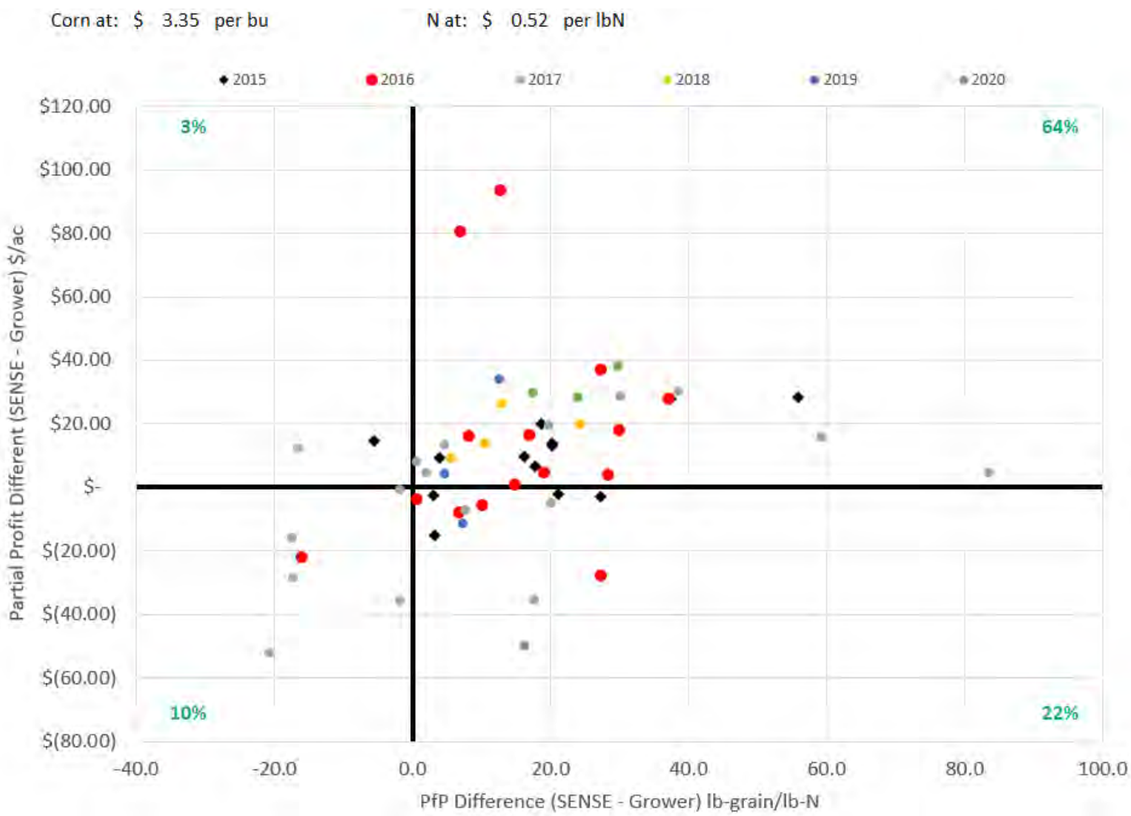


Figure 4: Profitability and nitrogen use efficiency of sensor-based N management compared to the grower's traditional management.

2019 & 2020 Non-Irrigated Site Results

Four sites in 2020 were placed on non-irrigated fields to evaluate the SENSE methodology with increased temporal and spatial variability. Five or six replications of grower and sensor-based N strips with a high N reference strip were used in the randomized complete block design just as in the irrigated sites *(Figure 2)*. N was applied between V8 and V12 growth stages and an N inhibitor was used with the UAN on the 2020 sites. Throughout the season, aerial imagery, precipitation, and soil moisture data were logged and at harvest, yield data were collected.

Table 2. Summary of nine sites from 2019 and 2020 comparing sensor-based N management to the grower's traditional method in non-irrigated corn production.

Two-Year Average	SENSE	Grower
Total N rate (lb-N/ac)	119.8 B*	149.8 A
Yield (bu/ac)	207.6 B	214.0 A
Partial Factor Productivity of N (lb grain/lb-N)	99.0 A	82.6 B
Nitrogen Use Efficiency (lb-N/bu grain)	0.58 B	0.71 A
Partial Profitability ($/ac) [@3.65/bu and $0.65/lb-N]	$680.00 B	$683.68 A
Partial Profitability ($/ac) [@3.15/bu and $0.41/lb-N]	$604.93 B	$612.64 A

*Values with the same letter are not significantly different at a 95% confidence interval (SENSE vs. Grower).

2020 Overview

Results of eight studies, four irrigated and four non-irrigated, in 2020 are in the following pages of this report. Project SENSE will continue with further emphasis on sensor-based fertigation and drone-based sensors for improved timing and accuracy. Additionally, field demonstration days will continue to be held in each NRD to showcase the equipment, teach how it is used, and present study results.

Project SENSE was made possible through support from:

Nebraska's Natural Resources Districts

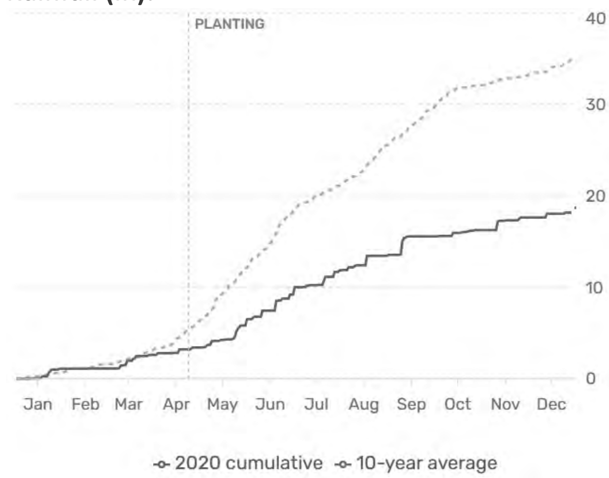
Central Platte
Little Blue
Lower Loup
Lower Platte North
Upper Big Blue

Nebraska CornBoard

USDA

Project SENSE (Sensor-based In-season N Management) on Non-irrigated Corn

Study ID: 0108155202001
County: Saunders
Soil Type: Yutan silty clay loam; Tomek silt loam; Filbert silt loam
Planting Date: 4/23/20
Harvest Date: 10/9/20
Seeding Rate: 28,000
Row Spacing (in): 30
Hybrid: DEKALB® DKC63-57 VTP2 RIB
Reps: 5
Previous Crop: Soybean
Tillage: No-Till
Herbicides: ***Pre:*** 40 oz/ac Roundup PowerMAX®, 4 oz/ac Corvus®, 19.4 oz/ac MSO, 2 pt/ac atrazine 4L, and 2.3 lb/ac AMS with 15 gal/ac water on 4/23/20
Post: 40 oz/ac Roundup PowerMAX®, 3 oz/ac Laudis®, 6 oz/ac InterLock®, 1 pt/ac atrazine 4L, 2.31 lb/ac AMS, and 19.2 oz/ac MSO with 15 gal/ac water on 6/4/20
Irrigation: None
Rainfall (in):



Soil Samples (June 2020, minimum, maximum, and average values from zone sample):

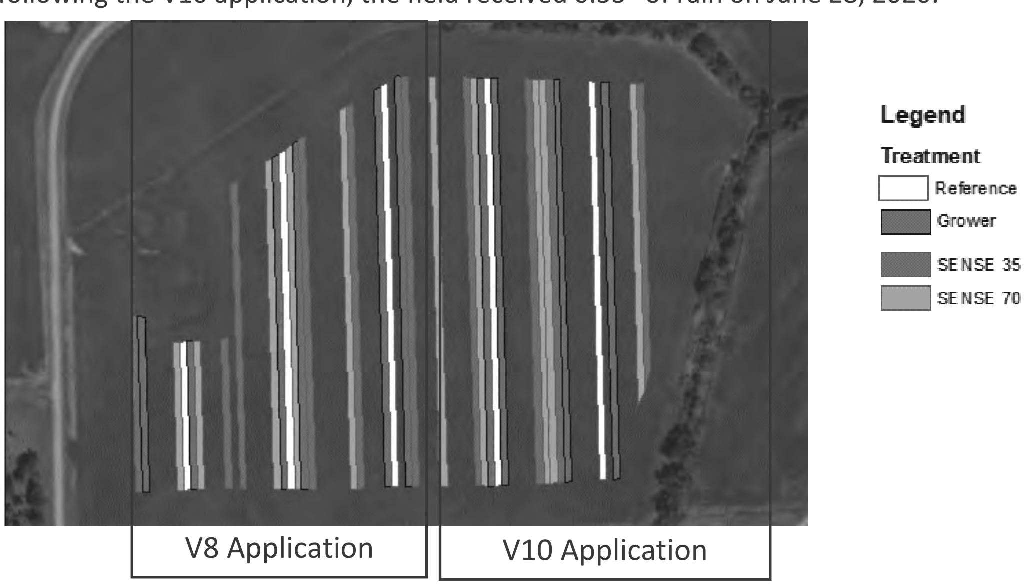
	Soil pH 1:1	BpH	OM LOI %	Nitrate – N ppm N 75 lb Base	Nitrate – N ppm N 35 lb Base	Mehlich P-III ppm P	Sulfate-S ppm S	Ammonium Acetate (ppm) K	Ca	Mg	Na	CEC me/100g	% Base Saturation H	K	Ca	Mg	Na
Min	4.7	5.9	3.5	10.9*	7.9*	13	6.7	156	1611	192	12	18	27	2	39	8	0
Max	5.6	6.4	4.6	72.7*	49.2*	157	15.4	496	2461	462	20	24.7	50	6	51	17	0
Avg	5.2	6.1	4.0	31.9*	19.1*	40.8	11.6	257	1974	303	15	21.8	39	3	45	11	0

*All samples are 0-8" depth except nitrate-N ppm N sampled at 0-24" depth

Introduction: A high-clearance applicator was equipped with Ag Leader® OptRx® sensors. UAN fertilizer was applied with drop nozzles as the crop canopy was sensed. This study compares crop canopy sensor-based in-season N application with the grower's standard N management.

Grower Nitrogen Treatment: The grower rate was 137 lb N/ac, applied as anhydrous ammonia on March 26, 2020.

Project SENSE Nitrogen Treatment: The SENSE approach evaluated two in-season application timings: V8 on June 17, 2020, and V11 on June 26, 2020. The SENSE treatments also evaluated two base rates: 35 lb/ac N and 70 lb/ac N, applied on March 26, 2020. In-season N was applied as 28% UAN with Nitrain Bullet™ pronitridine stabilizer. Following the V8 application, the field received 0.92" of rain on June 18, 2020, and following the V10 application, the field received 0.53" of rain on June 28, 2020.



Results:

Grower and Project SENSE results with V8 Project SENSE application and two base rates.

	Total N rate (lb/ac)	Yield (bu/ac)†	Partial Factor Productivity of N (lb grain/lb N)	lbs N/ bu grain	Marginal Net Return‡ ($/ac)
Grower	138 A*	220 A	89 B	0.63 A	727.70 A
Project SENSE 35 lb/ac base	120 B	212 A	100 A	0.57 B	698.13 A
Project SENSE 70 lb/ac base	120 B	217 A	101 A	0.56 B	717.92 A
P-Value	<0.0001	0.123	0.009	0.006	0.115

*Values with the same letter are not significantly different at a 90% confidence level.
†Yield values are from cleaned yield monitor data. Bushels per acre corrected to 15.5% moisture.
‡Marginal net return based on $3.51/bu corn, $0.41/lb N UAN, and $0.32/lb N anhydrous ammonia.

Grower and Project SENSE with V11 Project SENSE application and two base rates.

	Total N rate (lb/ac)	Yield (bu/ac)†	Partial Factor Productivity of N (lb grain/lb N)	lbs N/ bu grain	Marginal Net Return‡ ($/ac)
Grower	137 A	220 A	90 B	0.62 A	727.38 A
Project SENSE 35 lb/ac base	103 C	206 B	112 A	0.50 B	684.68 B
Project SENSE 70 lb/ac base	107 B	210 B	110 A	0.51 B	698.05 B
P-Value	<0.0001	0.012	<0.0001	0.0001	0.022

*Values with the same letter are not significantly different at a 90% confidence level.
†Yield values are from cleaned yield monitor data. Bushels per acre corrected to 15.5% moisture.
‡Marginal net return based on $3.51/bu corn and $0.41/lb N.

Summary:

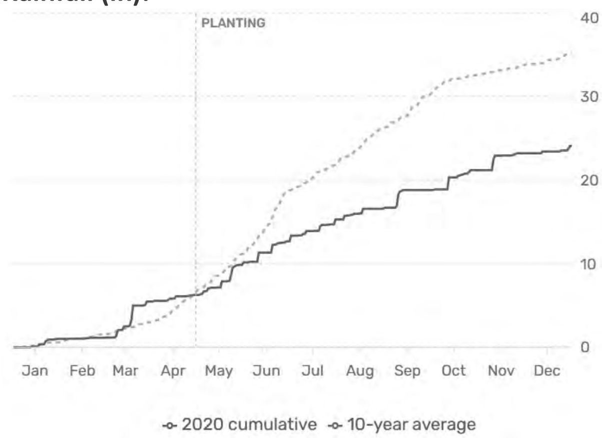
At the V8 in-season application timing, the Project SENSE treatments applied 18 lb/ac less N than the grower. There was no difference in Project SENSE total application rate based on the initial base rate. For the 35 lb/ac base rate, the sensors directed that 85 lb/ac N should be applied in-season to bring the total to 120 lb/ac. For the 70 lb/ac base rate, the sensors directed that 50 lb/ac N was applied in-season to bring the total to 120 lb/ac. There was no difference in yield or marginal net return between the grower and Project SENSE treatments with V8 timing. The Project SENSE treatments had greater nitrogen use efficiency. This indicates that with a planned in-season application at the V8 growth stage, a range of initial base rates (35-70 lb/ac N) may be acceptable.

At the V11 in-season application timing, the Project SENSE treatments applied 30-34 lb/ac less N than the grow. The Project SENSE total application rate varied slightly based on the initial base rate. For the 35 lb/ac base rate, the sensors directed that 68 lb/ac N should be applied in-season to bring the total to 103 lb/ac. For the 70 lb/ac base rate, the sensors directed that 37 lb/ac N should be applied in-season to bring the total to 107 lb/ac. Yield was 10-14 bu/ac lower for the V11 Project SENSE treatments compared to the grower treatments. Nitrogen use efficiency was greater for the Project SENSE treatments than the grower treatments. Marginal net return was lower for the Project SENSE treatments compared to the grower treatments.

Project SENSE (Sensor-based In-season N Management) on Non-irrigated Corn

Study ID: 0103053202001
County: Dodge
Soil Type: Moody silty clay loam; Alcester silty clay loam; Coleridge silty clay loam
Planting Date: 4/30/20
Harvest Date: 10/9/20
Seeding Rate: 31,000
Row Spacing (in): 30
Hybrid: Fontanelle Hybrids® 13D843
Reps: 6
Previous Crop: Soybean
Tillage: No-Till

Irrigation: None
Rainfall (in):



Soil Samples (June 2020, minimum, maximum, and average values from zone sample):

	Soil pH 1:1	BpH	OM LOI %	Nitrate – N ppm N	Mehlich P-III ppm P	Sulfate-S ppm S	Ammonium Acetate (ppm) K	Ca	Mg	Na	CEC me/100g	% Base Saturation H	K	Ca	Mg	Na
Min	5.6	6.4	3.4	2.3*	21	4.2	183	2078	418	6	19.3	0	2	50	17	0
Max	7.1	7.2	4.3	12.2*	103	7.6	378	2952	597	10	23.1	29	5	76	23	0
Avg	6.2	6.6	3.7	7.3*	44	5.5	265	2529	493	8	21.1	17	4	60	20	0

*All samples are 0-8" depth except nitrate-N ppm N sampled at 0-24" depth

Introduction: A high-clearance applicator was equipped with Ag Leader® OptRx® sensors. UAN fertilizer was applied with drop nozzles as the crop canopy was sensed. This study compares crop canopy sensor-based in-season N application with the grower's standard N management.

Grower Nitrogen Treatment: The grower rate was 124 lb N/ac, applied as 10 gal/ac UAN with the planter on April 30, 2020 (contributing 35 lb/ac N), and 25 gal/ac UAN at V6 with a coulter applicator on June 17, 2020 (contributing 87 lb/ac N).

Project SENSE Nitrogen Treatment: For the SENSE treatment strips, the base rate (prior to in-season sensing) was established with 10 gal/ac UAN with the planter on April 30, 2020 (contributing 35 lb/ac N), for a total base rate of 35 lb/ac N. Crop canopy sensing and application occurred on June 29, 2020, at the V11 growth stage. Across all Project SENSE treatments, the average N rate applied based on the in-season sensing was 88 lb N/ac, applied as 28% UAN with Nitrain Bullet™ pronitridine stabilizer. Following the application, the field received 0.71" of rain on June 30, 2020. The average total N rate was 123 lb N/ac.

This field had a cereal rye cover crop seeded at 50 lb/ac on October 20, 2019. The cover crop was terminated by herbicide on April 28, 2020, at a height of 10".

Results:

	Total N rate (lb/ac)	Yield (bu/ac)†	Partial Factor Productivity of N (lb grain/lb N)	lbs N/bu grain	Marginal Net Return‡ ($/ac)
Grower	124 A*	177 A	80 A	0.70 A	569.71 A
Project SENSE	123 A	177 A	80 A	0.70 A	570.17 A
P-Value	0.771	0.99	0.889	0.995	0.983

*Values with the same letter are not significantly different at a 90% confidence level.
†Yield values are from cleaned yield monitor data. Bushels per acre corrected to 15.5% moisture.
‡Marginal net return based on $3.51/bu corn and $0.41/lb N.

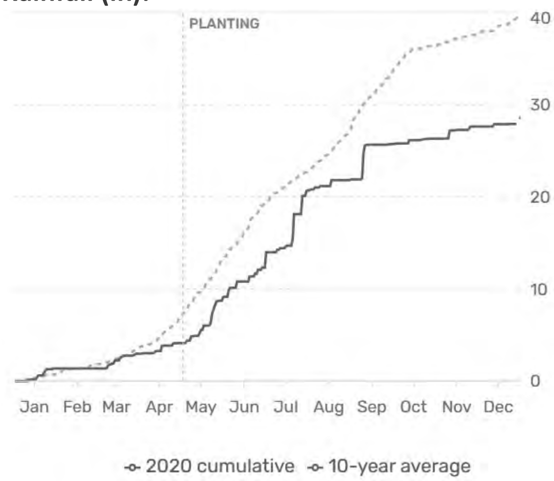
Summary:

- At this site, the grower N management and Project SENSE N management resulted in very similar total N rates.
- There were no differences in yield, partial factor productivity of N, lbs of N per bushel of grain, or profit.

Project SENSE (Sensor-based In-season N Management) on Non-irrigated Corn

Study ID: 0816025202001
County: Cass
Soil Type: Wymore silty clay loam; Judson silt loam; Yutan silty clay loam
Planting Date: 5/2/20
Harvest Date: 11/6/20
Seeding Rate: 27,000
Row Spacing (in): 30
Hybrid: DEKALB® DKC70-27 RIB
Reps: 6
Previous Crop: Soybean
Tillage: No-Till
Herbicides: ***Pre:*** 4/23/20 ***Post:*** 6/11/20
Seed Treatment: Standard Treatment
Fertilizer: 310 lb/ac ag lime

Irrigation: None
Rainfall (in):



Soil Samples (November 2019, minimum, maximum, and average values from grid sample):

	Soil pH 1:1	BpH	OM LOI %	Nitrate – N ppm N	Mehlich P-III ppm P	Sulfate-S ppm S	Zn (DPTA)	Ammonium Acetate (ppm) K	Ca	Mg	Na	CEC me/100g	% Base Saturation H	K	Ca	Mg	Na
Min	5.4	6.3	2.3	1.8	9	5	0.4	113	1580	205	11	14	0	2	44	9	0
Max	6.4	6.8	4.1	5.2	24	14	1	406	2860	627	59	74	44	6	74	24	2
Avg	5.8	6.5	2.9	3.3	14	9	0.57	197	2093	350	17	55	28	3	55	15	0.1

Introduction: A high-clearance applicator was equipped with Ag Leader® OptRx® sensors. UAN fertilizer was applied with drop nozzles as the crop canopy was sensed. This study compares crop canopy sensor-based in-season N application with the grower's standard N management.

Grower Nitrogen Treatment: The grower rate was 191 lb N/ac, applied as anhydrous ammonia on April 4, 2020 (contributing 161 lb/ac N) and 275 lb/ac 11-52-0 (contributing 30 lb/ac N).

Project SENSE Nitrogen Treatment: For the SENSE treatment strips, the base rate (prior to in-season sensing) was established with anhydrous ammonia on April 4, 2020 (contributing 40 lb/ac N), and 275 lb/ac 11-52-0 (contributing 30 lb/ac N), for a total base rate of 70 lb/ac N. Crop canopy sensing and application occurred on June 25, 2020, at the V10 growth stage. Across all Project SENSE treatments, the average N rate applied based on the in-season sensing was 55 lb N/ac, applied as 28% UAN with Nitrain Bullet™ pronitridine stabilizer. Following the application, the field received 1.59" of rain on June 28. The average total N rate was 125 lb N/ac.

Results:

	Total N rate (lb/ac)	Yield (bu/ac)†	Partial Factor Productivity of N (lb grain/lb N)	lbs N/bu grain	Marginal Net Return‡ ($/ac)
Grower	191 A*	212 A	62 B	0.90 A	668.30 A
Project SENSE	125 B	192 B	86 A	0.65 B	629.26 B
P-Value	<0.0001	<0.0001	0.0001	<0.0001	<0.0001

*Values with the same letter are not significantly different at a 90% confidence level.
†Yield values are from cleaned yield monitor data. Bushels per acre corrected to 15.5% moisture.
‡Marginal net return based on $3.51/bu corn, $0.41/lb N UAN, and $0.32/lb N anhydrous ammonia.

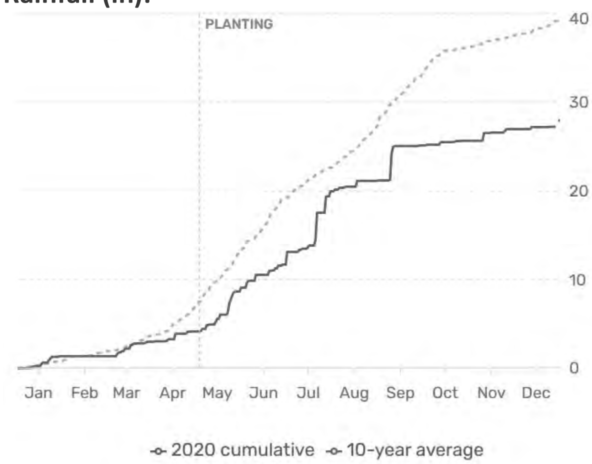
Summary:

- The Project SENSE management N rate was 66 lb/ac lower than the grower's N management.
- Yield for the Project SENSE N management was 20 bu/ac lower than the grower's N management.
- Project SENSE had better nitrogen use efficiency; Project SENSE N management used 0.25 lb/ac less N to produce a bushel of grain than the grower's method.
- Marginal net return was $39.05/ac lower for the Project SENSE N management than the grower's N management.

Project SENSE (Sensor-based In-season N Management) on Non-irrigated Corn

Study ID: 0816025202002
County: Cass
Soil Type: Otoe silty clay loam; Wymore silty clay loam
Planting Date: 5/3/20
Harvest Date: 10/28/20
Seeding Rate: 28,000
Row Spacing (in): 30
Hybrid: Renk RK945DG VT2P RIB
Reps: 6
Previous Crop: Soybean
Tillage: No-Till
Herbicides: ***Pre:*** 4/21/20 ***Post:*** 6/9/20
Foliar Insecticides: None
Foliar Fungicides: None
Fertilizer: 400 lb/ac ag lime

Irrigation: None
Rainfall (in):



Soil Samples (June 2020, minimum, maximum, and average values from zone sample):

	Soil pH 1:1	BpH	OM LOI %	Nitrate – N ppm N	Mehlich P-III ppm P	Sulfate-S ppm S	Ammonium Acetate (ppm) K	Ca	Mg	Na	CEC me/100g	% Base Saturation H	K	Ca	Mg	Na
Min	5.5	6.3	4.3	9.8*	26	7.1	155	2346	297	11	21.7	25	2	54	11	0
Max	5.8	6.4	4.6	44.9*	44	11.8	255	2901	482	13	25.4	31	3	57	16	0
Avg	5.6	6.3	4.4	23.7*	33.3	9.9	206	2601	387	12	23.6	29	2	55	13	0

*All samples are 0-8" depth except nitrate-N ppm N sampled at 0-24" depth

Introduction: A high-clearance applicator was equipped with Ag Leader® OptRx® sensors. UAN fertilizer was applied with drop nozzles as the crop canopy was sensed. This study compares crop canopy sensor-based in-season N application with the grower's standard N management.

Grower Nitrogen Treatment: The grower rate was 175 lb N/ac, applied as anhydrous ammonia on April 6, 2020.

Project SENSE Nitrogen Treatment: For the SENSE treatment strips, the base rate (prior to in-season sensing) was established with 70 lb/ac N from anhydrous ammonia on April 6, 2020. Crop canopy sensing and application occurred on June 25, 2020, at the V9 growth stage. Across all Project SENSE treatments, the average N rate applied based on the in-season sensing was 51 lb N/ac, applied as 28% UAN with Nitrain Bullet™ pronitridine stabilizer. The field received 0.08" of rain on June 28, 2020, and 1.74" on July 1, 2020. The average total N rate was 121 lb N/ac.

Results:

	Total N rate (lb/ac)	Yield (bu/ac)†	Partial Factor Productivity of N (lb grain/lb N)	lbs N/bu grain	Marginal Net Return‡ ($/ac)
Grower	175 A*	210 A	67 B	0.84 A	679.75 A
Project SENSE	121 B	214 A	99 A	0.57 B	706.29 A
P-Value	<0.0001	0.522	<0.0001	<0.0001	0.236

*Values with the same letter are not significantly different at a 90% confidence level.
†Yield values are from cleaned yield monitor data. Bushels per acre corrected to 15.5% moisture.
‡Marginal net return based $3.51/bu corn, $0.41/lb N UAN, and $0.32/lb N anhydrous ammonia.

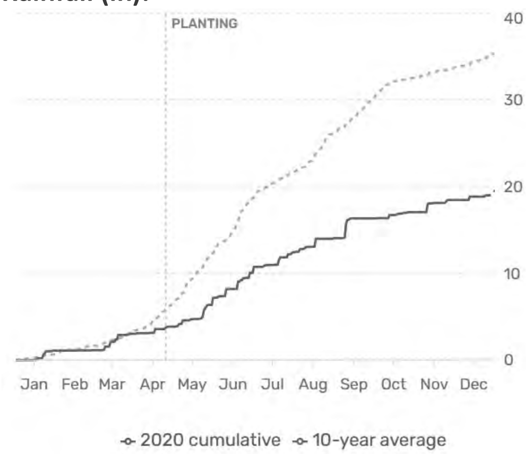
Summary:

- The Project SENSE management N rate was 54 lb/ac lower than the grower's N management.
- There was no yield difference between the Project SENSE N management and the grower's N management.
- Project SENSE had better nitrogen use efficiency; Project SENSE N management used 0.27 lb/ac less N to produce a bushel of grain than the grower's method.
- Marginal net return was $26.54/ac greater for the Project SENSE N management than the grower's N management.

Project SENSE (Sensor-based In-season N Management) on Irrigated Corn

Study ID: 0078155202001
County: Saunders
Soil Type: Yutan silty clay loam; Filbert silty clay loam; Fillmore silt loam; Scott silt loam
Planting Date: 4/25/20
Harvest Date: 10/6/20
Seeding Rate: 33,000
Row Spacing (in): 30
Hybrid: Pioneer® P1082
Reps: 6
Previous Crop: Soybean
Tillage: No-Till
Herbicides: ***Pre:*** 80 oz/ac Acuron®
Foliar Insecticides: 2.19 oz/ac Baythroid®

Irrigation: Pivot, Total: 6.5"
Rainfall (in):



Introduction: A high-clearance applicator was equipped with Ag Leader® OptRx® sensors. UAN fertilizer was applied with drop nozzles as the crop canopy was sensed. This study compares crop canopy sensor-based in-season N application with the grower's standard N management. This site was unique; in other Project SENSE study sites, a high N reference strip is established. This strip of the field receives N fertilizer levels that are non-limiting to plant growth. The strip is scanned with the sensors to calibrate the sensor algorithm prior to sensing and fertilizing the Project SENSE treatments. At this particular site, this strip was not established. Some sensor-based management protocols recommend this approach (not using a high N reference strip) and instead simply scan a portion of the field without a high N reference strip to calibrate the sensors; this site allowed us to test this approach. Without a high N reference to calibrate the sensors, the sensors operated at their set minimum application rate of 30 lbs/ac a majority of the time.

Grower Nitrogen Treatment: The grower rate totaled 154 lb N/ac. This consisted of a preplant application of 17.6 gal/ac 32% UAN (contributing 62 lb/ac N) and 3 gal/ac 12-0-0-26S thiosulfate (contributing 4 lb/ac N). A sidedress application was made on July 9 at VT growth stage and consisted of 23 gal/ac 32% UAN (contributing 80 lb/ac N) and 5.7 gal/ac thiosulfate (contributing 7 lb/ac N).

Project SENSE Nitrogen Treatment: For the SENSE treatment strips, the base rate (prior to in-season sensing) was established with 17.6 gal/ac 32% UAN and 3 gal/ac 12-0-0-26S thiosulfate, for a total base rate of 66 lb/ac N. Crop canopy sensing and application occurred on June 30, 2020, at the V12 growth stage. Across all Project SENSE treatments, the average N rate applied based on the in-season sensing was 32 lb N/ac. The field received 0.77" of rain on July 1, 2020. The average total N rate was 98 lb N/ac.

Results:

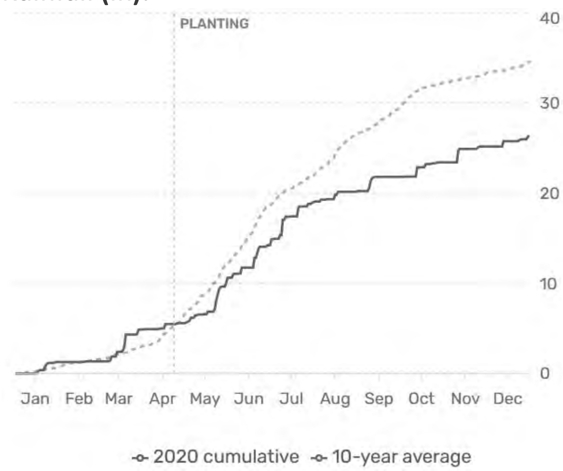
	Total N rate (lb/ac)	Yield (bu/ac)†	Partial Factor Productivity of N (lb grain/lb N)	lbs N/bu grain	Marginal Net Return‡ ($/ac)
Grower	154 A*	211 A	77 B	0.73 A	679.04 A
Project SENSE	98 B	180 B	103 A	0.55 B	592.47 B
P-Value	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001

*Values with the same letter are not significantly different at a 90% confidence level.
†Yield values are from cleaned yield monitor data. Bushels per acre corrected to 15.5% moisture.
‡Marginal net return based on $3.51/bu corn and $0.41/lb N.

Summary:
- The Project SENSE management N rate was 56 lb/ac lower than the grower's N management.
- Yield for the Project SENSE management was 31 bu/ac lower than the grower's N management.
- Project SENSE had better nitrogen use efficiency; Project SENSE N management used 0.19 lb/ac less N to produce a bushel of grain than the grower's method.
- Marginal net return was $86.57/ac lower for the Project SENSE N management than the grower's N management.
- The use of a high N reference strip is recommended for sensor calibration.

Project SENSE (Sensor-based In-season N Management) on Irrigated Corn

Study ID: 0621023202001
County: Butler
Soil Type: Brocksburg sandy loam 0-2% slope; Gibbon silty clay loam; Ovina loamy fine sand
Planting Date: 4/23/20
Harvest Date: 10/9/20
Seeding Rate: 33,000
Row Spacing (in): 30
Hybrid: Pioneer® P1366Q
Reps: 6
Previous Crop: Corn
Tillage: Ridge-Till
Herbicides: ***Pre:*** 24 oz TripleFLEX® II, 3 oz/ac Balance® Flexx, and 6 oz/ac Sterling Blue® ***Post:*** 1.3 qt/ac Resicore®, 1 qt/ac atrazine, and 32 oz/ac Roundup®
Seed Treatment: Lumivia™ 250 and Lumialza™
Foliar Insecticides: None
Foliar Fungicides: None
Irrigation: Pivot
Rainfall (in):



Introduction: A high-clearance applicator was equipped with Ag Leader® OptRx® sensors. UAN fertilizer was applied with drop nozzles as the crop canopy was sensed. This study compares crop canopy sensor-based in-season N application with the grower's standard N management.

Grower Nitrogen Treatment: The grower rate was 226 lb N/ac, applied as 100 lb/ac 11-52-0 in February 2020 (contributing 11 lb/ac N), 15 gal/ac 32% UAN with pre-emerge herbicide (contributing 53 lb/ac N), 5 gal/ac 10-34-0 in-furrow (contributing 5 lb/ac N), 7 gal/ac 8-20-5-5S-0.5Zn at planting (contributing 6 lb/ac N), 100 lb/ac 21-0-0-24 AMS (contributing 21 lb/ac N), and 40 gal/ac 32% UAN (contributing 130 lb/ac N).

Project SENSE Nitrogen Treatment: For the SENSE treatment strips, the base rate (prior to in-season sensing) was established with 100 lb/ac 11-52-0 in February 2020 (contributing 11 lb/ac N), 15 gal/ac 32% UAN with pre-emerge herbicide (contributing 53 lb/ac N), 5 gal/ac 10-34-0 in-furrow (contributing 5 lb/ac N), 7 gal/ac 8-20-5-5S-0.5Zn at planting (contributing 6 lb/ac N), and 100 lb/ac 21-0-0-24 AMS (contributing 21 lb/ac N), for a total base rate of 96 lb/ac N. Crop canopy sensing and application occurred on June 26, 2020, at the V12 growth stage. Across all Project SENSE treatments, the average N rate applied based on the in-season sensing was 59 lb N/ac. The average total N rate was 156 lb N/ac. The field received 0.13" of rain on June 28, 2020, and 0.64" of rain on June 30, 2020.

Results:

	Total N rate (lb/ac)	Yield (bu/ac)†	Partial Factor Productivity of N (lb grain/lb N)	lbs N/bu grain	Marginal Net Return‡ ($/ac)
Grower	226 A*	227 A	56 B	1.00 A	714.10 A
Project SENSE	156 B	201 B	73 A	0.77 B	649.47 B
P-Value	<0.0001	<0.0001	<0.0001	<0.0001	0.0001

*Values with the same letter are not significantly different at a 90% confidence level.
†Yield values are from cleaned yield monitor data. Bushels per acre corrected to 15.5% moisture.
‡Marginal net return based on $3.51/bu corn and $0.41/lb N.

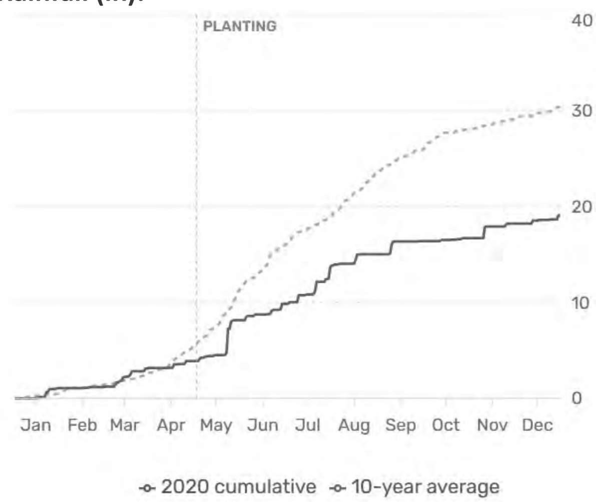
Summary:

- The Project SENSE management N rate was 70 lb/ac lower than the grower's N management.
- Yield for the Project SENSE N management was 26 bu/ac lower than the grower's N management.
- Project SENSE had better nitrogen use efficiency; Project SENSE N management used 0.22 lb/ac less N to produce a bushel of grain than the grower's method.
- Marginal net return was $64.63/ac lower for the Project SENSE N management than the grower's N management.

Project SENSE (Sensor-based In-season N Management) on Irrigated Corn

Study ID: 0715035202001
County: Clay
Soil Type: Crete silt loam 0-1% slope; Fillmore silt loam frequently ponded; Hastings silt loam 1-3% slope
Planting Date: 5/2/20
Harvest Date: 10/23/20
Seeding Rate: 32,000
Row Spacing (in): 30
Hybrid: Channel® 212-48 VT2P RIB Complete
Reps: 6
Previous Crop: Sudangrass
Tillage: Strip-till
Herbicides: ***Pre:*** 2.5 qt/ac Acuron® ***Post:*** 22 oz/ac glyphosate and 16 oz/ac atrazine 4L
Seed Treatment: Poncho® 250
Foliar Insecticides: None
Foliar Fungicides: None

Irrigation: Pivot, Total: 9.1"
Rainfall (in):



Introduction: A high-clearance applicator was equipped with Ag Leader® OptRx® sensors. UAN fertilizer was applied with drop nozzles as the crop canopy was sensed. This study compares crop canopy sensor-based in-season N application with the grower's standard N management.

Grower Nitrogen Treatment: The grower rate was 217 lb N/ac, applied as 30 gal/ac 32% UAN strip-till (contributing 106 lb/ac N), 5 gal/ac 10-34-0 in-furrow (contributing 5 lb/ac N), and 30 gal/ac 32% UAN sidedress at V8 (contributing 106 lb/ac N).

Project SENSE Nitrogen Treatment: For the SENSE treatment strips, the base rate (prior to in-season sensing) was established with 30 gal/ac 32% UAN strip-till (contributing 106 lb/ac N) and 5 gal/ac 10-34-0 in-furrow (contributing 5 lb/ac N), for a total base rate of 111 lb/ac N. Crop canopy sensing and application occurred on June 30, 2020, at the V13 growth stage. Across all Project SENSE treatments, the average N rate applied based on the in-season sensing was 39 lb N/ac. The field was irrigated following sidedress application. The average total N rate was 150 lb N/ac.

Results:

	Total N rate (lb/ac)	Yield (bu/ac)†	Partial Factor Productivity of N (lb grain/lb N)	lbs N/bu grain	Marginal Net Return‡ ($/ac)
Grower	217 A*	215 A	55 B	1.01 A	664.12 B
Project SENSE	150 B	213 A	80 A	0.71 B	686.28 A
P-Value	<0.0001	0.281	0.0001	<0.0001	0.006

*Values with the same letter are not significantly different at a 90% confidence level.
†Yield values are from cleaned yield monitor data. Bushels per acre corrected to 15.5% moisture.
‡Marginal net return based on $3.51/bu corn and $0.41/lb N.

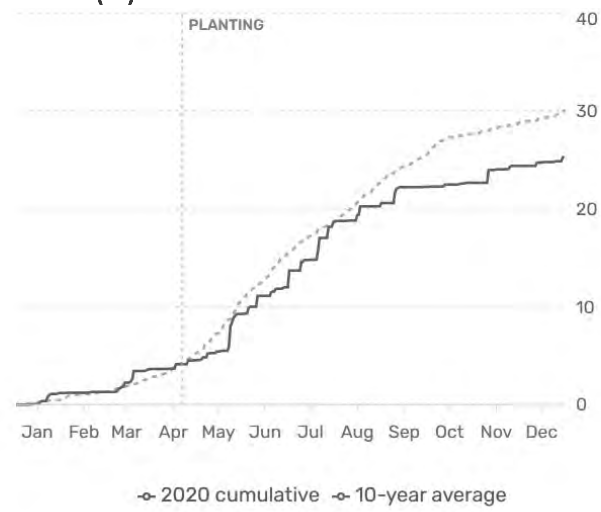
Summary:

- The Project SENSE management N rate was 67 lb/ac lower than the grower's N management.
- There was no yield difference between the N management approaches evaluated.
- Project SENSE had better nitrogen use efficiency; Project SENSE N management used 0.31 lb/ac less N to produce a bushel of grain than the grower's method.
- Marginal net return was $22.16/ac greater for the Project SENSE N management than the grower's N management.

Project SENSE (Sensor-based In-season N Management) on Irrigated Corn

Study ID: 0811185202001
County: York
Soil Type: Uly silt loam 11-30% slopes; Hastings silt loam 1-3% slope
Planting Date: 4/21/20
Harvest Date: 10/16/20
Seeding Rate: 34,000
Row Spacing (in): 30
Hybrid: Channel® 216-36 DG VT2P RIB
Reps: 6
Previous Crop: Soybean
Tillage: No-Till
Herbicides: ***Pre:*** 2 qt/ac Lexar®, 22 oz/ac Roundup®, and 8 oz/ac 2,4-D LV on 4/20/20 ***Post:*** 3.50 pt/ac Resicore®, 1 pt/ac atrazine, and 22 oz/ac Roundup® on 6/5/20
Seed Treatment: Acceleron® B-300
Foliar Insecticides: 6.4 oz/ac Brigade® on 7/31/20
Foliar Fungicides: 13.7 oz/ac Trivapro® on 7/31/20

Note: Field had 19% green snap damage from storm on 7/9/20
Irrigation: Pivot, Total: 6.5"
Rainfall (in):



Introduction: A high-clearance applicator was equipped with Ag Leader® OptRx® sensors. UAN fertilizer was applied with drop nozzles as the crop canopy was sensed. This study compares crop canopy sensor-based in-season N application with the grower's standard N management.

Grower Nitrogen Treatment: The grower rate was 205 lb N/ac, applied as 170 lb/ac N as anhydrous ammonia on April 4, 2020, and 35 lb/ac N fertigated.

Project SENSE Nitrogen Treatment: For the SENSE treatment strips, the base rate (prior to in-season sensing) was established with 40 lb/ac N as anhydrous ammonia on April 4, 2020, and 35 lb/ac N fertigated, for a total base rate of 75 lb/ac N. Crop canopy sensing and application occurred on June 24, 2020, at the V10 growth stage. Across all Project SENSE treatments, the average N rate applied based on the in-season sensing was 94 lb N/ac. The average total N rate was 169 lb N/ac.

Results:

	Total N rate (lb/ac)	Yield (bu/ac)†	Partial Factor Productivity of N (lb grain/lb N)	lbs N/bu grain	Marginal Net Return‡ ($/ac)
Grower	205 A*	266 A	73 B	0.77 A	848.27 B
Project SENSE	169 B	269 A	89 A	0.63 B	875.93 A
P-Value	<0.0001	0.298	0.0001	<0.0001	0.057

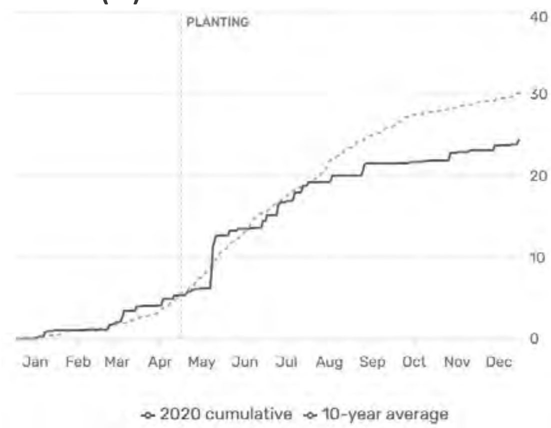
*Values with the same letter are not significantly different at a 90% confidence level.
†Yield values are from cleaned yield monitor data. Bushels per acre corrected to 15.5% moisture.
‡Marginal net return based on $3.51/bu corn and $0.41/lb N.

Summary:

- The Project SENSE management N rate was 36 lb/ac lower than the grower's N management.
- There was no yield difference between the Project SENSE N management and the grower's N management.
- Project SENSE had better nitrogen use efficiency; Project SENSE N management used 0.15 lb/ac less N to produce a bushel of grain than the grower's method.
- Marginal net return was $27.66/ac greater for the Project SENSE N management than the grower's N management.

Project SENSE (Sensor-based In-season N Management) on Irrigated Corn

Study ID: 0817081202002
County: Hamilton
Soil Type: Hastings silt loam 0-1% slope; Hastings silty clay loam 3-7% slopes, eroded; Hastings silty clay loam 7-11% slopes, eroded
Planting Date: 4/30/20
Harvest Date: 10/8/20
Seeding Rate: 33,000
Row Spacing (in): 30
Hybrid: Pioneer® P1082AM
Reps: 6
Previous Crop: Soybean
Tillage: Ridge-Till
Herbicides: ***Pre:*** 12 oz/ac Verdict®, 1 qt/ac ATRA-V™ 4L, 32 oz/ac of Abundit® Edge on 4/22/20 ***Post:*** 32 oz/ac Mountaineer®, 1 qt/ac ATRA-V™ 4L, 16 oz/ac Armezon® PRO on 6/11/20
Seed Treatment: Maxim® Quattro, Lumiflex™, Lumiante™, L-2012R, Lumivia™, Lumisure™, Lumialza™
Foliar Insecticides: 5 oz/ac Hero® on 7/18/20
Foliar Fungicides: 10 oz/ac Headline AMP® on 7/18/20
Irrigation: Pivot, Total: 10"
Rainfall (in):



Introduction: A high-clearance applicator was equipped with Ag Leader® OptRx® sensors. UAN fertilizer was applied with drop nozzles as the crop canopy was sensed. This study compares crop canopy sensor-based in-season N application with the grower's standard N management.

Grower Nitrogen Treatment: The grower rate was 210 lb N/ac, applied as 275 lb/ac 11-52-0 (contributing 30 lb/ac N), 5 gal/ac 10-34-0 in-furrow (contributing 5 lb/ac N), 10 gal/ac 32% UAN with pre-emerge herbicide (contributing 35 lb/ac N), and 140 lb/ac N as anhydrous ammonia.

Project SENSE Nitrogen Treatment: For the SENSE treatment strips, the base rate (prior to in-season sensing) was established with 275 lb/ac 11-52-0 (contributing 30 lb/ac N), 5 gal/ac 10-34-0 in-furrow (contributing 5 lb/ac N), 10 gal/ac 32% UAN with pre-emerge herbicide (contributing 35 lb/ac N), for a total base rate of 70 lb/ac N. Crop canopy sensing and application occurred on July 1, 2020, at the V12 growth stage. Across all Project SENSE treatments, the average N rate applied based on the in-season sensing was 80 lb N/ac. The field received 0.3" of rain the following day, July 2, 2020. The average total N rate was 150 lb N/ac.

Results:

	Total N rate (lb/ac)	Yield (bu/ac)†	Partial Factor Productivity of N (lb grain/lb N)	lbs N/bu grain	Marginal Net Return‡ ($/ac)
Grower	210 A*	259 A	69 B	0.81 A	823.73 B
Project SENSE	150 B	257 A	96 A	0.59 B	840.37 A
P-Value	<0.0001	0.179	<0.0001	<0.0001	0.026

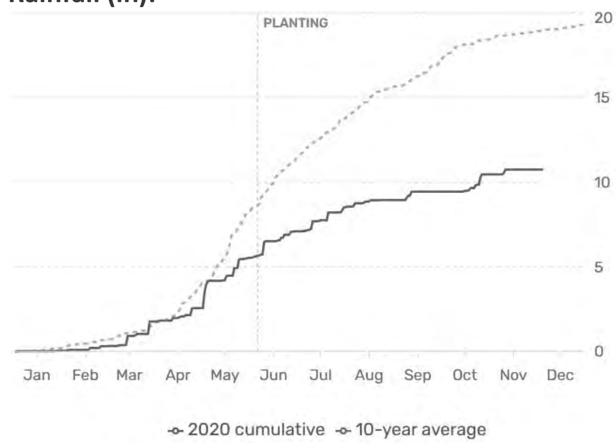
*Values with the same letter are not significantly different at a 90% confidence level.
†Yield values are from cleaned yield monitor data. Bushels per acre corrected to 15.5% moisture.
‡Marginal net return based on $3.51/bu corn and $0.41/lb N.

Summary:

- The Project SENSE management N rate was 60 lb/ac lower than the grower's N management.
- There was no yield difference between the N management approaches evaluated.
- Project SENSE had better nitrogen use efficiency; Project SENSE N management used 0.23 lb/ac less N to produce a bushel of grain than the grower's method.
- Marginal net return was $16.64/ac greater for the Project SENSE N management than the grower's N management.

Impact of Verdesian N-Charge® Inoculant on Dry Edible Beans

Study ID: 0152013202001
County: Box Butte
Soil Type: Alliance-Rosebud loam 3-6% slopes; Keith loam 1-3% slope; Keith loam 3-6% slopes
Planting Date: 6/5/20
Harvest Date: 9/22/20
Population: 102,880
Row Spacing (in): 15
Variety: Torreon pinto beans
Reps: 6
Previous Crop: Corn
Tillage: Double disked and rolled before planting
Herbicides: ***Pre:*** 30 oz/ac Prowl®, 15 oz/ac Outlook®, 64 oz/ac Roundup® on 5/29/20 ***Post:*** 4 oz/ac Raptor®, 30 oz/ac Basagran®, 10 oz/ac Select® on 6/8/20
Seed Treatment: Apron XL®, Maxim®, Rancona®, Vibrance®, Cruiser®
Foliar Insecticides: None
Foliar Fungicides: None
Irrigation: Pivot, Total: 12"
Rainfall (in):



Soil Samples (September 2020)

pH	OM %	Nitrate – N lb/ac (0-8”)	Nitrate – N lb/ac (8-36”)	Bicarb P ppm	Sulfate-S ppm S	DPTA (ppm) Zn	Fe	Mn	Cu	Ammonium Acetate (ppm) K	Ca	Mg	Na	CEC me/100g	% Base Saturation H	K	Ca	Mg	Na
8.2	1.3	17	39	11	10	3	4.4	2.3	0.3	507	2440	268	49	15.9	0	8	77	14	1

Introduction: This study evaluated Verdesian N-Charge® inoculant on dry edible bean production. The active ingredient is *Rhizobium leguminosarum* biovar *phaseoli.* The dry inoculant was thoroughly blended with seed in the planter box before planting at a rate of 2.5 oz per 50 lb of seed. The field experienced a serious hail event on July 9 resulting in 50% leaf loss. The dry edible beans were direct harvested on September 22 at a temperature of 85°F and 26% relative humidity.

Results:

	Stand Count (plants/ac)	Pods > 2" Above Ground (%)	Harvest Loss (bu/ac)	Small (%)	Moisture (%)	Density (lb/bu)	Seeds per lb	Yield (bu/ac)†	Marginal Net Return‡ ($/ac)
No inoculant	102,880 A*	82 A	4.9 A	3 A	10.8 A	61.1 A	1,308 A	38.2 A	550.38 A
Verdesian N-Charge® Inoculant	91,191 B	82 A	4.8 A	3 A	10.8 A	60.6 A	1,282 A	37.8 A	541.65 A
P-Value	0.011	0.597	0.924	0.346	0.928	0.293	0.653	0.603	0.515

*Values with the same letter are not significantly different at a 90% confidence level.
†Bushels per acre corrected to 14% moisture and adjusted for clean yield (% splits, % small, and % foreign material removed).
‡Marginal net return based on $24/cwt ($14.40/bu at 60lb/bu) and inoculant cost of $2.13/ac.

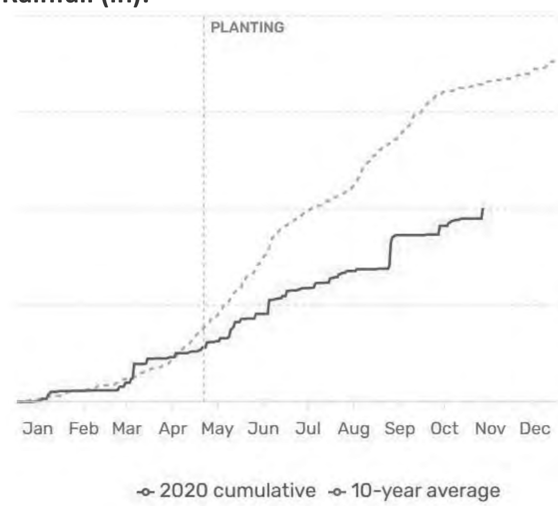
Summary:

- Beans with inoculant had a lower stand count of 91,181 plants/ac compared to 102,880 plants/ac for the non-treated beans.
- The use of the inoculant treatment did not result in statistically significant differences in harvest loss, percent of pods greater than 2" above the ground, percent small beans, moisture, density, seeds per lb, yield, or marginal net return.

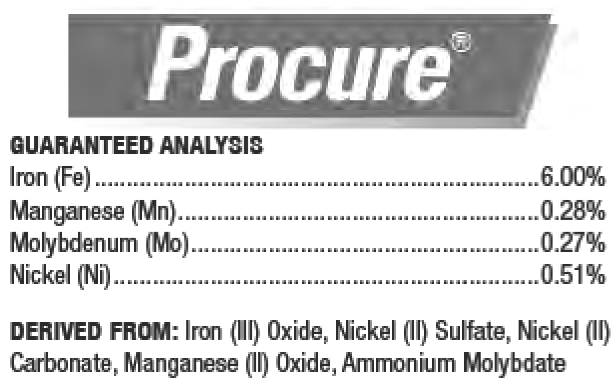
Non-Traditional Products

Impact of Agnition Procure® on Soybeans

Study ID: 0018177202002
County: Washington
Soil Type: Moody silty clay loam
Planting Date: 5/6/20
Harvest Date: 10/1/20
Population: 165,000
Row Spacing (in): 30
Hybrid: Asgrow® AG29X9
Reps: 9
Previous Crop: Corn
Tillage: No-Till
Herbicides: ***Pre:*** 1.5 pts/ac trifluralin HF ***Post:*** 46 oz/ac Flexstar® GT; 6.4 oz/ac Cornbelt® Trophy Gold™; 7.7 oz/ac Volunteer®
Seed Treatment: Acceleron®
Foliar Insecticides: None
Foliar Fungicides: None
Fertilizer: 4 gal/ac of starter (analysis of 6.2 N, 20.9 P, 5.0 K, 3.4 S) applied in-furrow with a FurrowJet applied through the wings (2 gal/ac through each wing) and placed 1" above and 3/4" to each side of the seed); 300 lb/ac pell lime broadcast
Irrigation: None
Rainfall (in):



Introduction: The purpose of this study was to evaluate the impact of Agnition Procure® on soybean yield and net return. Procure® was developed to increase nitrogen fixation in soybeans, increase nodulation, improve root mass, and improve yield potential. In this study, Procure® was applied with starter fertilizer at a rate of 1.5 pt/ac. The product label is below.


Procure®

GUARANTEED ANALYSIS
Iron (Fe)....................6.00%
Manganese (Mn)....................0.28%
Molybdenum (Mo)....................0.27%
Nickel (Ni)....................0.51%

DERIVED FROM: Iron (III) Oxide, Nickel (II) Sulfate, Nickel (II) Carbonate, Manganese (II) Oxide, Ammonium Molybdate

Product information from Agnition

Results:

	Early Season Stand Count (plants/ac)*	Test Weight (lb/bu)	Moisture (%)	Yield (bu/ac)†	Marginal Net Return‡ ($/ac)
Check	158,105 A*	56 A	7.3 A	47 A	450.35 A
Procure	158,169 A	56 A	7.3 A	47 A	435.35 A
P-Value	0.982	0.901	0.247	0.936	0.133

*Values with the same letter are not significantly different at a 90% confidence level.
†Bushels per acre adjusted to 13% moisture.
‡Marginal net return based on $9.50/bu soybean and $9.50/pt Procure.

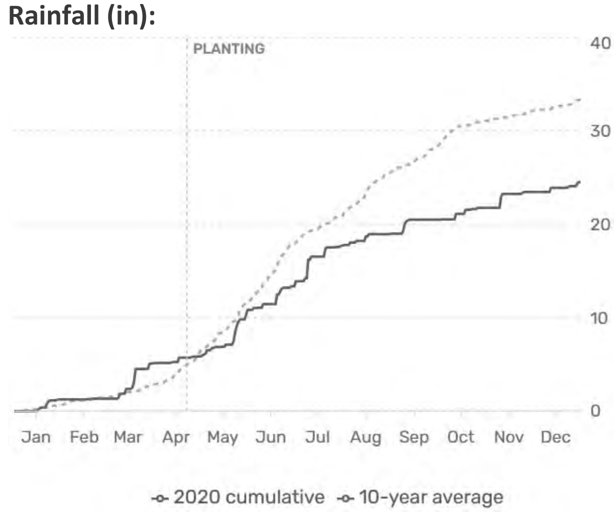
Summary: There were no statistically significant differences in V1 stand counts, test weight, moisture, yield, or net return between the Procure® treatment and the untreated check.

This study was sponsored in part by Ralco Nutrition, Inc.

Impact of Agnition Procure® on Corn

Study ID: 0085141202001
County: Platte
Soil Type: Boel fine sandy loam
Planting Date: 4/22/20
Harvest Date: 9/28/20
Seeding Rate: 36,000
Row Spacing (in): 30
Hybrid: DEKALB® DKC60-87
Reps: 8
Previous Crop: Soybean
Tillage: Ridge-Till 4/22/20, rolling stalk chopper
Herbicides: ***Pre:*** 2 qt/ac Degree Xtra®, 32 oz/ac Roundup PowerMAX®, 4 oz/ac Sterling Blue®, 2 oz/ac Balance® Flexx on 4/24/20 ***Post:*** 32 oz/ac Roundup PowerMAX®, 8 oz/ac atrazine, 3 oz/ac Laudis®, and 40 oz/ac Warrant® on 6/6/20
Seed Treatment: Acceleron®
Foliar Insecticides: None
Foliar Fungicides: 2 oz/ac Stratego® YLD on 6/6/20

Fertilizer: 50 lb/ac MicroEssentials® ZH™ (12-40-0-10S-1Zn) and 100 lb/ac 0-0-60 on 4/1/20; 4.5 gal/ac Kugler LS 624 6-24-6-1Zn, 1 pt/ac Zn, and 1 pt/ac Kugler KS MicroMax in-furrow on 4/22/20; 10 gal/ac of a 90:10 mix of 32% UAN and thiosulfate dribbled on top on 4/22/20; 121 lb/ac N as 32% UAN and 4 gal/ac 12-0-0-26 sidedressed with y-drops on 6/1/20
Irrigation: Gravity, Total: 8"
Rainfall (in):



Soil Test (November 2020):

		OM	Nitrate –	Bray P1	Bray P2	Sulfate-S	Zn	Ammonium Acetate (ppm)				CEC	% Base Saturation				
pH	BpH	LOI %	N ppm N	ppm P	ppm P	ppm S	(DPTA)	K	Ca	Mg	Na	me/100g	H	K	Ca	Mg	Na
6.2	6.9	1.5	11	48	75	10	8.6	300	1075	126	23	8.3	12	9.3	64.8	12.7	1.2

Introduction: This study evaluated Agnition Procure® on corn. Procure® was applied at a rate of 2 pt/ac with starter fertilizer. The product label is below.

GUARANTEED ANALYSIS
Iron (Fe)..6.5%
Zinc (Zn)..0.55%
Molybdenum (Mo)..............................0.30%

DERIVED FROM: Iron (III) Oxide, Zinc Carbonate, Zinc Sulfate, Ammonium Molybdate

Results:

	Stand Count (plants/ac)	Moisture (%)	Yield (bu/ac)†	Marginal Net Return‡ ($/ac)
Check	29,063 A*	19.4 A	215 A	752.86 A
Procure	28,500 A	19.5 A	215 A	735.55 B
P-Value	0.182	0.567	0.447	0.0001

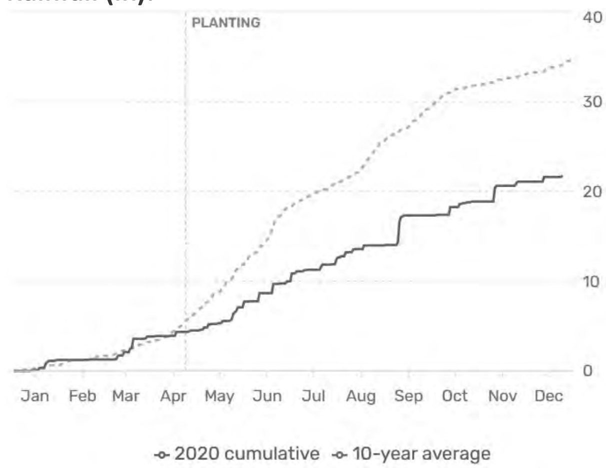
*Values with the same letter are not significantly different at a 90% confidence level.
†Bushels per acre adjusted to 15.5% moisture.
‡Marginal net return based on $3.51/bu corn and $19/ac for Procure®.

Summary:
- There were no differences in stand counts, moisture, or yield between the Procure® and untreated check.
- The use of Procure® resulted in a $17.31/ac decrease in net return.

This study was sponsored in part by Ralco Nutrition, Inc.

Effects of Ascend® SL on Dryland Corn Yield in Two Yield Zones

Study ID: 0029053202001
County: Dodge
Soil Type: Moody silty clay loam 0-2% slope; Moody silty clay loam 2-6% slopes
Planting Date: 4/23/20
Harvest Date: 10/19/20
Seeding Rate: 28,830
Row Spacing (in): 30
Hybrid: Hoegemeyer® 8028 AM™
Reps: 7
Previous Crop: Soybean
Tillage: No-Till
Herbicides: ***Pre:*** 2 qt/ac Bicep II Lite Magnum®, 0.17 qt/ac atrazine, 0.67 pt/ac 2,4-D LV6 ***Post:*** 32 oz/ac Roundup®, 3 oz/ac Explorer™
Seed Treatment: Fungicide
Foliar Insecticides: None
Foliar Fungicides: None
Fertilizer: 159 lb/ac N as NH_3, 5.7 gal/ac 10-34-0
Irrigation: None
Rainfall (in):



Introduction: This study evaluated Ascend® SL, a plant growth regulator developed to support cell division, leaf expansion, and root formation. Ascend® SL contains cytokinin, gibberellic acid, and indole-3-butyric acid. Ascend® SL was applied in-furrow with starter fertilizer. The field was divided into two productivity zones based on historical yields and electrical conductivity (EC) data (Figure 1). Zone 1 includes cooler, wetter low spots in the field with historically lower yields. Zone 2 includes the higher elevations in the field with historically higher yields. The producer was interested in determining if Ascend® SL would provide more benefit in the cooler, wetter spots in the field through increased root formation. Stand counts, moisture, yield, and net return were evaluated.

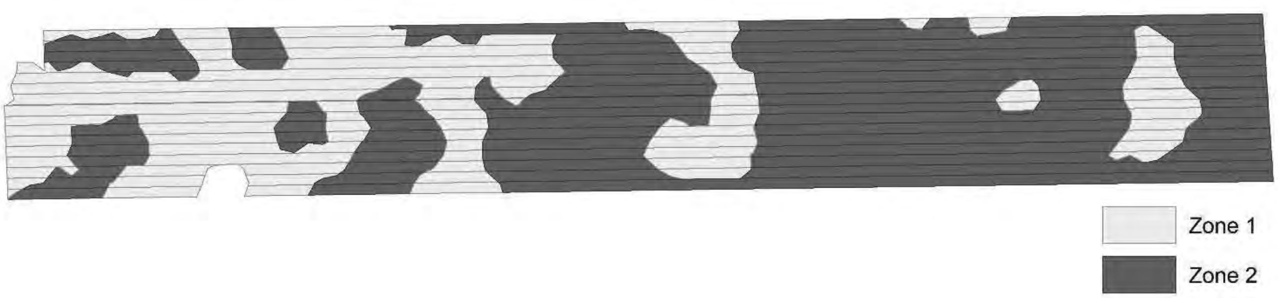


Figure 1. Map of two productivity zones. Zone 1 includes cooler, wetter low spots with lower historic yield. Zone 2 includes higher areas with historically higher yields.

Yield data were analyzed with a main-plot factor of productivity zone and sub-plot factor of treatment (Ascend® SL versus check). There was no interaction effect of zone and treatment. Yield differed by zone and treatment; therefore, zone and treatment were analyzed separately (Table 1, Figure 2).

Results:

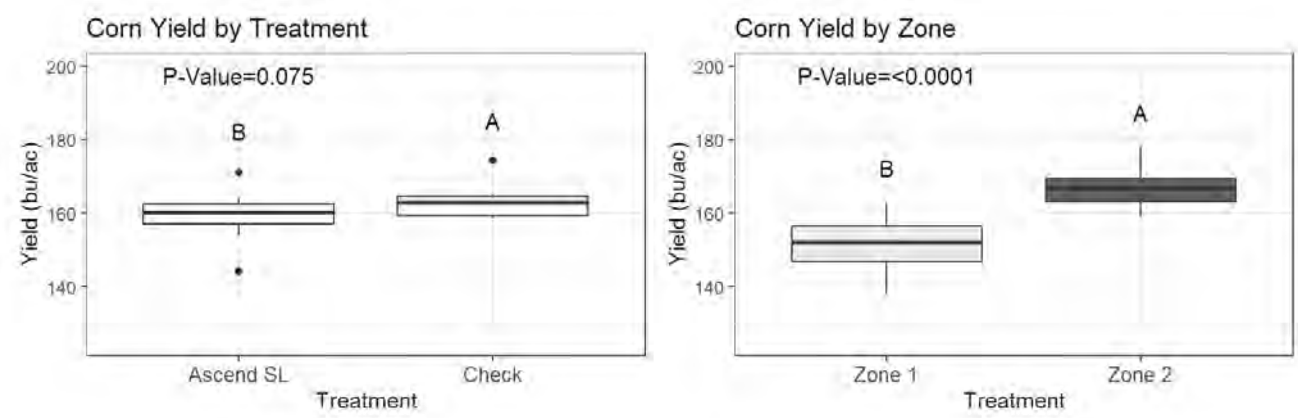


Figure 2. Corn yield by treatment and corn yield by management zone.

Table 1. Early season stand counts, moisture, yield, and marginal net return for check and Ascend® SL treatments averaged across productivity zone.

	Early Season Stand Count (plants/ac)	Moisture (%)	Yield (bu/ac)†	Marginal Net Return‡ ($/ac)
Check	25,869 A*	12.5 A	163 A	573.53 A
6.3 oz/ac Ascend® SL	26,464 A	12.4 A	159 B	547.59 B
P-Value	0.215	0.318	0.075	0.009

*Values with the same letter are not significantly different at a 90% confidence level.
†Yield values are from cleaned yield monitor data. Bushels per acre adjusted to 15.5% moisture.
‡Marginal net return based on $3.51/bu corn and $11.32/ac Ascend SL.

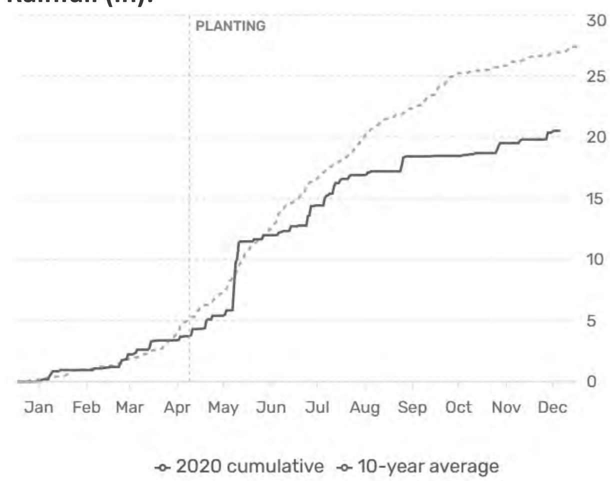
Summary:

- There was no difference in stand count between the two treatments.
- The use of Ascend® SL reduced yield by 4 bu/ac and reduced profit by $25.94/ac compared to the check.
- Zone 2 had significantly higher yields than zone 1. Zone 2 averaged 167 bu/ac compared to 151 bu/ac for zone 1.

Impact of Ag Concepts® AgZyme® with In-Furrow Starter

Study ID: 1120019202001
County: Buffalo
Soil Type: Uly silt loam 6-11% slopes; Holdrege silt loam 6-11% slopes; Coly silt loam 6-11% slopes
Planting Date: 4/23/20
Harvest Date: 10/21/20
Seeding Rate: 34,000
Row Spacing (in): 30
Hybrid: Channel® 213-19VT2RIB
Reps: 7
Previous Crop: Corn
Tillage: Strip-Till
Herbicides: ***Pre:*** 1.5 qt/ac Degree Xtra®, 3 oz/ac mesotrione, 1% COC, and 8.5 lb AMS per 100 gal water ***Post:*** 1.5 qt/ac Resicore®, 1 pt/ac atrazine, 32 oz/ac Roundup PowerMAX®, and 8.5 lb AMS per 100 gal water
Foliar Insecticides: None
Foliar Fungicides: Delaro® at VT

Fertilizer: 33-40-0-11S-1Zn through strip-till; 3 gal/ac 10-34-0 in-furrow and 12 gal/ac 32% UAN as starter on 4/23/20; 51 gal/ac 32% UAN through fertigation
Note: Green snap on 7/9/20
Irrigation: Pivot
Rainfall (in):



Soil Tests (April 2020):

pH	Soluble Salts	Excess Lime	% OM	Nitrate	Nitrate	P	K	S	Zn	Fe	Mn	Cu
				ppm	lb/ac	-------	-------	-------	ppm	-------	-------	-------
6.6	0.16	None	3.6	8.5	26	35	336	7.6	1.77	15.1	3.7	0.4

Introduction: The objective of this study was to evaluate Ag Concepts® AgZyme®. The product information notes the product will activate the microbial potential of the soil to increase nutrient uptake. The study evaluated 3 gal/ac 10-34-0 in-furrow at planting (check) compared to 3 gal/ac 10-34-0 with 12.8 oz/ac AgZyme® in-furrow at planting. Stand counts, moisture, yield, and net return were evaluated.

Results:

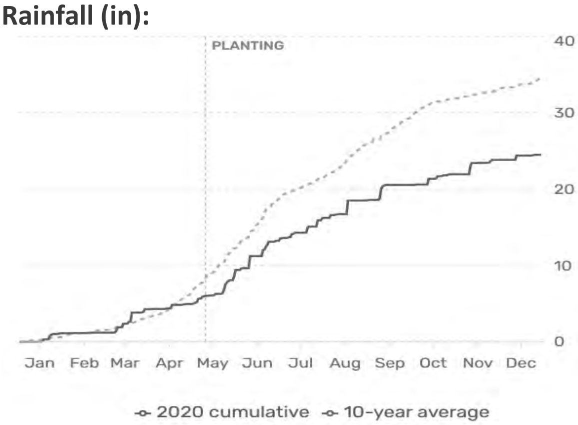
	Early Season Stand Count (plants/ac)	Harvest Stand Count (plants/ac)	Moisture (%)	Yield (bu/ac)†	Marginal Net Return‡ ($/ac)
Check	32,952 A*	30,571 A	15.2 A	248 A	868.98 A
12.8 oz/ac AgZyme®	33,381 A	30,714 A	15.1 A	249 A	863.49 A
P-Value	0.306	0.884	0.308	0.207	0.209

*Values with the same letter are not significantly different at a 90% confidence level.
†Bushels per acre adjusted to 15.5% moisture.
‡Marginal net return based on $3.51/bu corn and $11/ac for AgZyme.

Summary: The use of Ag Concepts® AgZyme® did not result in differences in stand counts, corn moisture, yield, or net return.

Impact of Humic Growth Solutions' Diamond Grow® Humi[K] WSP In-Furrow Treatment

Study ID: 0129155202003
County: Saunders
Soil Type: Alda fine sandy loam, occasionally flooded
Planting Date: 5/10/20
Harvest Date: 11/3/20
Seeding Rate: 32,400
Row Spacing (in): 30
Hybrid: Pioneer® P1108Q
Reps: 4
Previous Crop: Corn
Tillage: Stalk chopping May 5, 2020
Herbicides: ***Pre:*** 2 qt/ac Vilify™ and 24 oz/ac Roundup® on 5/16/20 ***Post:*** 32 oz/ac Roundup®, 1.25 pt/ac Resicore®, 1 pt/ac AAtrex®, and 2.5 lb/ac AMS on 6/16/20
Insecticides: 5 oz/ac Capture® at planting; Brigade® 2 EC aerially applied
Foliar Fungicides: Veltyma™ aerially applied
Irrigation: Pivot, Total: 8.5"
Rainfall (in):



Soil Test (December 2019):

Soil pH	Soluble Salts mmhos/cm	Na ppm	OM %	Nitrate N ppm	Bray P1 ppm	K ppm	Mg ppm	Ca ppm	S ppm	Zn ppm	Mn ppm	Cu ppm	Fe ppm	B ppm	Bulk Density
6.8	0.2	12.0	1.5	3.6	30	133	112	1483	5	0.8	6.6	0.3	52.9	0.2	1.4
6.6	0.2	12.0	1.3	4.9	23	183	121	1422	5	1.4	6.9	0.4	50.2	0.2	1.4

Introduction: This study evaluated Humic Growth Solutions' Diamond Grow® Humi[K] WSP in-furrow treatment. Humi[K] contains 12% potassium and 60-65% humic acid (with ISO/Lamar/AOAC/IHSS methods). Product information is available at: https://humicgrowth.com/product/humic-acid-powder/.

The check treatment included the following:

- In-furrow application of 3 gal/ac 10-34-0 + 1 pint ammoniated zinc + 1 gallon/ac water
- 2x2x2 placement application of 5 gal/ac 32% UAN + 15 gal/ac 10-34-0 + 1 gal/ac thiosulfate + 2 gal/ac water
- V8 sidedress application of 44 gal/ac 32% UAN + 2.7 gal/ac thiosulfate + 3 gal/ac water

The Humi[K] treatment applied the same fertilizer, but replaced the water with Humi[K]:

- In-furrow application of 3 gal/ac 10-34-0 + 1 pint ammoniated zinc + 1 gallon/ac Humi[K]
- 2x2x2 placement application of 5 gal/ac 32% UAN + 15 gal/ac 10-34-0 + 1 gal/ac thiosulfate + 2 gal/ac Humi[K]
- V8 sidedress application of 44 gal/ac 32% UAN + 2.7 gal/ac thiosulfate + 3 gal/ac Humi[K]

Both treatments also received 7.5 gal/ac 32% UAN with herbicide application on 5/16/20 and 52 lb/ac N through the center pivot. Stand counts, yield, test weight, grain moisture, and net return were evaluated.

Results:

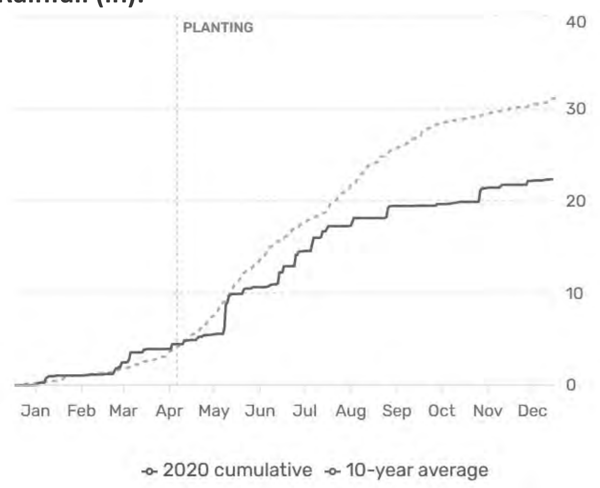
	Stand Count (plants/ac)	Moisture (%)	Test Weight (lb/bu)	Yield (bu/ac)†	Marginal Net Return‡ ($/ac)
Check	33,332 A*	15.8 A	60 A	278 A	975.73 A
Humi[K]	34,060 A	15.9 A	59 A	280 A	961.85 B
P-Value	0.342	0.707	0.160	0.242	0.066

*Values with the same letter are not significantly different at a 90% confidence level.
†Bushels per acre adjusted to 15.5% moisture.
‡Marginal net return based on $3.51/bu corn and $21/ac Humi[K].

Summary: There was no difference in stand count, moisture, test weight, and yield between the check and the Humi[K] treatment. The Humi[K] resulted in a $13.88/ac reduction in net return.

Impact of AgXplore® HumaPak™ In-Furrow Treatment

Study ID: 1050081202001
County: Hamilton
Soil Type: Hastings silt loam; Crete silt loam
Planting Date: 4/20/20
Harvest Date: 10/15-16/20
Seeding Rate: 32,500
Row Spacing (in): 36
Hybrid: DEKALB® DKC70-27 VT2
Reps: 4
Previous Crop: Soybean
Tillage: Ridge-Till
Herbicides: 5.5 oz/ac Corvus®, 32 oz/ac atrazine, 22 oz/ac Roundup®, and 1.5 lb/ac AMS on 5/6/20
Seed Treatment: Acceleron® 250
Foliar Insecticides: None
Foliar Fungicides: 8 oz/ac Delaro® aerial applied on 7/22/20
Fertilizer: 190 lb/ac N as anhydrous ammonia on 11/19/19, 4 gal/ac 7-23-4-zinc in-furrow on 4/20/20, 150 lb/ac MESZ was applied the fall of 2019
Note: 11% green snap on 7/9/20
Irrigation: Gravity, Total: 11"
Rainfall (in):



Soil Test (October 2019, 0-8" depth):

OM %	Bray P1 ppm	Bray P2 ppm	K ppm	Mg ppm	Ca ppm	pH	BpH	CEC me/100g	K%	Mg%	Ca%	H%	Nitrate-N ppm	Nitrate-N lb/ac	S ppm	Zn ppm
2.7	10	28	271	214	1852	6.4	6.8	12.9	5.4	13.8	71.8	9.0	7	17	6	1.9
2.8	10	23	282	238	2051	6.4	6.8	14.3	5.1	13.9	71.7	9.3	7	17	6	1.9
2.9	11	25	330	334	2317	6.3	6.7	17.0	5.0	16.4	68.1	10.5	9	22	5	1.3
3.1	23	56	340	294	2289	6.5	6.8	16	5.4	15.3	71.5	7.8	10	24	6	2.1

Introduction: This study evaluated AgXplore® HumaPak™ in-furrow treatment. HumaPak™ contains 8% nitrogen, 0.1% copper, and 6% humic acids derived from leonardite. HumaPak™ was applied at a rate of 32 oz/ac in-furrow. Stand counts, yield, grain moisture, and net return were evaluated.

Results:

	Harvest Stand Count (plants/ac)	Moisture (%)	Yield (bu/ac)†	Marginal Net Return‡ ($/ac)
Check	32,125 A*	18.4 A	252 A	884.01 A
HumaPak (32 oz/ac)	31,250 A	18.4 A	249 A	870.53 A
P-Value	0.162	0.877	0.353	0.226

*Values with the same letter are not significantly different at a 90% confidence level.
†Yield values are from cleaned yield monitor data. Bushels per acre adjusted to 15.5% moisture.
‡Marginal net return based on $3.51/bu corn and $3.75/ac for HumaPak.

Summary: There was no difference in stand count, moisture, yield, or net return between the untreated check and the HumaPak treatment. The study will continue in future years with the treatments applied to the same areas in order to document long-term impacts.

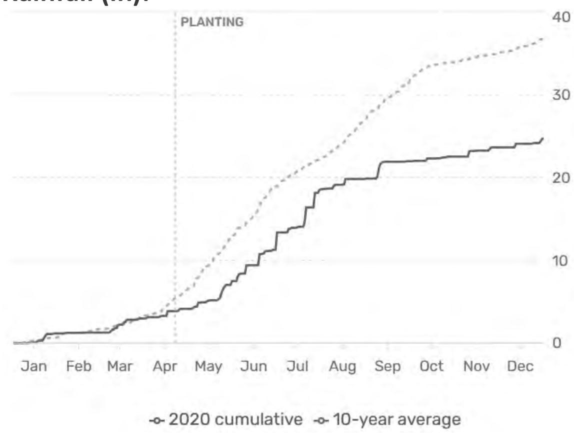
COVER CROPS

NRCS DEMO FARMS:

Non-irrigated Corn Planted into Living Cereal Rye Cover Crop

Study ID: 0136109202001
County: Lancaster
Soil Type: Yutan silty clay loam; Judson silt loam; Aksarben silty clay loam
Planting Date: 4/22/20
Harvest Date: 10/24/20
Seeding Rate: 30,000
Row Spacing (in): 30
Hybrid: Pioneer® P1563AM
Reps: 8
Previous Crop: Soybean
Tillage: No-Till
Fertilizer: 176 lb/ac N as NH_3 applied 11/19/19

Irrigation: None
Rainfall (in):



Introduction: This study evaluate the impact of a rye cover crop. The two treatments were a rye cover crop and a no cover crop control. This is the third year of the study with cover crop strips established in the same location each year. Elbon cereal rye was seeded at 40 lb/ac on November 3, 2019. Corn was planted on April 22, 2020. The cover crop was terminated May 5, 2020, with Roundup® and Bicep® at a height of 6".

Results:

	Corn Yield (bu/ac)†	Marginal Net Return‡ ($/ac)
Check	197 A*	690.15 A
Cover Crop - Rye	184 B	630.40 B
P-Value	0.0002	<0.0001

†Bushels per acre corrected to 15.5% moisture.
*Values with the same letter are not significantly different at a 90% confidence level.
‡Marginal net return based on $3.51/bu corn and $15/ac cover crop seed and drilling cost.

Summary: Corn yield following the cover crop was 13 bu/ac lower than corn yield following the no cover crop control. Net return for the corn crop was reduced by $60/ac where the cover crop was used.

Summary of Previous Years

YEAR ONE | In year one (2018), the rye cover crop was drilled at a rate of 40 lb/ac on November 1, 2017, following soybean harvest. Rye was terminated with glyphosate in mid-May at a height of approximately 12”. Corn was planted into the strips on April 23, 2018, with 5 gal/ac of 10-34-0 starter fertilizer.

	Moisture (%)	Corn Yield† (bu/ac)	Marginal Net Return‡ ($/ac)
Check	15.5 B*	213 A	686.95 A
Cover Crop - Rye	15.9 A	208 B	656.99 B
P-Value	<0.0001	0.0099	0.0004

*Values with the same letter are not significantly different at a 90% confidence level.
†Bushels per acre corrected to 15.5% moisture.
‡Marginal net return based on $3.23/bu corn, $7.67/ac rye cover crop seed, and $6/ac for drilling cover crop.

YEAR TWO | In year two (2019), the rye cover crop was drilled at a rate of 40 lb/ac on November 1, 2018, following corn harvest. The rye was terminated with Roundup® on May 20, 2019, at a height of 14-18” high and 20-40% headed. Soybeans were planted into the strips on May 15, 2019.

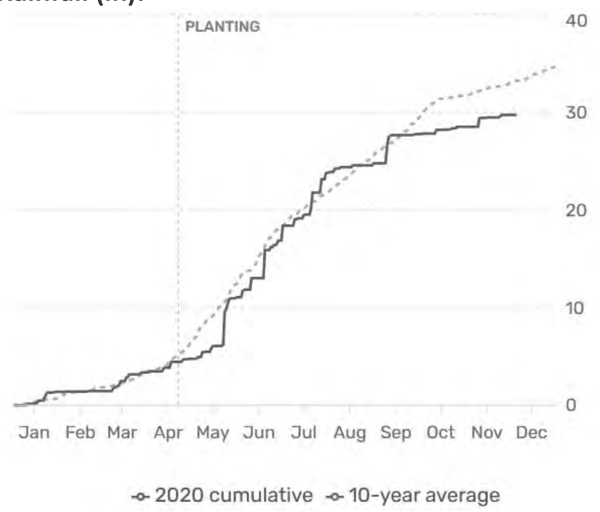
	Moisture (%)	Soybean Yield (bu/ac)†	Marginal Net Return‡ ($/ac)
Check	11.9 A*	60 A	486.68 A
Cover Crop - Rye	11.9 A	58 A	453.71 A
P-Value	0.857	0.391	0.119

*Values with the same letter are not significantly different at a 90% confidence level.
†Bushels per acre adjusted to 13% moisture.
‡Marginal net return based on $8.10/bu soybean and $16/ac rye cover crop seed and drilling cost.

Non-irrigated Corn Planted into Cereal Rye Cover Crop

Study ID: 0417109202001
County: Lancaster
Soil Type: Aksarben silty clay loam 6-11% slopes; Judson silt loam 2-6% slopes; Wymore silty clay loam 3-6% slopes, eroded
Planting Date: 4/22/20
Harvest Date: 10/19/20
Population: 26,500
Row Spacing (in): 30
Hybrid: Golden Harvest®11B63-3120
Reps: 6
Previous Crop: Soybean
Tillage: No-Till
Herbicides: ***Pre:*** Verdict®, Roundup PowerMAX®, and 2,4-D LV
Seed Treatment: None
Foliar Insecticides: None
Foliar Fungicides: None
Fertilizer: 98 lb/ac N as 32% UAN applied on 4/8/20; 32 lb /ac N as 46% Urea, 6.23 lb/ac N and 7 lb/ac S as 21-0-0-24S applied on 6/11/20

Irrigation: None
Rainfall (in):



Introduction: The purpose of this study was to evaluate the impact of a rye cover crop on subsequent corn crop production. There were two treatments, a rye cover crop and a no cover crop control. The cereal rye was variety not stated (VNS) and was seeded at a rate of 1 bu/ac on October 28, 2019. The cover crop was terminated with 32 oz/ac Roundup® PowerMAX on April 8, 2020. The rye was approximately 6" tall at the time of termination.

Results:

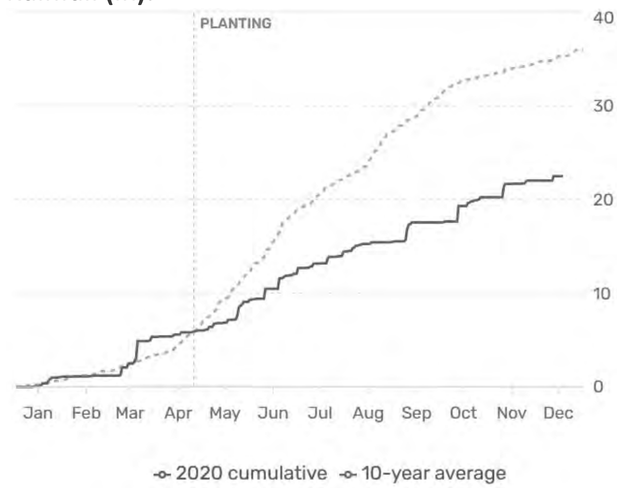
	Harvest Stand Count (plants/ac)	Test Weight (lb/bu)	Moisture (%)	Yield (bu/ac)†	Marginal Net Return‡ ($/ac)
Check	27,462 A*	57 A	12.1 A	178 A	625.03 A
Cover Crop - Rye	27,365 A	57 A	11.9 B	177 A	592.70 A
P-Value	0.880	0.770	0.093	0.794	0.156

*Values with the same letter are not significantly different at a 90% confidence level.
†Bushels per acre corrected to 15.5% moisture.
‡Marginal net return based on $3.51/bu corn $14/ac rye seed cost, and $13/ac rye drilling cost.

Summary: There were no differences in corn stand count, test weight, yield, or net return between the rye cover crop treatment and the no cover crop control. Corn moisture was slightly lower following the rye cover crop.

Rye Cover Crop Seeding Rate Effects on Non-Irrigated Corn

Study ID: 0919053202001
County: Dodge
Soil Type: Alcester silty clay loam 2-6% slopes; Moody silty clay loam 2-6% slopes; Moody silty clay loam 6-11% slopes; Monona silt loam 0-2% slope
Planting Date: 4/25/20
Harvest Date: 10/1/20
Seeding Rate: 30,012
Row Spacing (in): 30
Hybrid: Pioneer® P1244AM YGCB HX1, LL, RR2
Reps: 4
Previous Crop: Soybean
Tillage: No-Till
Herbicides: ***Pre:*** 2.8 oz/ac Balance® Flexx, 45.16 oz/ac Harness® Xtra, 7.53 oz/ac NutriSphere-N® HV, and 30.1 oz/ac Roundup Ultra® MAX on 4/27/20 ***Post:*** 1.5 lb/ac AMS, 7.98 oz/ac atrazine 4L, 1.5 oz/ac Enlite®, 2.99 oz/ac Laudis®, and 31.93 oz/ac Roundup Ultra® MAX on 6/9/20
Foliar Insecticides: None
Foliar Fungicides: None
Fertilizer: 144 lb/ac N as anhydrous ammonia on 11/12/19; 5 gal/ac 10-34-0 on 4/23/20; 44 lb/ac N as 32% UAN on 4/27/20
Irrigation: None
Rainfall (in):



Introduction: The objectives of this study were to evaluate the effect of rye cover crops on soil characteristics and the following corn crop yield. The rye cover crops were planted at three different seeding rates: 30 lb/ac, 60 lb/ac, and 90 lb/ac and included a 0 lb/ac control. The cover crop was planted by drilling on October 19, 2019. Rye biomass was sampled on April 27, 2020, from 20 ft^2 per plot. Biomass was oven-dried, weighed, and analyzed for carbon and nitrogen content. The cover crop was terminated on April 27, 2020, at a height of 12". Corn was planted on April 25, 2020, in 30" row spacing at a planting depth of 2.5". Soil samples were taken on April 30, 2020, for chemical and biological analysis at a 0-8" depth. The corn crop was harvested on October 1, 2020. Corn yield and net return were evaluated.

Results:

	Cover Crop		Soil (0-8")						
	Dry Biomass (lb/ac)	Biomass N (lb/ac)	Nitrate (lb/ac)	P (ppm)	K (ppm)	C %	Microbial Biomass (ng/g)	Bacteria Biomass (ng/g)	Fungi Biomass (ng/g)
Check	N/A	N/A	37.9 A	86 A	155 A	2 A	1,174 A	570 AB	102 A
30 lb/ac	293 B*	15.4 A	39.4 A	113 A	182 A	2 A	1,231 A	529 AB	79 A
60 lb/ac	459 AB	22.8 A	23.6 A	103 A	210 A	2 A	962 A	403 B	84 A
90 lb/ac	594 A	28.4 A	20.8 A	80 A	176 A	2 A	1,364 A	701 A	111 A
P-Value	0.114	0.162	0.237	0.108	0.287	0.153	0.411	0.067	0.718

	Corn			
	Stand Count (plants/ac)	Moisture (%)	Yield (bu/ac)†	Marginal Net Return‡ ($/ac)
Check	28,167 A	15.3 B	275 A	966.26 A
30 lb/ac	26,917 A	15.7 AB	274 A	941.83 AB
60 lb/ac	25,819 A	15.8 AB	280 A	959.26 AB
90 lb/ac	28,708 A	16.1 A	272 A	926.77 B
P-Value	0.138	0.023	0.312	0.086

*Values with the same letter are not significantly different at a 90% confidence level.
†Bushels per acre corrected to 15.5% moisture.
‡Marginal net return based on $3.51/bu corn, $19.82/ac for 30 lb/ac rye seed and drilling, $24.64/ac for 60 lb/ac rye seed and drilling, and $29.46/ac for 90 lb/ac rye seed and drilling.

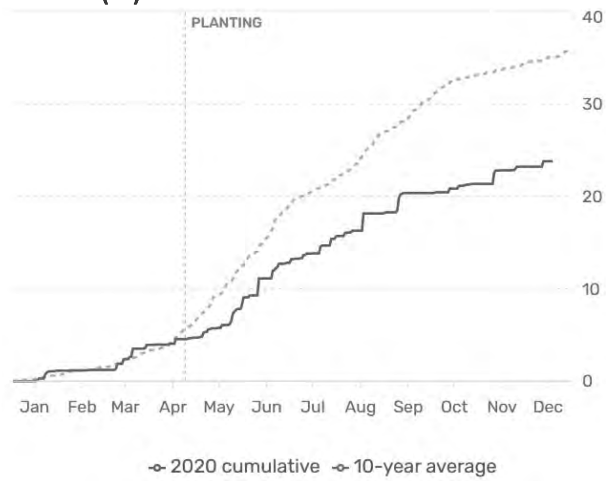
Summary:

- Cover crop total dry biomass increased with increasing rye seeding rate. Cover crop biomass N (lb/ac) was not statistically different between the three rye seeding rates.
- Soil nitrate, P, K, and C at 0-8" were not different between the rye seeding rates. Total microbial biomass was also not different between the rye seeding rates.
- Corn yield was not impacted by the rye treatments. Corn grain moisture was higher following the 90 lb/ac rye treatment compared to the no cover crop check. The 90 lb/ac rye treatment also had lower net return compared to the no cover crop check.

Rye Cover Crop Seeding Rate Effects on Irrigated Corn

Study ID: 0129155202001
County: Saunders
Soil Type: Alda fine sandy loam occasionally flooded
Planting Date: 4/23/20
Harvest Date: 10/29/20
Population: 32,500
Row Spacing (in): 30
Hybrid: Pioneer® P1563AM
Reps: 4
Previous Crop: Soybean
Tillage: No-Till
Herbicides: ***Pre:*** 10 oz/ac Verdict®, 48 oz/ac Roundup® on 4/21/20 ***Post:*** 5 oz/ac Status®, 3 oz/ac Callisto®, and 1 pt/ac AAtrex® applied 6/5/20
Seed Treatment: Poncho® 250
Insecticides: Capture® with planting; 5 oz/ac Brigade® aerially applied on 7/26/20
Foliar Fungicides: 7 oz/ac Veltyma™ aerially applied on 7/26/20

Fertilizer: 3 gal/ac 10-34-0, 1 pt/ac zinc, 1 gal/ac Humi[K] as starter; 5 gal/ac 32% UAN, 15 gal/ac 10-34-0, 1 gal/ac thiosulfate, 2 gal/ac Humi[K] applied 4/23/20; 40 gal/ac 32% UAN, 3 gal/ac thiosulfate applied 6/15/20; 15 gal/ac 32% UAN, 3 gal/ac thiosulfate fertigated 7/15/20
Irrigation: Pivot, Total: 8"
Rainfall (in):



Introduction: The objectives of this study were to evaluate the effect of rye cover crops on soil characteristics and the following corn crop yield. The cereal rye cover crops (variety not stated) were planted at three different seeding rates: 30 lb/ac, 60 lb/ac, and 90 lb/ac and included a 0 lb/ac control. The cover crop was planted by drilling on October 16, 2019. Rye biomass was sampled on April 22, 2020, from 20 ft^2 per plot. Biomass was oven-dried, weighed, and analyzed for carbon and nitrogen content. The cover crop was terminated on April 22, 2020, at a height of 6". Corn was planted on April 23, 2020, in 30" row spacing at a planting depth of 1.75". Soil samples were taken on April 30, 2020, for chemical and biological analysis at a 0-8" depth. The corn crop was harvested on October 29, 2020. Corn yield and net return were evaluated.

Results:

	-----------Cover Crop-----------			---------------Soil (0-8")---------------				---------------------Corn-------------------		
	Dry Biomass (lb/ac)	Biomass N (lb/ac)	C:N	Nitrate (lb/ac)	P (ppm)	K (ppm)	Microbial Biomass (ng/g)	Stand Count (plants/ac)	Yield (bu/ac)†	Marginal Net Return‡ ($/ac)
Control	N/A	N/A	N/A	9.4 A	14 A	103 A	1,432 A	30,167 A	262 A	918.81 A
30 lb/ac	229 B	10.0 A	10 C	4.6 B	25 A	95 A	1,601 A	29,250 A	264 A	906.28 A
60 lb/ac	317 A	11.7 A	12 B	4.7 B	16 A	94 A	1,593 A	30,417 A	268 A	911.29 A
90 lb/ac	361 A	12.0 A	13 A	4.3 B	25 A	93 A	1,784 A	31,333 A	269 A	910.09 A
P-Value	0.013	0.137	0.0001	0.001	0.357	0.632	0.686	0.226	0.513	0.912

*Values with the same letter are not significantly different at a 90% confidence level.
†Bushels per acre corrected to 15.5% moisture.
‡Marginal net return based on $3.51/bu corn, $21/ac for 30 lb/ac rye seed and drilling, $27.60/ac for 60 lb/ac rye seed and drilling, and $34.20/ac for 90 lb/ac rye seed and drilling.

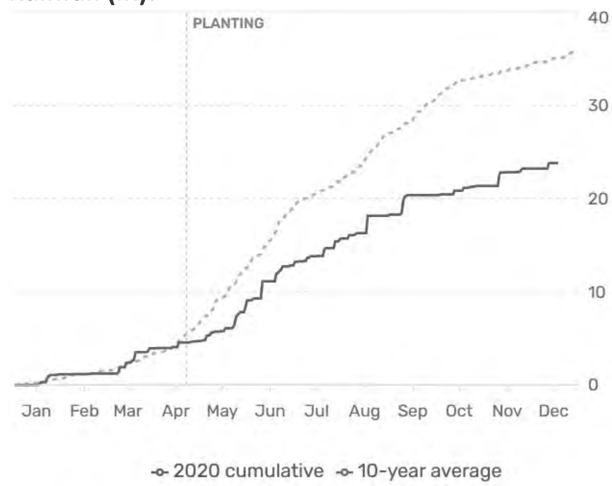
Summary:

- Cover crop total dry biomass was greater for the 60 lb/ac and 90 lb/ac seeding rate. Cover crop biomass N (lb/ac) was not statistically different between the three rye seeding rates; however, cover crop C:N ratio increased with increasing rye seeding rate.
- Soil nitrate at 0-8" was significantly reduced where the rye cover crop was planted; there was no difference in soil nitrate between the rye seeding rate treatments. Soil P, K, and total microbial biomass at 0-8" were not different between the rye seeding rates.
- There were no differences in corn yield or marginal net return between any of the treatments.

Rye Cover Crop Seeding Rate Effects on Irrigated Soybean

Study ID: 0129155202002
County: Saunders
Soil Type: Alda sandy loam occasionally flooded
Planting Date: 4/22/20
Harvest Date: 10/1/20
Population: 144,000
Row Spacing (in): 18
Hybrid: Pioneer® P28A42X
Reps: 4
Previous Crop: Corn
Tillage: No-Till
Herbicides: ***Pre:*** 10 oz/ac Veltyma™, 48 oz/ac Roundup® on 4/21/20 ***Post:*** None
Seed Treatment: None
Foliar Insecticides: 2.8 oz/ac Leverage® 360 aerially applied on 8/2/20
Foliar Fungicides: 4 oz/ac Fitness®, 4 oz/ac Priaxor® aerially applied on 8/2/20

Fertilizer: 100 lb/ac 11-52-0, 100 lb/ac 0-0-60, 25 lb/ac ammonium sulfate broadcast fall 2019
Irrigation: Pivot, Total: 9"
Rainfall (in):



Introduction: The objectives of this study were to evaluate the effect of rye cover crops on soil characteristics and the following soybean crop yield. The cereal rye cover crops (variety not stated) were planted at three different seeding rates: 30 lb/ac, 60 lb/ac, and 90 lb/ac and included a 0 lb/ac control. The cover crop was planted by drilling on October 29, 2019. Rye biomass was sampled on April 22, 2020, from 20 ft^2 per plot. Biomass was oven-dried, weighed, and analyzed for carbon and nitrogen content. The cover crop was terminated on April 22, 2020, at a height of 6". Soybeans were planted on April 22, 2020, at a planting depth of 1.5". Soil samples were taken on April 30, 2020, for chemical and biological analysis at a 0-8" depth. Soybeans were harvested on October 1, 2020. Soybean yield and net return were evaluated.

Results:

	----------Cover Crop---------			--------------Soil (0-8")-------------				-----------------Soybean-----------------		
	Dry Biomass (lb/ac)	Biomass N (lb/ac)	C:N	Nitrate (lb/ac)	P (ppm)	K (ppm)	Microbial Biomass (ng/g)	Stand Count (plants/ac)	Yield (bu/ac)†	Marginal Net Return‡ ($/ac)
Control	N/A	N/A	N/A	8.6 A	9 A	107 A	1,723 A	102,850 A	76 A	717.23 A
30 lb/ac	40 C*	2.0 B	9 A	8.1 A	13 A	138 A	1,463 A	98,494 A	74 A	684.98 A
60 lb/ac	71 B	3.2 AB	9 A	7.5 A	12 A	106 A	1,838 A	101,882 A	76 A	689.48 A
90 lb/ac	98 A	4.0 A	10 A	5.6 A	13 A	103 A	2,064 A	100,430 A	75 A	678.50 A
P-Value	0.002	0.021	0.148	0.143	0.567	0.133	0.915	0.989	0.937	0.304

*Values with the same letter are not significantly different at a 90% confidence level.
†Bushels per acre corrected to 13% moisture.
‡Marginal net return based on $9.50/bu soybean, $21/ac for 30 lb/ac rye seed and drilling, $27.60/ac for 60 lb/ac rye seed and drilling, and $34.20/ac for 90 lb/ac rye seed and drilling.

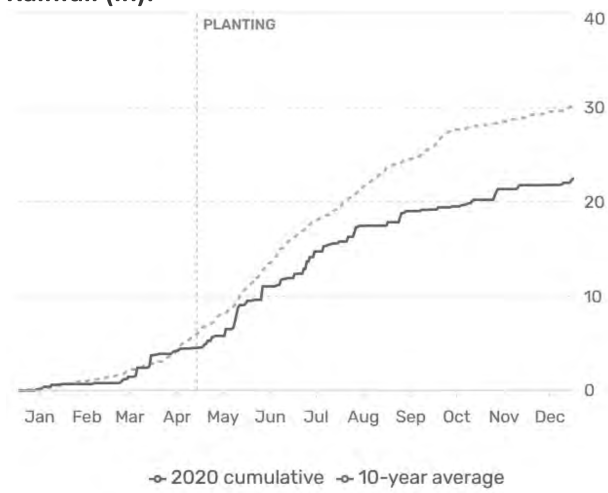
Summary:

- Cover crop biomass increased with increasing seeding rate, but was overall very low. Cover crop biomass N (lb/ac) was higher for the 90 lb/ac seeding rate than the 30 lb/ac seeding rate. Cover crop C:N ratio was the same for all rye seeding rates.
- Soil nitrate, P, K, and total microbial biomass at 0-8" were not significantly impacted by the rye seeding rates.
- There were no differences in soybean yield or marginal net return between any of the treatments.

Integrating Cover Crops on Sandy Soils to Improve Water Quality and Soil Health

Study ID: 0737119202001
County: Madison
Soil Type: Boel sandy loam 0-1% slope
Planting Date: 4/28/20
Harvest Date: 9/23/20
Seeding Rate: 30,400
Row Spacing (in): 30
Hybrid: Pioneer® P0950AM
Reps: 6
Previous Crop: Soybean
Tillage: No-Till
Herbicides: ***Pre:*** 3.15 oz/ac Balance® Flexx, 18 oz/ac 2,4-D LV6, 23.25 oz/ac FulTime®, and 14.5 oz/ac Buccaneer® 5 Extra applied 5/1/20 ***Post:*** 5 oz/ac Callisto®, 16 oz/ac atrazine 4L, Me-Too-Lachlor™ II, and 14.5 oz/ac glyphosate with AMS applied 6/14/20
Fertilizer: 8.8 lb/ac N and 41.6 lb/ac P from 11-52-0, 24 lb/ac K from 0-0-60, 18 lb/ac S from 20 lb/ac 90% S, 0.02 lb/ac Zn from 0.05 lb/ac 33% Zn; 22.6 lb/ac N, 14.6 lb/ac P, 4 lb/ac K, 7 lb/ac S, and 0.4 lb/ac Zn from 12 gal/ac 17-11-3-5.3S-0.3Zn starter with planting; 144.9 lb/ac N from 315 lb/ac 46-0-0 and 10.5 lb/ac N, 12 lb/ac S from 50 lb/ac 21-0-0-24 sidedressed on 6/4/20; 28-0-0-5S applied through fertigation in July

Irrigation: Pivot
Rainfall (in):



Soil Test (November 2019, 0-8"):

OM (%)	Bray P1 (ppm)	Bray P2 (ppm)	K (ppm)	Mg (ppm)	Ca (ppm)	pH	BpH	CEC (Me/100g)	K%	Mg%	Ca%	H%	Nitrate-N (ppm)	Nitrate-N (lb/ac)	S (ppm)	Zn (ppm)	Mn (ppm)	Fe (ppm)	Cu (ppm)	B (ppm
1.5	120	132	230	51	491	4.5	6.3	8.3	7.1	5.1	29.6	58.2	10	24	10	3.4	5	157	1.2	0.3
0.8	64	82	89	85	815	5.9	6.9	6.0	3.8	11.8	67.9	16.5	6	14	5	1.9	4	61	0.5	0.2
2.7	10	101	158	224	3346	7.7	-	19.0	2.1	9.8	88.1	0.0	11	26	15	3.1	3	22	1.0	1.1

Introduction:

The objectives of this study were to evaluate the potential for cover crops to reduce water erosion of nutrients, improve water quality by reducing nitrate leaching, and enhance soil health in Nebraska corn/soybean production systems on sandy soils.

This is the fourth year of this study. Treatments are located on the same plots during each year of the study to monitor changes in soil erosion, water quality, and soil health over time. This study includes three treatments with six replications: check (no cover crop), pre-harvest planted cereal rye cover crop, and post-harvest planted cereal rye cover crop. Cover crop treatments were seeded at a rate of 50 lb/ac. The pre-harvest cover crop was planted on September 18, 2019, with a high-clearance applicator. The post-harvest planted cover crop was seeded on October 18, 2019, with a drill. Corn was planted on April 28, 2020, and cover crops were terminated with herbicide on May 1, 2020.

Cover crop biomass was measured and soil samples were collected to determine nitrate concentration change with depth on September 18. Yield data were collected by hand harvesting ears from a 17.5-foot-long corn row in the center of each plot on September 23, 2020. Ears were dried, shelled, and dried again. Grain weight was then determined and corrected to 15.5% moisture content.

Results:

	Cover Crop Biomass (lb/ac)	OM (%)	Water Stable Aggregate Mean Weight Diameter (in)	Soil Nitrate (ppm)			Yield (bu/ac)†	Marginal Net Return‡ ($/ac)
		(0-4")	(0-4")	(0-4")	(4-8")	(8-12")		
No Cover Crop	N/A	6.64 A	0.019 A	34.4 A	12.5 A	8.5 AB	219 A	769.95 A
Pre-harvest Cover Crop	457 A*	8.31 A	0.016 A	29.4 AB	10.2 A	12.4 A	217 A	734.85 A
Post-harvest Cover Crop	384 A	7.01 A	0.019 A	22.2 B	9.7 A	7.2 B	225 A	760.41 A
P-Value	0.224	0.371	0.620	0.028	0.161	0.072	0.794	0.649

*Values with the same letter are not significantly different at a 90% confidence level.
†Bushels per acre corrected to 15.5% moisture.
‡Marginal net return based on $3.51/bu corn, $9.38/ac cover crop seed, $18/ac for drilling post-harvest cover crop treatments, and $18/ac for interseeding pre-harvest cover crop treatments.

Summary:

- Soil nitrate-N in the top 0-4" was lower for the post-harvest cover crop compared to the no cover crop check. There were no differences in soil nitrate-N in the 4-8" depth. Soil nitrate-N in the 8-12" depth was lower for the post-harvest cover crop compared to the pre-harvest cover crop.
- There were no differences in cover crop biomass, OM at 0-4" depth, water stable aggregate mean weight diameter, yield, or net return between the treatments evaluated.
- Previous years of this study showed similar results with no effects on soil properties or yields.

CLICK TO WATCH A VIDEO ABOUT THIS STUDY https://go.unl.edu/croprotation

Effects of Grazing Cover Crops in a Three-Year Non-irrigated Rotation

4-year summary report

Study ID: 0720129202001
County: Nuckolls
Soil Type: Hastings silt loam 0-1% slope
Reps: 4

Introduction

In rainfed systems, adding cover crops into the rotation can decrease crop yields if precipitation is limited; however, the use of cover crops for forage may offset monetary costs while retaining soil benefits. This study evaluated three treatments: grazed cover crop (or stubble, depending on the year of crop rotation), non-grazed cover crop, and non-grazed wheat stubble. This is a three-year, no-till crop rotation of wheat, corn, and soybean, with cover crops planted in the cover crop treatments following the wheat crop only. Watermark™ Soil Moisture Sensors were installed to determine treatment impacts for each growing season.

Year 1 (2017 crop)

In year one of the study, cover crop treatments were planted on August 14, 2016, following wheat harvest and consisted of a mix of winter peas, spring triticale, oats, collards, and purple top turnip. Cover crop biomass measured on October 19, 2016, was 3,401 lb/ac and consisted mainly of grass and turnip (Table 1).

Table 1. Cover crop composition (% of biomass on DM basis).

Grass	53.5%
Winter Pea	1.5%
Collards	8.7%
Turnip Tops	20.9%
Turnip Bottoms	14.5%
Other	0.9%

The grazed treatment was grazed in the fall of 2016. Starting in November 2016, 28 (1,100 lb) first-calf heifers grazed 9.6 acres for 22 days, resulting in the cover crop carrying 2.4 animal unit months (AUM)/ac. Post-grazing 2,177 lb/ac of biomass were still present. Baseline soil samples were collected in April 2017, prior to planting corn (Table 2).

Table 2. Soil analysis taken prior to corn planting in April 2017.

	---0 to 8 inches---			
	Soil pH	**OM %**	**Nitrate-N ppm**	**Nitrogen lb N/A**
Cover Crop – Non-grazed	5.52 A	3.1 A	5.4 B	9.3 B
Cover Crop/Stubble – Grazed	5.68 A	3.1 A	7.3 B	12.6 B
Stubble – Non-grazed	5.40 A	3.1 A	12.9 A	24.5 A
P-Value	0.38	0.90	0.01	<0.01

	---0 to 4 inches---				
	Solvita CO_2-C (ppm)	**Total Biomass (ng/g)**	**Total Bacteria Biomass (ng/g)**	**Total Fungi Biomass (ng/g)**	**Diversity Index**
Cover Crop – Non-grazed	133 A	4,225 A	2,187 A	351 A	1.44 A
Cover Crop/Stubble – Grazed	161 A	3,927 AB	2,142 A	333 A	1.44 A
Stubble – Non-grazed	128 A	3,046 B	1,605 A	306 A	1.5 A
P-Value	0.19	0.09	0.12	0.90	0.90

*Values with the same letter are not significantly different at a 90% confidence level.

During March through May 2017, prior to planting corn, the cover crop treatments were around 35% depletion (the typical trigger point for irrigation on these soil types), whereas the wheat stubble treatments remained near field capacity (full soil moisture profile). Corn was planted in 2017 across all treatments. In May 2017, 8” of rain recharged the soil profile and all treatments had a full 4’ soil moisture profile at the beginning of June. Therefore, the cover crop treatments did not result in lower beginning moisture, which could limit yield potential. The grazed treatments began to show greater soil moisture depletion than the ungrazed treatments as time progressed. In June 2017, it was observed that the grazed treatments had concentrations of Palmer amaranth where the cattle created trails walking along the electric fence; Palmer amaranth was controlled with dicamba herbicide. For the 2017 corn crop, no significant yield differences occurred (Table 3). Corn yield where the cover crop was planted and not grazed (213 bu/ac) did not differ from where it was grazed (211 bu/ac).

Table 3. 2017 corn yield results.

	Stand Count (plants/ac)	Moisture (%)	Test Weight	Corn Yield (bu/ac)†
Cover Crop—Non-grazed	22,500 A	15.0 A	61 A	213 A
Cover Crop/Stubble—Grazed	22,167 A	14.9 A	61 A	211 A
Stubble—Non-grazed	22,500 A	15.2 A	61 A	218 A
P-Value	0.952	0.129	0.267	0.141

*Values with the same letter are not significantly different at a 90% confidence level.
†Bushels per acre corrected to 15.5% moisture for corn.

Year 2 (2018 crop)

In year two of the study, following corn harvest in the fall of 2017, no cover crops were planted. In the previously established grazed cover crop treatment, 11 bulls grazed on the corn stalks (9.6 acres) for 18 days. The two previously non-grazed treatments remained non-grazed. Soybeans were planted in 2018 across all treatments. In August, the grazed treatment showed greater moisture stress than the non-grazed treatments (Figure 1).

Figure 1. August 3, 2018, image with grazed treatment (cover crop in 2016 and stubble in 2017) showing greater moisture stress.

Table 4. 2018 soybean yield results.

	Stand Count (plants/ac)	Test Weight	Moisture (%)	Soybean Yield† (bu/ac)
Cover Crop—Non-grazed	120,750 A*	55 A	10.7 B	50 A
Cover Crop/Stubble—Grazed	120,500 A	55 A	11.0 A	40 B
Stubble—Non-grazed	117,750 A	55 A	10.6 C	52 A
P-Value	0.629	0.397	0.0002	0.0004

*Values with the same letter are not significantly different at a 90% confidence level.
†Bushels per acre corrected to 13% moisture for soybeans.

For the 2018 soybean crop, there were no differences in test weight or stand counts between the three treatments (Table 4). Grain moisture was significantly higher for the grazed cover crop treatment, followed by the non-grazed cover crop treatment, then the non-grazed wheat stubble. Yield of the non-grazed treatments was 10-12 bu/ac higher than for the grazed cover crop treatment.

Year 3 (2019 crop)

Following soybean harvest in October of 2018, Overland wheat was planted on October 22, 2018, at a seeding rate of 120 lb/ac and row spacing of 7.5". The field received 10 gal/ac 10-34-0 at planting and 80 lb N/ac as a spring topdress application. Wheat was harvested on July 26, 2019, and yield and grain moisture were recorded. For the 2019 wheat crop, there was no difference in test weight or yield (Table 5). Grain moisture was slightly different with the grazed cover crop treatment being wetter than the ungrazed wheat stubble treatment. The wet 2019 season delayed wheat harvest to July 26, 2019. The cover crop was planted on September 4, 2019, due to the rain and wet field. Three-year follow-up soil analysis for nutrient and soil health (Table 6) were taken August 5, 2019 (following wheat harvest and prior to planting cover crops).

Table 5. 2019 wheat yield results.

	Test Weight (lb/bu)	Moisture (%)	Wheat Yield (bu/ac)†
Cover Crop – Non-grazed	59 A*	10.3 AB	84 A
Cover Crop/Stubble – Grazed	59 A	10.4 A	84 A
Stubble – Non-grazed	59 A	10.2 B	83 A
P-Value	0.483	0.067	0.613

*Values with the same letter are not significantly different at a 90% confidence level.
†Bushels per acre adjusted to 13% moisture.

Table 6. Three-year follow up soil analysis taken prior to cover crop planting August 5, 2019.

	0 to 8 inches			
	Soil pH	OM %	Nitrate-N ppm	Nitrogen lb N/A
Cover Crop – Non-grazed	5.7 A*	3.3 A	6.6 A	16.0 A
Cover Crop/Stubble – Grazed	5.5 AB	3.2 A	6.3 A	15.0 A
Stubble – Non-grazed	5.5 B	3.1 A	6.0 A	14.5 A
P-Value	0.090	0.105	0.395	0.390

*Values with the same letter are not significantly different at a 90% confidence level.

	Solvita CO_2-C (ppm)	Total Biomass (ng/g)	Total Bacteria Biomass (ng/g)	Total Fungi Biomass (ng/g)	Diversity Index	Soil Health Calculation
	0 to 4 inches					
Cover Crop – Non-grazed	59	2860	1073	183	1.06	10.00
Cover Crop/Stubble – Grazed	44	3498	1524	298	1.44	7.87
Stubble – Non-grazed	63	2760	1287	198	1.30	9.69
	4 to 8 inches					
Cover Crop – Non-grazed	31	906	353	4	0.94	5.89
Cover Crop/Stubble – Grazed	29	1526	569	53	1.22	5.53
Stubble – Non-grazed	21	977	354	12	1.06	4.65

3-Year Soil Physical Properties Changes

Sampling for soil physical properties including bulk density was completed on August 5, 2019. Neither cover crops nor grazing had a significant effect on soil bulk density in the top 2 inches. The average bulk density for the grazed cover crops was 1.08 g/cm^3, for ungrazed cover crops was 1.09 g/cm^3, and the ungrazed wheat stubble was 1.06 g/cm^3. There was no effect of grazing or cover crop in the 2-4" depth of soil. The average bulk density for the soil in the 2-4" depth was 1.31 g/cm^3 for the grazed cover crop treatment, 1.28 g/cm^3 for the ungrazed cover crop treatment, and 1.28 g/cm^3 for the ungrazed wheat stubble treatment.

Soil cone index value is a measurement of how easy it is to penetrate the soil. Figure 2 shows no significant effect on soil cone index value at any of the soil depths. The ungrazed cover crop tended to have a lower soil cone index value, but it was not significantly different from the other two treatments.

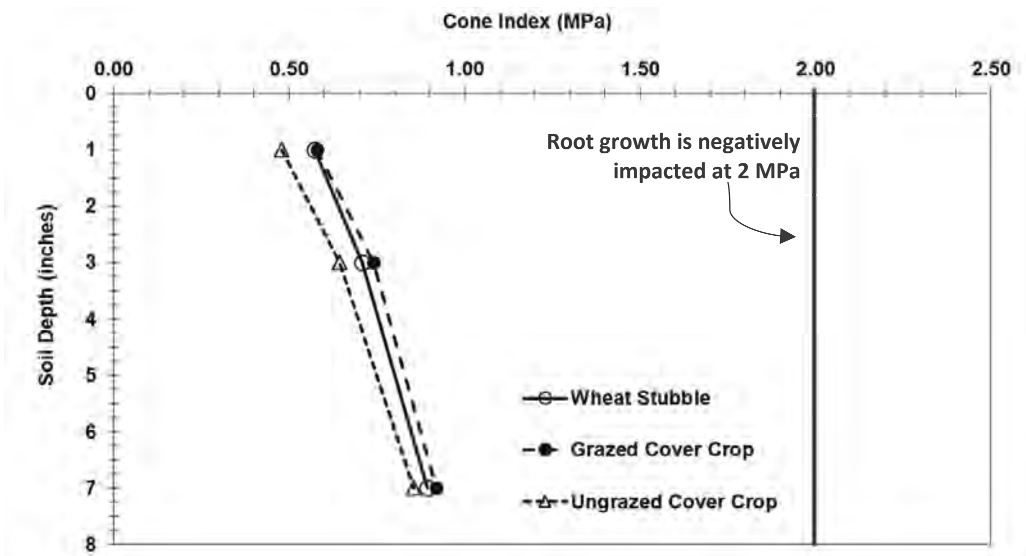
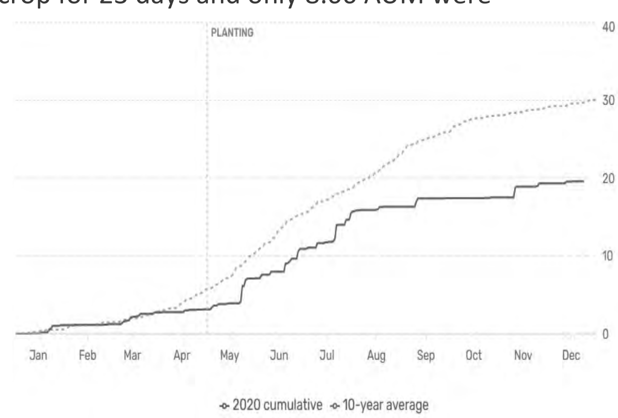


Figure 2. Three-year follow up soil cone index values by treatment taken August 5, 2019. The line on the far right represents where root growth is negatively impacted, because roots are no longer able to easily penetrate through the soil.

Year 4 (2019 Cover Crop and 2020 Corn)

Following wheat harvest, 20 ton/ac manure was applied, then a cool-season cover crop was planted on 9/3/19. Cover crop contained 10 lb/ac winter peas, 25 lb/ac winter triticale, 25 lb/ac black oats, 1.3 lb/ac collards, and 1.3 lb/ac turnip. Nine bulls grazed the cover crop for 23 days and only 8.66 AUM were achieved (much less than the 19.03 AUM in 2016) due to the wet fall, late planting, and minimal growth. Cover crop was 8" at time of termination by 32 oz Roundup®, 8 oz/ac dicamba, 0.5 lb/ac atrazine, and 4 oz/ac Balance® Flexx on 3/20/20. Manure application on a wet field resulted in deep ruts. This may have impacted corn emergence and stand counts the following spring.



For the corn crop, 190 lb/ac N as anhydrous ammonia was applied on 3/15/20. Pioneer® P1244 was planted no-till on 5/1/20 at a seeding rate of 25,000 seeds/ac in 30" rows. Six gallons of starter fertilizer (10-34-0) was applied in-furrow at planting. Post-emergent herbicides included 0.5 lb/ac atrazine, 30 oz/ac DiFlexx® DUO, and 32 oz/ac of Roundup. On 8/20/20, Headline AMP® at 10 oz/ac was applied for southern rust. Harvest occurred on 10/13/20. All treatments had a full soil moisture profile at the beginning of the 2020 growing season. By the end of August, all treatments had reached 50% depletion (Figure 3). There were no differences amongst treatments for stand counts, percent stalk rot, percent moisture, and test weight. The corn in the ungrazed wheat stubble yielded more than the cover crop treatments (Table 7). Economic analysis can be viewed in Table 8. This study will continue for two more years.

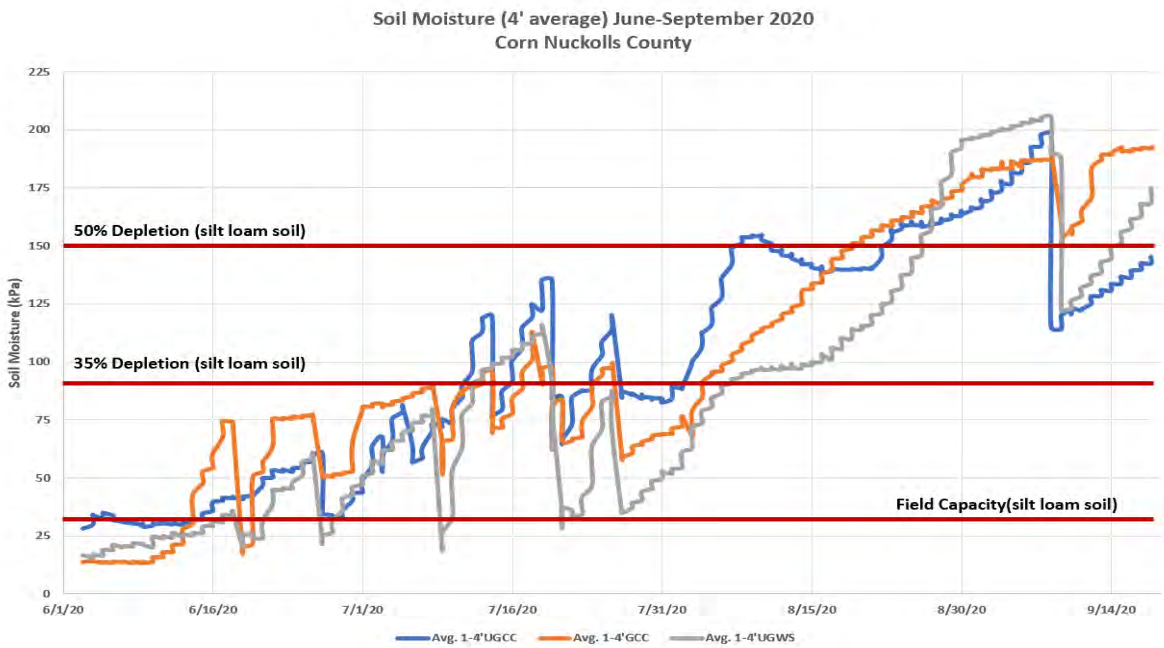


Figure 3. Soil moisture depletion for June-September 2020 corn in Nuckolls County. All treatments began the season with soil moisture at or above field capacity. The ungrazed cover crop (UGCC) and grazed cover crop (GCC) treatments reached 50% depletion by mid-August with the ungrazed wheat stubble (UGWS) reaching 50% depletion toward the end of August.

Table 7. 2020 corn yield results.

	Stand Count (plants/ac)	Stalk Rot (%)	Moisture (%)	Test Weight	Corn Yield (bu/ac)†
Cover Crop—Non-grazed	16,875 A	0 A	13.8 A	60.125 A	215 B
Cover Crop/Stubble—Grazed	18,000 A	0 A	13.58 A	60.3 A	216 B
Stubble—Non-grazed	18,125 A	2.5 A	13.6 A	60.2 A	227 A
P-Value	0.4355	0.454	0.2648	0.9201	0.0057

*Values with the same letter are not significantly different at a 90% confidence level.
†Bushels per acre corrected to 15.5% moisture for corn.

Multi-Year Economic Analysis (2016 cover crop to 2020 corn crop)

2016 Cover Crop: Cost for spraying wheat stubble was $18/ac. Costs for the non-grazed cover crop treatments were $46.64/ac ($28.64/ac for seed and $18/ac for drilling). Costs for grazed cover crop treatments were $61.94/ac ($46.64/ac for the cover crop seed and planting, $5/ac for fencing, and

$10.30/ac for water). Water cost was calculated assuming hauling water (1,000 gal) 15 miles every two days at $2 per loaded mile and $6 per $1,000 gal. Costs for the grazed cover crop treatments equaled $30.97/AUM (animal unit months). Value of the forage is estimated to be $84.80/ac (based on rental rates of $53/pair/month [1.25 AUMs] or $42.40 AUM).

2017 Corn: The economic analysis had no input differences for any of the treatments for corn production. UNL Corn Budget 21 (EC872, 2017 Nebraska Crop Budgets, revised Nov. 2016) was the closest that fit this operation, so a total cost/ac of $459.60/ac and a market year average price of $3.15/bu was used. In the previously established grazed cover crop treatment, cattle grazed on the corn stalks. A $5/ac cornstalk rental rate value was assessed to this 9.6 acre area. This rate assumes water, fencing, and the care of the animals.

2018 Soybean: The inputs were the same for the soybeans planted into all the previous treatments. UNL Budget 56 (EC872, 2018 Nebraska Crop Budgets, revised Nov. 2017) was used, which states a $315.82/ac total cost. A market year average price of $7.40/bu was used.

2019 Wheat: The inputs were the same for the wheat planted into all the previous treatments. UNL Budget 70 (EC872, 2019 Nebraska Crop Budgets, revised Nov. 2018) was used which stated a $247.04/ac total cost. A market year average price of $3.65/bu was used.

2019 Cover Crop: Cost for spraying the wheat stubble was $18 ($9/ac application and $9/ac herbicide cost). Costs for the non-grazed cover crop treatments were $49.42/ac ($31.42/ac for seed and $18/ac for drilling). Costs for grazed cover crop treatments were $64.00/ac ($49.42/ac for the cover crop seed and planting, $5/ac for fencing, and $9.58/ac for water). Water cost was calculated based on hauling water (5.75 water trips at $16/trip, which included cost of water).

Costs for the grazed cover crop treatments equaled $54.78/AUM (49.42*9.6=474.43/8.66AUM from what was grazed=54.78). Value of the forage was estimated to be $84.80/ac (based on rental rates of $53/pair/month [1.25 AUMs] or $42.40 AUM). Forage production was limited in the fall of 2019 compared to 2016 due to a wet summer that delayed wheat harvest, which, in turn, delayed cover crop planting. A cool fall led to less growth. Only 8.66 AUM was achieved with the 2019 cover crop compared to 19.03 AUM with the 2016 cover crop.

2020 Corn: The economic analysis had no input differences for any of the treatments for corn production. UNL Corn Budget 23 (EC872, 2020 Nebraska Crop Budgets, revised Nov. 2019) was the closest that fit this operation, so a total cost/ac of $452.10 and a market year average price of $3.51 was used. In the previously established grazed cover crop treatment, cattle grazed on the corn stalks. A $5/ac cornstalk rental rate value was assessed to this 9.6 acre area. This rate assumes water, fencing, and the care of the animals.

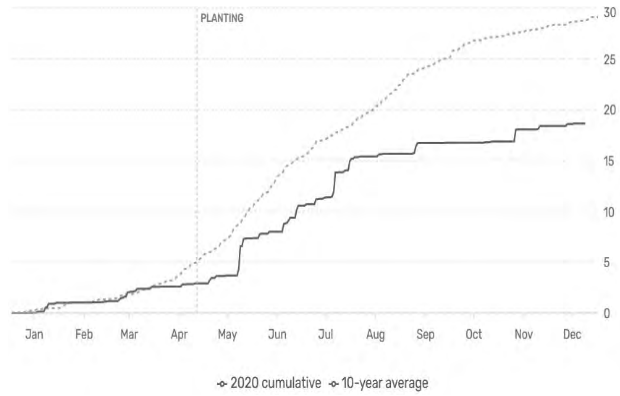
Table 7. Three crop year economic analysis summary of this study.

	2016 Cover	2017 Corn	2018 Soy	2019 Wheat	3-Year Total
Cover Crop—Non-grazed	-$46.64	$211.35	$54.18	$59.56	**$278.45**
Cover Crop/Stubble—Grazed	$22.86	$210.05	-$19.82	$59.56	**$272.65**
Stubble—Non-grazed	-$18.00	$227.10	$68.98	$55.91	**$333.99**

	2019 Cover	2020 Corn	2021 Soy	2022 Wheat	6-Year Total
Cover Crop—Non-grazed	-$49.42	$304.23	TBD	TBD	*$533.26*
Cover Crop/Stubble—Grazed	$20.80	$311.13	TBD	TBD	*$604.58*
Stubble—Non-grazed	-$18.00	$342.99	TBD	TBD	*$658.98*

Effects of Grazing Cover Crops in a Three-Year Non-irrigated Rotation

Study ID: 0721181202001
County: Webster
Soil Type: Hastings silt loam 0-1% slope
Planting Date: 4/26/20
Harvest Date: 9/18/20
Seeding Rate: 160,000
Row Spacing (in): 15"
Variety: Pioneer® P31A22
Reps: 4
Previous Crop: Corn
Tillage: No-Till
Herbicides: ***Pre:*** 22 oz/ac XtendiMax®, 22 oz/ac Roundup®, 4 oz/ac Fierce® XLT on 4/15/20
Post: 22 oz/ac XtendiMax®, 22 oz/ac Roundup® on 5/25/20
Fertilizer: 60 lb/ac actual P on 3/21/20
Irrigation: None
Rainfall (in):



Introduction

This is the second year of a study evaluating crop rotation and cover crop impacts. In rainfed systems, adding cover crops into the rotation has the potential to decrease yields when precipitation is limited; however, the use of cover crops for forage may offset the costs while retaining soil benefits. This study evaluated three treatments: grazed cover crop (or stubble only depending on year of crop rotation), non-grazed cover crop, and non-grazed stubble.

Year 1 (2019 crop)

Following wheat harvest in 2018, beginning soil nutrient and health samples were taken on July 10, 2018 (Table 1). Initial infiltration tests were also conducted. This is the amount of time for 70 mL of water to enter the soil. Four replications were taken with values (minutes:seconds) of: 4:00, 4:05, 1:25, and 1:30. The longer infiltration times correspond to the two replications in heavier clay soils.

Table 1. Beginning soil analysis prior to cover crop planting on July 10, 2018. The lab didn't specify treatments for the nutrient levels in its report, so 12 reps each are represented in the 0-4" and 4-8" beginning nutrient depths.

	---0 to 8 inches---			
	Soil pH	OM %	Nitrate-N ppm	Nitrogen lb N/A
0-4"	5.2	2.7	9.9	12
4-8"	5.7	2.5	6.3	7.5

	---0 to 4 inches---				
	Solvita CO_2-C (ppm)	Total Biomass (ng/g)	Total Bacteria Biomass (ng/g)	Total Fungi Biomass (ng/g)	Diversity Index
Cover Crop – Non-grazed	58 A*	2054 A	594 AB	93 B	1.34 B
Cover Crop/Stubble – Grazed	67 A	2095 A	808 A	187 A	1.58 A
Stubble – Non-grazed	57 A	1556 A	491 B	62 B	1.27 B
P-Value	0.304	0.184	0.049	0.004	0.002

*Values with the same letter are not significantly different at a 90% confidence level.

Cover crops were planted in the cover crop treatments on July 15, 2018. The cover crop mix included 6 lb/ac cowpea, 7 lb/ac BMR sorghum-sudangrass, 4 lb/ac pearl millet, 2 lb/ac radish, and 1.5 lb/ac turnip. Cover crops frost-killed and sorghum-sudangrass was 4-5' tall at that time. Cover crop biomass was measured on November 6, 2018, following frost-kill. These samples were taken from the ungrazed cover crop treatments as cattle were currently grazing the grazed treatment. Total average pounds of grass and brassica biomass was 8,405 lb/ac. The cover crop contained 12.3% turnip/radishes and 87.7% grass species. The grazed area contained 52.3 acres. Starting October 21, 2018, 35 head of first-calf heifers weighing 1,100 lbs grazed for 91 days. A great deal of forage remained in the grazed area when cattle were removed according to the cooperating producer. Post-grazing biomass samples were not able to be collected.

Watermark™ Soil Moisture Sensors were installed in the treatments after cover crop emergence. The wet fall of 2018 and wet spring of 2019 resulted in no differences in soil moisture amongst treatments prior to corn planting (Figure 1). Heavy rains washed the wheat residue into piles toward the field end rows; no washing was present in the portion of the field with cover crops, regardless of cover crop grazing. This left bare ground in that portion of the field compared to the ungrazed and grazed treatment areas (Figure 2). The lack of cover in the ungrazed wheat stubble was visible via aerial imagery in this field (Figure 3).

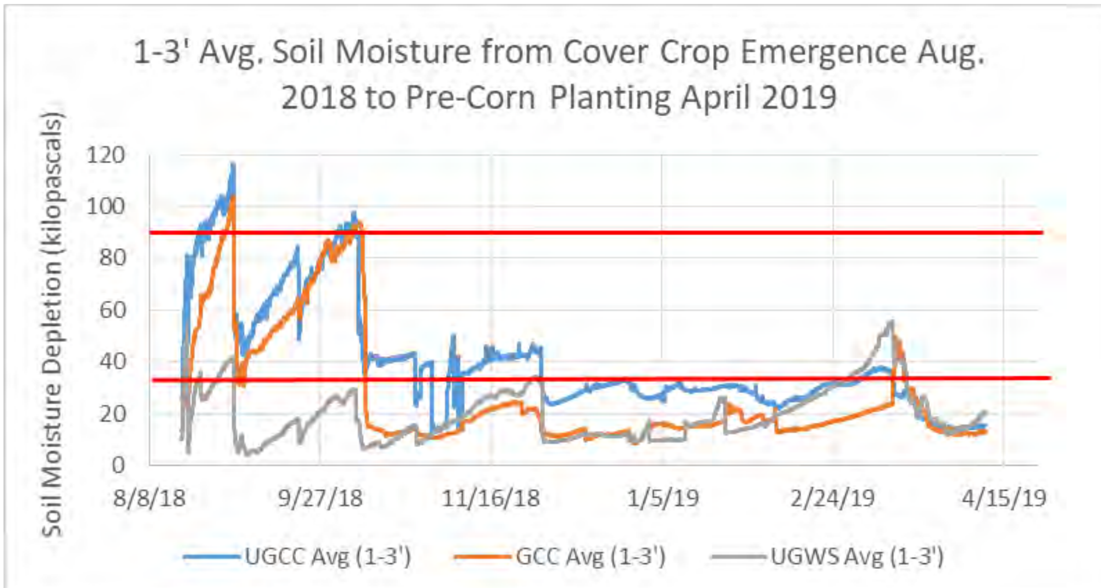


Figure 1. Soil moisture data for three feet depth from September 2018 to April 2019 for the three treatments. UGWS = Ungrazed Wheat Stubble, UGCC = Ungrazed Cover Crop, GCC = Grazed Cover Crop. Lines for field capacity (30 kPa) and 35% depletion (90 kPa) for silt loam soils are shown for reference. While this is a non-irrigated field, 35% depletion is the suggested irrigation trigger for silt loam soils in Nebraska. The data shows that all treatments had a full soil moisture profile going into the corn growing season of 2019.

Figures 2 and 3. Heavy spring rains dislodged and washed the ungrazed wheat stubble in the field leaving residue piles in the end rows (left). The lack of residue cover in the ungrazed wheat stubble treatments could be seen throughout the growing season via aerial imagery (shown via June 20, 2019, true color image photo as dark colored strips in center of field in the photo on the right).

Corn was planted on May 17, 2019. Stand counts, stalk rot, grain moisture, test weight, and yield were evaluated for the corn crop (Table 2). Soil moisture via Watermark™ sensors was also evaluated for all treatments for the duration of the growing season (not shown in this report).

Table 2. Corn yield data for 2019.

	Stand Count (plants/ac)	Stalk Rot (%)	Test Weight (lb/bu)	Moisture (%)	Corn Yield (bu/ac)†
Cover Crop – Non-grazed	24,333 A*	3.33 A	61 AB	15.0 A	189 A
Cover Crop – Grazed	24,833 A	1.00 A	61 B	14.6 B	191 A
Wheat Stubble – Non-grazed	23,167 A	0.83 A	62 A	14.2 B	187 A
P-Value	0.409	0.474	0.067	0.009	0.233

*Values with the same letter are not significantly different at a 90% confidence level.
†Bushels per acre adjusted to 15.5% moisture.

The addition of cover crops and grazing did not impact beginning soil moisture for the 2019 corn crop due to a wet fall in 2018 and wet spring in 2019. Corn stand count, stalk rot, and yield were not impacted by the cover crop and grazing treatments. Corn test weight for the ungrazed wheat stubble treatment was higher than for the grazed cover crop treatment. Grain moisture was higher for the ungrazed cover crop treatment than the grazed cover crop treatment and ungrazed wheat stubble treatment.

Year 2 (2020 crop)

Soybeans were planted on April 26, 2020. Additional background information for the 2020 soybean crop is listed at the top of this report. Stand counts, grain moisture, test weight, and yield were evaluated (Table 3). Soil moisture via WATERMARK™ sensors was also evaluated for all treatments for the duration of the growing season.

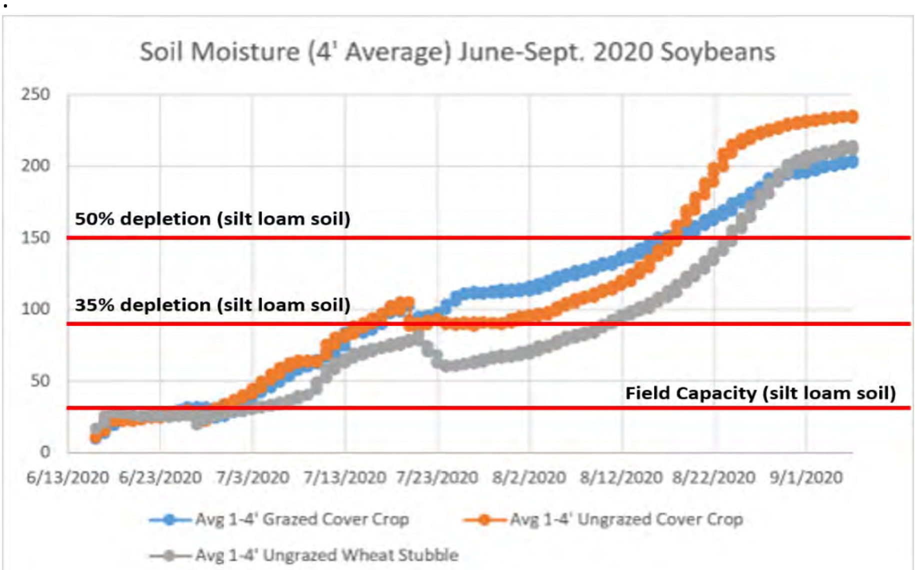


Figure 4. Soil moisture data for four feet depth from June 2020 to September 2020 for the three treatments. UGWS = Ungrazed Wheat Stubble, UGCC = Ungrazed Cover Crop, GCC = Grazed Cover Crop. Lines for field capacity (30 kPa) and 35% depletion (90 kPa) for silt loam soils are shown for reference. While this is a non-irrigated field, 35% depletion is the suggested irrigation trigger for silt loam soils in Nebraska. The data shows that all treatments had a full soil moisture profile going into the soybean growing season of 2020. The cover crop treatments were above 50% depletion by mid-August, whereas the wheat stubble treatment reached 50% depletion toward the end of August.

Table 3. Soybean yield data for 2020.

	Stand Count (plants/ac)	Test Weight (lb/bu)	Moisture (%)	Soybean Yield (bu/ac)†
Cover Crop – Non-grazed	88,500 A*	55.55 B	11.73 A	61 A
Cover Crop – Grazed	84,250 A	56.13 A	11.97 A	63 A
Wheat Stubble – Non-grazed	87,000 A	55.5 B	11.7 A	61 A
P-Value	0.851	0.03	0.128	0.685

*Values with the same letter are not significantly different at a 90% confidence level.
†Bushels per acre adjusted to 13.0% moisture.

There were no impacts on beginning soil moisture amongst treatments. The cover crop treatments reached 50% soil moisture depletion sooner than the ungrazed wheat stubble treatment; however, no yield differences were observed. There were no differences in soybean stand count and moisture amongst the treatments. Soybean test weight for the grazed cover crop treatment was higher than for the ungrazed cover crop and ungrazed wheat stubble treatments.

Economic Summary (Final)

2018 Cover Crop: Costs to spray the wheat stubble for weed control were $18/ac. Costs for the non-grazed cover crop treatments were $41.82/ac for cover crop seed and drilling. Costs for the grazed cover crop treatments were $47.74 ($41.82/ac for cover crop seed and drilling, $5/ac for fencing, and $0.92/ac water). Grazing benefit is $6,370 (using a value of $2.00/head/day) for the 52.3 acres grazed. The resulting net benefit is $74.06/acre.

2019 Corn: The economic analysis had no input differences for any of the treatments for corn production. UNL Corn Budget 23 (EC872, 2019 Nebraska Crop Budgets, revised Nov. 2018) was the closest that fit this operation, so a total cost/ac of $438.08/ac and a market year average price of $3.83/bu was used. In the previously established grazed cover crop treatment, cattle grazed on the corn stalks. A $5/ac cornstalk rental rate value was assessed to this 52.3 acre area. This rate assumes water, fencing, and the care of the animals.

2020 Soybean: The economic analysis had no input differences for any of the treatments for soybean production. UNL Soybean Budget 58 (EC872, 2020 Nebraska Crop Budgets, revised Nov. 2019) was used, which states a $392.90/ac total cost. A market year average price of $9.50 was used.

Table 4. Marginal net return ($/ac) economic analysis of this study for two crop years.

	2018 Cover	2019 Corn	2020 Soy	2-Year Total
Cover Crop—Non-grazed	(-$41.82)	$285.79	$190.16	***$434.13***
Cover Crop/Stubble—Grazed	$74.06	$298.45	$202.28	***$574.79***
Stubble—Non-grazed	(-$18.00)	$278.13	$183.51	***$443.64***

This study is now concluded as the landowner did not desire wheat to be planted in the fall of 2020. The grazed cover crop treatment was the most profitable for the 2018-2020 time-frame in this field. One factor that led to this increased profitability included the use of a warm-season cover crop that allowed greater biomass and more grazing days. Another factor is that water was not hauled to this location. These are important considerations when determining the overall economics of cover crop studies. Ending soil health samples have not been collected for this field yet.

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Cover Crop Interseeding Studies

These studies evaluated the impact of interseeded cover crops on corn yield and soil quality. There were six sites examining the impact of interseeding in 2020. This on-farm research study is a collaboration of Nebraska Extension, The Nature Conservancy, Upper Big Blue NRD, NRCS, and Kellogg's.

SITES

Six studies were conducted in Seward, York, Clay, and Hamilton counties in 2020 (Figure 1). Site details are displayed in Table 1. The diversity mix consisted of 4 lb/ac hairy vetch, 4 lb/ac Pinkeye cowpeas, 1 lb/ac red clover, 1 lb/ac yellow blossom sweet clover, 4 lb/ac Red Ripper cowpeas, 3 lb/ac annual ryegrass, 1 lb/ac Italian ryegrass, 0.5 lb/ac smart radish, 0.5 lb/ac impact forage collards, 4 lb/ac Mancan buckwheat, 2 lb/ac golden flax, and 0.5 lb/ac mini pumpkins. A half rate of this mixture was used for a seeding rate of 13 lb/ac. The nitrogen mix consisted of 4 lb/ac Laredo forage soybean, 2 lb/ac yellow blossom sweet clover, 1.5 lb/ac red clover, 4 lb/ac hairy vetch, 6 lb/ac Red Ripper cowpeas, 4 lb/ac Pinkeye cowpeas, 0.5 lb/ac Nitro radish, 0.5 lb/ac impact forage collards, and 4 lb/ac Mancan buckwheat. All cover crops were interseeded at the V4 corn growth stage. Cover crop and weed biomass were measured for all sites in late September (Figure 2).

Table 1. Sites, location, year, replications, cover crop mixtures, interseeding dates, row direction and irrigation status for six sites evaluating cover crop interseeding.

ID	Report ID	County	Cover Crop Mix	Interseeding Date	Row Direction	Irrigation
2020-1	0145159202001	Seward	Diversity Mix	6/1/20	East-West	SDI
2020-2	0580035202001	Clay	Nitrogen Mix	6/3/20	North-South	Pivot
2020-3	0916185202002	York	Custom Mix	6/1/20	North-South	Pivot
2020-4	0618159202001	Seward	Diversity Mix	6/8/20	East-West	Pivot
2020-5	0073081202001	Hamilton	Diversity Mix	6/3/20	East-West	Pivot
2020-6	0918159202001	Seward	Diversity Mix	6/8/20	North-South	Pivot

RESULTS

Yield from the studies were analyzed as a large group by comparing the check and interseeded treatments (Table 2). There was no interaction of site and treatment; therefore, treatments are examined across all sites.

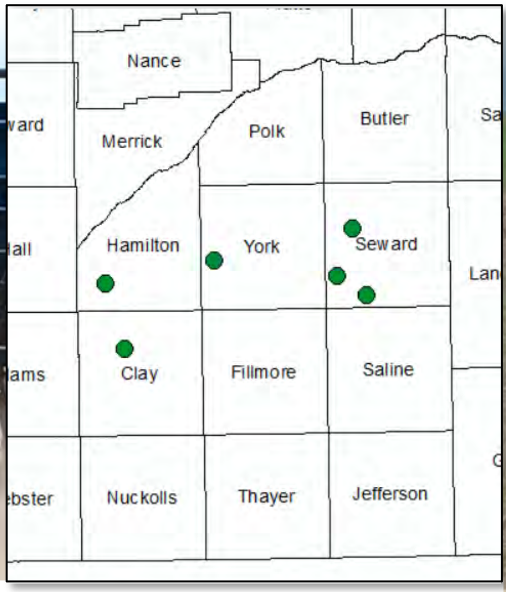


Figure 1. Locations of 2020 interseeding studies.

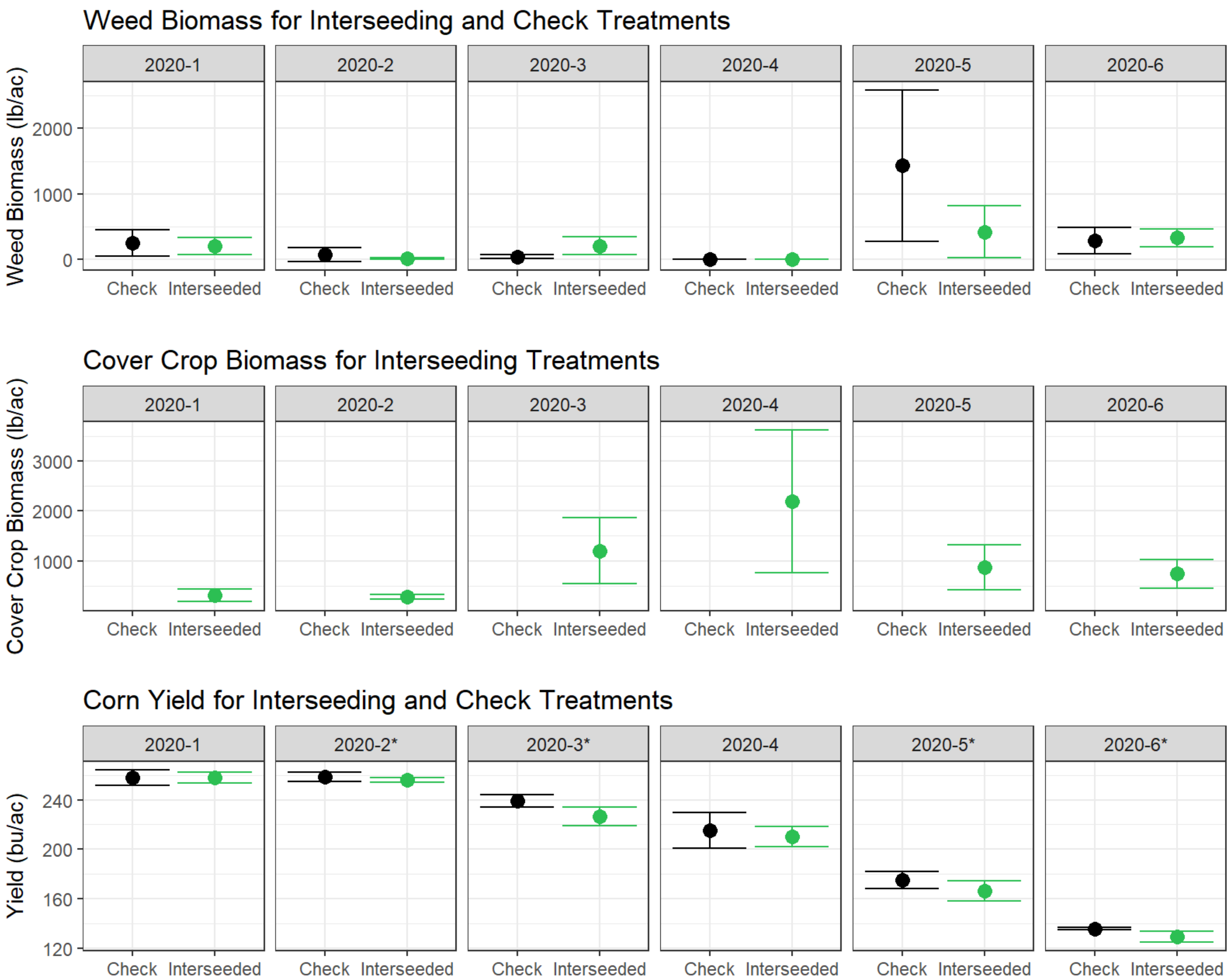


Figure 2. Mean (points) and standard deviation (bars) for weed biomass for interseeded and check treatments at six sites (top), cover crop biomass for interseeded treatments (middle), and corn yield for interseeded and check treatments at six sites (bottom). For yield, asterisks indicate sites with statistically lower corn yield following interseeded cover crop.

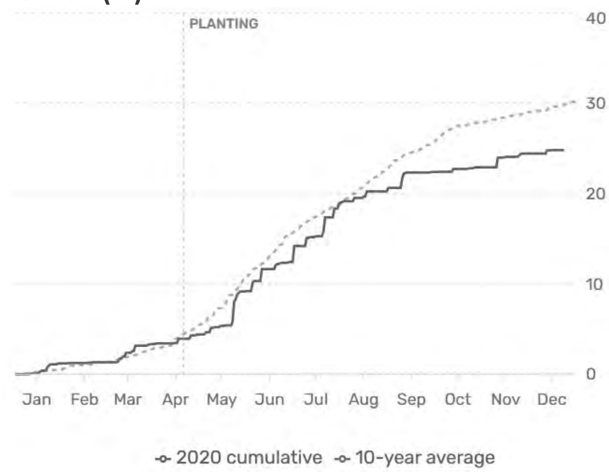
Summary:

Site 2020-3 had greater weed biomass for the interseeded treatment. At this site the check was cultivated for weed control, resulting in lower weed pressure. At all other sites there was no statistically significant differences in weed biomass between the check and interseeded cover crop treatments. Average cover crop biomass accumulated varied by site and ranged from 277 lb/ac at site 2020-2 to 2,192 lb/ac at site 2020-4. Across all the sites, corn yield for the check averaged 214 bu/ac, whereas corn yield for the interseeded treatment yielded 209 bu/ac (p-value=0.001). At four of the six sites, yield was significantly lower where the interseeded cover crop was used (sites 2020-2, 2020-3, 2020-5, and 2020-6). At the remaining two sites (2020-1 and 2020-4) yield was not different between treatments.

Impact of Interseeded Cover Crop at V4 on Irrigated Corn

Study ID: 0145159202001
County: Seward
Soil Type: Muir silt loam 0-1% slope
Planting Date: 4/20/20
Harvest Date: 10/13/20
Seeding Rate: 32,000
Row Spacing (in): 30
Hybrid: Channel® 217-92
Reps: 7
Previous Crop: Soybean
Tillage: No-Till
Herbicides: ***Pre:*** 2.3 qt/ac Volley®, 3 oz/ac Callisto®, 48 oz/ac glyphosate on 4/22/20
Seed Treatment: Standard treatment
Foliar Insecticides: None
Foliar Fungicides: None

Fertilizer: 100 lb/ac N as anhydrous ammonia in fall of 2019; 40 lb/ac N as 32% UAN on 6/20/20; 40 lb/ac N as 32% on 7/5/20; 250 lb/ac 11-52-0 on 3/20/20
Irrigation: SDI, Total: 4"
Rainfall (in):



Introduction: This on-farm research study is in collaboration with The Nature Conservancy, Upper Big Blue NRD, NRCS, and Kellogg's. The study evaluated the impact of interseeded cover crops on corn yield and soil quality. There were two treatments: a check with no cover crops interseeded and an interseeeded diversity mix. The diversity mix consisted of 4 lb/ac hairy vetch, 4 lb/ac Pinkeye cowpeas, 1 lb/ac red clover, 1 lb/ac yellow blossom sweet clover, 4 lb/ac Red Ripper cowpeas, 3 lb/ac annual ryegrass, 1 lb/ac Italian ryegrass, 0.5 lb/ac smart radish, 0.5 lb/ac impact forage collards, 4 lb/ac Mancan buckwheat, 2 lb/ac golden flax, and 0.5 lb/ac mini pumpkins. A half rate of this mixture was used for a seeding rate of 13 lb/ac. The cover crops were interseeded on June 1, 2020, when corn was V4. Corn yield, stand counts, and stalk quality were measured (Table 1). Cover crop species and biomass were also measured by sampling 18.75 sq ft per treatment on September 24, 2020 (Table 2). Soil quality was also measured with the Haney test, PLFA tests, and standard soil tests taken September 3, 2020 (Tables 3 and 4).

Results:

Table 1. Stand counts, yield, and net return for the check and interseeded cover crop treatments.

	Stand Count (plants/ac)	Stalk Rot (%)	Moisture (%)	Yield (bu/ac)†	Marginal Net Return‡ ($/ac)
Check	30,286 A	7.14 A	15.6 A	258 A	905.36 A
Interseeded Cover Crop	30,214 A	5.36 A	15.6 A	258 A	870.45 B
P-Value	0.930	0.356	0.457	1	0.006

†Bushels per acre corrected to 15.5% moisture.
‡Marginal net return based on $3.51/bu corn, $16.86/ac for cover crop seed cost, and $18/ac for interseeding.

Table 2. Biomass measurements from September 24, 2020. Plants were sorted in the field into weeds, interseeded forbs, and interseeded grasses and recorded weights are on a dry matter basis.

	Weed Biomass (lb/ac)	Cover Crop Biomass - Grass (lb/ac)	Cover Crop Biomass - Forbs (lb/ac)	Total Biomass (lb/ac)
Check	253 A*	-	-	253 B
Interseeded Cover Crop	205 A	71	241	516 A
P-Value	0.632	N/A	N/A	0.037

*Values with the same letter are not significantly different at a 90% confidence level.

Table 3. Soil tests from September 2020 for check and interseeded cover crop at 0-8” depth.

	pH	Buffer pH	OM LOI %	Nitrate-N ppm N	lbs N/A	K ppm	Sulfate-S ppm	Zn ppm	Fe ppm	Mn ppm	Cu ppm	Ca ppm	Mg ppm	Na ppm	CEC me/100g	%H Sat	%K Sat	%Ca Sat	%Mg Sat	%Na Sat	Mehlich P-III ppm P
Check	7	7.2	2.4	3.3	8	266	4.6	1.65	16	43.9	0.34	1342	151	7	8.7	0	8	77	15	0	8
Interseeded	6.8	7.2	2.4	2.8	7	251	1.7	1.67	19.7	41.3	0.39	1335	163	6	8.7	0	7	77	16	0	10

	Aggregate Stability 1-2 mm (%)	Aggregate Stability 1-2 mm in bulk soil (%)	Available Water (g H_2O/g soil)	Available Water (in H_2O/in soil)	Total Available Water (in H_2O/samples)	Field Capacity % (wt.)	Permanent Wilting Point % (wt.)
Check	33	34	0.19	0.25	2.03	33.26	14.03
Interseeded Cover Crop	43	44	0.19	0.25	1.97	32.32	13.64

Table 4. Phospholipid fatty acid (PLFA) and Haney tests for the check and interseeded cover crop at 0-8” depth. Total microbial biomass and fungal species are used as indicators of soil quality. Solvita® measures carbon dioxide emitted from microbes. The Haney soil health score is an aggregated indicator of soil health.

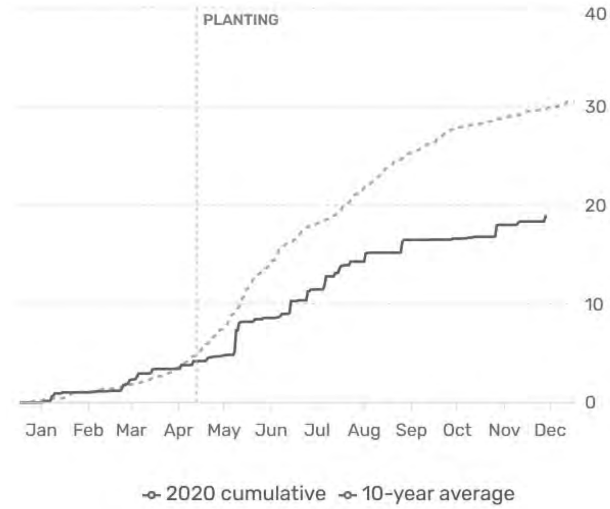
	Total Biomass (ng/g)	Diversity Index	Total Bacteria Biomass (ng/g)	Total Fungi Biomass (ng/g)	Solvita® (ppm C)	Haney Soil Health Score
Check	1905	1.21	312	13	86 A	12 A
Interseeded Cover Crop	1135	0.99	562	0	90 A	12 A
P-Value	N/A	N/A	N/A	N/A	0.577	0.655

Summary:

- The interseeded cover crop produced approximately 516 lb/ac biomass, of which 205 lb/ac was weeds. The check did not have any cover crop biomass but had 253 lb/ac weeds.
- There was no difference in stand count or stalk quality between the corn with interseeded cover crop and the check.
- The corn in the interseeded cover crop yielded the same as the corn with no interseeded cover crop. The corn with interseeded cover crop resulted in a $34.91/ac lower net return.
- Several legume species in the cover crop mix have the ability to fix nitrogen. The goal of the soil tests was to determine if there were differences in available soil N due to the cover crop. The soil test taken in September did not show any increase in soil N for the interseeded treatment. Because the samples from the replications were combined, no statistics are available. In future years tissue tests may be collected to evaluate N differences.
- There were no differences in the Solvita® or Haney soil health scores between the corn with interseeded cover crop and the check. Because the samples from the replications were combined, no statistics are available for the PLFA tests. These beginning numbers will serve as a reference for future years of the study.

Impact of Interseeded Cover Crop at V4 on Irrigated Corn

Study ID: 0580035202001
County: Clay
Soil Type: Crete silt loam 0-1% slope; Hastings silt loam 1-3% slope; Holder silty clay 7-11% slopes, eroded
Planting Date: 4/27/20
Harvest Date: 10/20/20
Population: 32,000
Row Spacing (in): 30
Hybrid: Pioneer® P1082
Reps: 7
Previous Crop: Corn
Tillage: No-Till
Herbicides: ***Pre:*** 16 oz/ac atrazine, 16 oz/ac meolachlor, and 32 oz/ac Roundup® ***Post:*** 32 oz/ac Liberty®
Seed Treatment: None
Foliar Insecticides: 3.8 oz/ac lambda-cyhalothrin and 6.4 oz/ac Capture® at brown silk
Foliar Fungicides: 10.5 oz/ac Quilt Xcel® at brown silk
Fertilizer: 170 lb N/ac as Anhydrous Ammonia in April; 60 lb N/ac as 28-0-0-5 through fertigation in June
Irrigation: Pivot, Total: 8"
Rainfall (in):



Introduction: This on-farm research study is in collaboration with The Nature Conservancy, Upper Big Blue NRD, NRCS, and Kellogg's. This study evaluated the impact of interseeded cover crops on corn yield and soil quality. There were two treatments: a check with no cover crops interseeded and an interseeeded nitrogen mix. The nitrogen mix consisted of 4 lb/ac Laredo forage soybean, 2 lb/ac yellow blossom sweet clover, 1.5 lb/ac red clover, 4 lb/ac hairy vetch, 6 lb/ac Red Ripper cowpeas, 4 lb/ac Pinkeye cowpeas, 0.5 lb/ac Nitro radish, 0.5 lb/ac impact forage collards, and 4 lb/ac Mancan buckwheat. A half rate of this mixture was used for a seeding rate of 13 lb/ac. The cover crops were interseeded on June 3, 2020, when corn was V4. Corn yield, stand counts, and stalk quality were measured (Table 1). Cover crop species and biomass were also measured by sampling 18.75 sq ft per treatment on September 23, 2020 (Table 2). Soil quality was also measured with the Haney test, PLFA (phospholipid fatty acid) tests, and standard soil tests (Tables 3 and 4).

Results:

Table 1. Stand counts, yield, and net return for the check and interseeded cover crop treatments.

	Stand Count (plants/ac)	Green snap (%)	Stalk Rot (%)	Test Weight (lb/bu)	Moisture (%)	Yield (bu/ac)†	Marginal Net Return‡ ($/ac)
Check	32,071 A	1 A	1.79 A	58 A	16.7 A	259 A	908.02 A
Interseeded Cover Crop	31,857 A	0 A	0.71 A	58 A	16.4 A	256 B	862.71 B
P-Value	0.639	0.289	0.356	0.561	0.280	0.090	0.0001

†Bushels per acre corrected to 15.5% moisture.
‡Marginal net return based on $3.51/bu corn, $18.16/ac for cover crop seed cost, and $18/ac for interseeding.

Table 2. Biomass measurements from September 23, 2020. Plants were sorted in the field into weeds and interseeded forbs and recorded weights are on a dry matter basis.

	Weed Biomass (lb/ac)	Cover Crop Biomass - Forbs (lb/ac)	Total Biomass (lb/ac)
Check	73 A	-	73 B*
Interseeded Cover Crop	13 A	277	290 A
P-Value	0.283	N/A	0.005

*Values with the same letter are not significantly different at a 90% confidence level.

Table 3. Soil tests from September 2020 for check and interseeded cover crop at 0-8" depth.

	pH	Buffer pH	OM LOI %	Nitrate-N ppm N	lbs N/A	K ppm	Sulfate-S ppm	Zn ppm	Fe ppm	Mn ppm	Cu ppm	Ca ppm	Mg ppm	Na ppm	CEC me/100g	%H Sat	%K Sat	%Ca Sat	%Mg Sat	%Na Sat	Mehlich P-III ppm P
Check	6.7	7.2	3.4	6.2	15	307	13.8	2.32	23.5	43.6	0.57	2050	201	41	12.9	0	6	79	13	1	21
Interseeded	6.7	7.2	3.4	4.3	10	273	10.9	1.96	41.3	30	0.47	1900	183	39	11.9	0	6	80	13	1	21

	Aggregate Stability 1-2 mm (%)	Aggregate Stability 1-2 mm in bulk soil (%)	Available Water (g H_2O/g soil)	Available Water (in H_2O/in soil)	Total Available Water (in H_2O/samples)	Field Capacity % (wt.)	Permanent Wilting Point % (wt.)
Check	36	36	0.19	0.25	2.04	36.81	17.53
Interseeded Cover Crop	38	38	0.18	0.24	1.89	36.64	18.7

Table 4. Phospholipid fatty acid (PLFA) and Haney tests for the check and interseeded cover crop at 0-8" depth. Total microbial biomass and fungal species are used as indicators of soil quality. Solvita® measures carbon dioxide emitted from microbes. The Haney soil health score is an aggregated indicator of soil health.

	Total Biomass (ng/g)	Diversity Index	Total Bacteria Biomass (ng/g)	Total Fungi Biomass (ng/g)	Solvita® CO2-C	Haney Soil Health Score
Check	1448	0.93	703	0	98.4 A	13.34 A
Interseeded Cover Crop	1213	1.05	582	7	103.6 A	13.95 A
P-Value	N/A	N/A	N/A	N/A	0.531	0.464

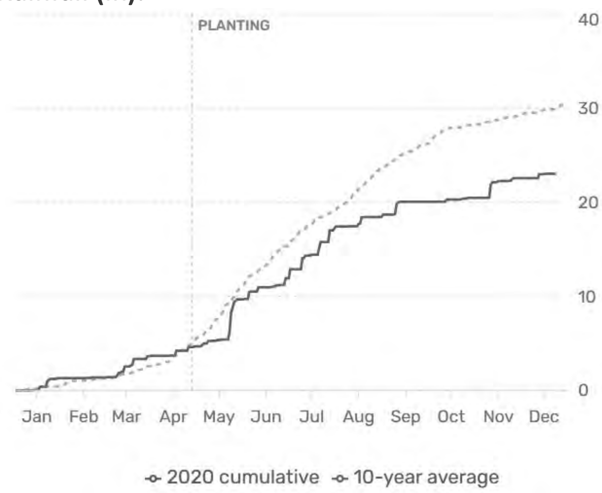
Summary:

- The interseeded cover crop produced approximately 290 lb/ac biomass, of which 12.7 lb/ac was weeds. The check did not have any cover crop biomass but had 72.5 lb/ac weeds.
- There were no differences in stand count, stalk quality, test weight, or moisture between the corn with interseeded cover crop and the check.
- The corn in the interseeded cover crop yielded 2.6 bu/ac lower than the corn with no interseeded cover crop. The corn with interseeded cover crop resulted in a $45.31/ac lower net return.
- Several legume species in the cover crop mix have the ability to fix nitrogen. The goal of the soil tests was to determine if there were differences in available soil N due to the cover crop. The soil test taken in September did not show any increase in soil N for the interseeded treatment. Because the samples from the replications were combined, no statistics are available. In future years tissue tests may be collected to evaluate N differences.
- There were no differences in the Solvita® or Haney soil health scores between the corn with interseeded cover crop and the check. Because the samples from the replications were combined, no statistics are available for the PLFA tests. These beginning numbers will serve as a reference for future years of the study.

Impact of Interseeded Cover Crop at V4 on Irrigated Corn

Study ID: 0916185202002
County: York
Soil Type: Hastings silt loam 0-1% slope
Planting Date: 4/27/20
Harvest Date: 10/2/20
Seeding Rate: 31,000
Row Spacing (in): 36
Hybrid: Big Cob 11-45 VT Double PRO® RIB
Reps: 4
Previous Crop: Corn
Tillage: Ridge-Till and Cultivate
Herbicides: ***Pre:*** Banded 1.25 qt/ac Stalwart® 3W at planting; 36 oz/ac GlyStar® 5 Extra and 1 pt/ac generic buctril 1 day prior to interseeding
Seed Treatment: Acceleron® 250
Foliar Insecticides: 7 oz/ac bifenthrin in-furrow at planting
Foliar Fungicides: 10.5 oz/ac Propaz at R3

Fertilizer: 190 lb/ac N spring applied as anhydrous ammonia
Irrigation: Pivot, Total: 10"
Rainfall (in):



Introduction: This on-farm research study is in collaboration with The Nature Conservancy, Upper Big Blue NRD, NRCS, and Kellogg's. The goal was to determine any impacts of corn population on interseeded cover crop biomass and corn yield and economics. There were three treatments: a check with no cover crops interseeded and corn planted at 31,000 seeds/ac, corn planted at 27,000 seeds/ac with a cover crop interseeeded, and corn planted at 31,000 seeds/ac with a cover crop interseeded. The check was cultivated for weed control. The cover crop mix consisted of 2 lb/ac hairy vetch, 4 lb/ac cowpeas, 1 lb/ac red clover, 0.3 lb/ac rapeseed, 1 lb/ac radish, 2 lb/ac buckwheat, and 2 lb/ac flax. The cover crops were interseeded on June 1, 2020, when corn was V4. Corn yield, stand counts, and stalk quality were measured (Table 1). Cover crop species and biomass were also measured by sampling 27 sq ft per treatment on September 24, 2020 (Table 2). Soil quality was also measured with the Haney test, PLFA tests, and standard soil tests taken September 2, 2020 (Tables 3 and 4). Wind in early July caused 2-5% breakage and damaged leaves. This allowed more light infiltration than normal and the interseeded cover crops took advantage of the light.

Results:

Table 1. Stand counts, yield, and net return for the check and interseeded cover crop treatments.

	Stand Count (plants/ac)	Stalk Rot (%)	Moisture (%)	Yield (bu/ac)†	Marginal Net Return‡ ($/ac)
Check (31,000 seeds/ac)	29,375	13.75	22.3 A	239 A	768.49 A
Cover Crop Interseeded into 27,000 seeds/ac Corn	27,000	3.75	22.2 A	217 B	716.66 B
Cover Crop Interseeded into 31,000 seeds/ac Corn	29,500	3.75	21.9 A	227 B	738.23 AB
P-Value	N/A	N/A	0.582	0.007	0.039

†Yield values are from cleaned yield monitor data. Bushels per acre corrected to 15.5% moisture.
‡Marginal net return based on $3.51/bu corn, $217/bag 80,000 seeds, $13/ac cultivation on the check, $10/ac for interseeding, and $16.70/ac for cover crop seed for the interseeded treatments.

Table 2. Biomass measurements from September 24, 2020. Plants were sorted in the field into weeds and interseeded forbs and recorded weights are on a dry matter basis.

	Weed Biomass (lb/ac)	Cover Crop Biomass - Forbs (lb/ac)	Total Biomass (lb/ac)
Check	39 B*	-	39 B
Interseeded Cover Crop	205 A	1199	1404 A
P-Value	0.080	N/A	0.036

*Values with the same letter are not significantly different at a 90% confidence level.

Table 3. Soil tests from September 2, 2020, for check and interseeded cover crop at 0-8” depth.

	pH	Buffer pH	OM LOI %	Nitrate-N ppm N	lbs N/A	K ppm	Sulfate-S ppm	Zn ppm	Fe ppm	Mn ppm	Cu ppm	Ca ppm	Mg ppm	Na ppm	CEC me/100g	%H Sat	%K Sat	%Ca Sat	%Mg Sat	%Na Sat	Mehlich P-III ppm P
Check	6.45	6.75	2.65	3.68	8.8	441	7.8	1.3	29	7.5	0.5	2108	250	33	16.4	14.5	7	65	13	1	12
Interseeded	6.2	6.68	2.65	2.4	5.8	411	7.5	1.4	34	9.3	0.5	1943	222	40	16.0	19.8	6.5	61	12	1	11.5
P-Value	0.14	0.32	1	0.32	0.30	0.12	0.72	0.60	0.04	0.18	1	0.03	0.06	0.06	0.43	0.29	0.18	0.34	0.25	-	0.79

Table 4. Phospholipid fatty acid (PLFA) and Haney tests for the check and interseeded cover crop at 0-8” depth. Total microbial biomass and fungal species are used as indicators of soil quality. Solvita® measures carbon dioxide emitted from microbes. The Haney soil health score is an aggregated indicator of soil health.

	Total Biomass (ng/g)	Diversity Index	Total Bacteria Biomass (ng/g)	Total Fungi Biomass (ng/g)	Solvita® (ppm C)	Haney Soil Health Score
Check	2479 A	1.37 A	1081 A	177 A	47.9 A	11.4
Interseeded Cover Crop	2691 A	1.40 A	1172 A	194 A	50.9 A	11.8
P-Value	0.291	0.844	0.173	0.829	0.689	0.619

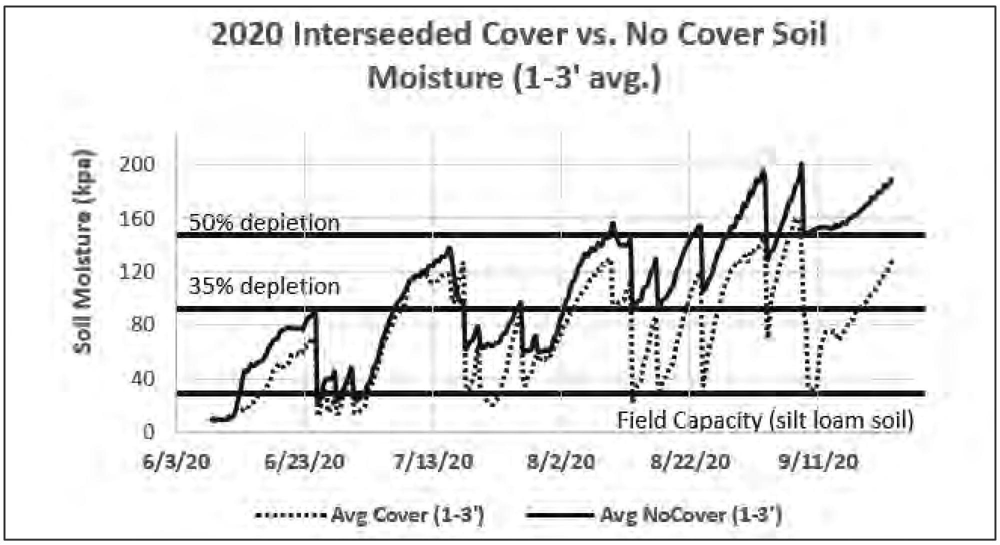


Figure 1. WATERMARK™ Soil Moisture Sensors were installed at 1’, 2’, 3’ depths in the corn that was interseeded (Cover) and the check (No Cover). The No Cover was consistently drier than the corn with the cover crop interseeded.

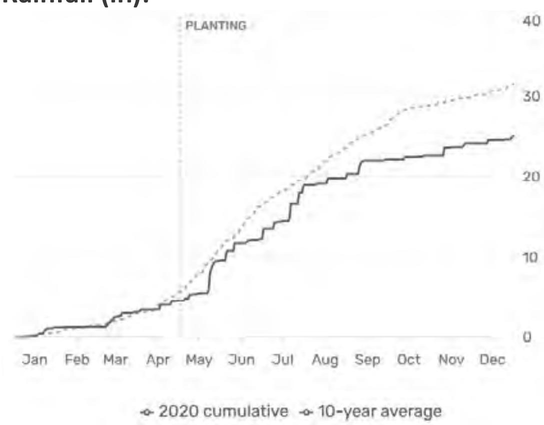
Summary:

- The interseeded cover crop produced approximately 1404 lb/ac biomass, of which 205 lb/ac was weeds. The check did not have cover crop biomass, but had 39 lb/ac weeds.
- The check (corn planted at 31,000 seeds/ac without the interseeded cover crop) yielded 12.5 bu/ac more than the corn with interseeded cover crop and seeded at 31,000 seeds/ac. The check yielded 21.8 bu/ac more than the corn with interseeded cover crop and seeded at 27,000 seeds/ac.
- There were no differences in total microbial biomass, diversity index, bacterial or fungal biomass, Solivta®, or Haney soil health score between the interseeded cover crops and the check.
- Several legume species in the cover crop mix have the ability to fix nitrogen. The goal of the soil tests was to determine if there were differences in available soil N due to the cover crop. Results of the test showed no differences in the soil N levels between the check and interseeded cover crop.

Impact of Interseeded Cover Crop at V4 on Irrigated Corn

Study ID: 0618159202001
County: Seward
Soil Type: Geary silty clay loam 3-7% slopes; Geary silty clay loam 7-11% slopes, eroded; Hastings silty clay loam 3-7% slopes; Hastings silty clay loam 7-11% slopes, eroded; Muir silt loam 1-3% slope
Planting Date: 5/1/20
Harvest Date: 10/14/20
Seeding Rate: 32,000
Row Spacing (in): 30
Hybrid: Channel® 213-19
Reps: 4
Previous Crop: Corn
Tillage: No-Till
Herbicides: ***Pre:*** 2.25 qt/ac Lexar® on 5/6/20
Post: 32 oz/ac glyphosate on 6/9/20

Fertilizer: 175 lb/ac N as 32% UAN on 5/6/20; 50 lb/ac N as 32% UAN pre-tassel
Note: 10% green snap
Irrigation: Pivot, Total: 3.75"
Rainfall (in):



Introduction: This on-farm study is in collaboration with The Nature Conservancy, Upper Big Blue NRD, NRCS, and Kellogg's. The study evaluated the impact of interseeded cover crops on corn yield and soil quality. There were three treatments: a check with no cover crops interseeded, an interseeeded diversity mix drilled with one drill unit between corn rows, and an interseeded diversity mix drilled with three drill units between corn rows. Each treatment was 8 rows wide. Seeding rates were adjusted so that the one drill unit and three drill units had similar per-acre seeding rates. The diversity mix consisted of 4 lb/ac hairy vetch, 4 lb/ac Pinkeye cowpeas, 1 lb/ac red clover, 1 lb/ac yellow blossom sweet clover, 4 lb/ac Red Ripper cowpeas, 3 lb/ac annual ryegrass, 1 lb/ac Italian ryegrass, 0.5 lb/ac smart radish, 0.5 lb/ac impact forage collards, 4 lb/ac Mancan buckwheat, 2 lb/ac golden flax, and 0.5 lb/ac mini pumpkins. A half rate of this mixture was used for a seeding rate of 13 lb/ac. The cover crops were interseeded on June 9, 2020, when corn was V4. Corn yield, stand counts, and stalk quality were measured (Table 1). Cover crop species and biomass were also measured by sampling 18.75 sq ft per treatment on September 24, 2020 (Table 2). Soil quality was also measured with the Haney test, PLFA tests, and standard soil tests taken September 3, 2020 (Tables 3 and 4). The field had approximately 10% green snap.

Results:

Table 1. Stand counts, yield, and net return for the check and interseeded cover crop treatments.

	Stand Count (plants/ac)	Stalk Rot (%)	Green snap (%)	Moisture (%)	Yield (bu/ac)†	Marginal Net Return‡ ($/ac)
Check	29,250 A	13.75 A	1 A	15.9 A	215 A	754.94 A
Interseeded (1 Drill Unit)	31,500 A	15.00 A	0 A	16.1 A	207 A	691.71 B
Interseeded (3 Drill Units)	31,500 A	12.50 A	0 A	16.1 A	213 A	713.84 B
P-Value	0.268	0.964	0.422	0.286	0.119	0.005

†Yield values are from cleaned yield monitor data. Bushels per acre corrected to 15.5% moisture.
‡Marginal net return based on $3.51/bu corn, $16.86/ac for cover crop seed cost, and $18/ac for interseeding.

Table 2. Biomass measurements from September 24, 2020. Plants were sorted in the field into weeds, interseeded forbs, and interseeded grasses and recorded weights are on a dry matter basis.

	Weed Biomass (lb/ac)	Cover Crop Biomass - Grass (lb/ac)	Cover Crop Biomass - Forbs (lb/ac)	Total Biomass (lb/ac)
Check	0	N/A	N/A	0 B
Interseeded (1 Drill Unit)	0	4 A*	1,224 A	1,227 A
Interseeded (3 Drill Units)	0	13 A	857 A	870 AB
P-Value	N/A	0.277	0.560	0.097

*Values with the same letter are not significantly different at a 90% confidence level.

Table 3. Soil tests from September 2020 for check and interseeded cover crop at 0-8" depth.

	pH	Buffer pH	OM LOI %	Nitrate-N ppm N	lbs N/A	K ppm	Sulfate-S ppm	Zn ppm	Fe ppm	Mn ppm	Cu ppm	Ca ppm	Mg ppm	Na ppm	CEC me/100g	%H Sat	%K Sat	%Ca Sat	%Mg Sat	%Na Sat	Mehlich P-III ppm P
Check	7.5	7.2	2.5	2.2	5	277	11.8	3.51	31.5	12.8	0.87	3513	334	18	21.1	0	3	83	13	0	38
Interseeded (1 Unit)	7.3	7.2	2.5	2.2	5	218	19.5	4.37	29.1	16.7	0.73	2501	335	19	15.9	0	4	77	18	1	33
Interseeded (3 Units)	7.1	7.2	3.2	4.5	11	423	10.8	2.79	90	19.4	1.1	2175	334	18	14.8	0	7	73	19	1	70

	Aggregate Stability 1-2 mm (%)	Aggregate Stability 1-2 mm in bulk soil (%)	Available Water (g H_2O/g soil)	Available Water (in H_2O/in soil)	Total Available Water (in H_2O/samples)	Field Capacity % (wt.)	Permanent Wilting Point % (wt.)
Check	45	43	0.21	0.28	2.21	32.82	11.84
Interseeded (1 Unit)	43	41	0.21	0.28	2.25	33.87	12.61
Interseeded (3 Units)	39	38	0.23	0.3	2.42	36.45	13.52

Table 4. Phospholipid fatty acid (PLFA) and Haney tests for the check and interseeded cover crop at 0-8" depth. Total microbial biomass and fungal species are used as indicators of soil quality. Solvita® measures carbon dioxide emitted from microbes. The Haney soil health score is an aggregated indicator of soil health.

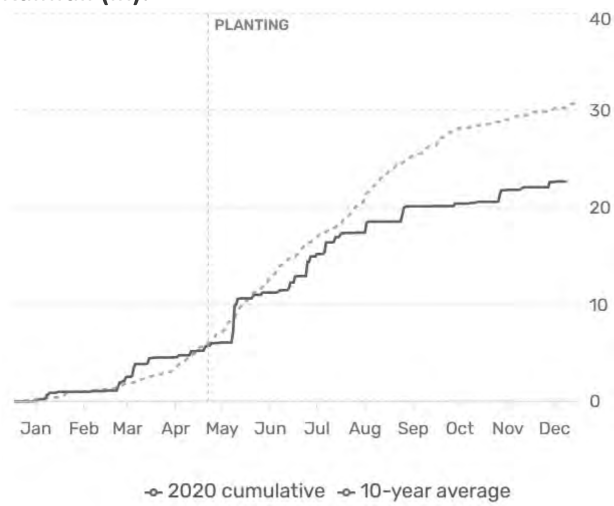
	Total Biomass (ng/g)	Diversity Index	Total Bacteria Biomass (ng/g)	Total Fungi Biomass (ng/g)	Solvita® (ppm C)	Haney Soil Health Score
Check	1138	1.01	528	7	83	12
Interseeded (1 Drill Unit)	800	1.06	428	8	65	10
Interseeded (3 Drill Units)	1568	1.07	795	19	68	13
P-Value	N/A	N/A	N/A	N/A	0.718	0.262

Summary:

- The interseeded cover crop with 1 drill unit configuration produced 1,227 lb/ac of biomass and the 3 drill unit configuration produced 870 lb/ac of biomass. The check did not have any cover crop biomass or weed biomass.
- There was no difference in stand count or stalk quality between the corn with interseeded cover crop and the check.
- The corn in the interseeded cover crop yielded the same as the corn with no interseeded cover crop. The corn with interseeded cover crop resulted in a $41.10/ac to $63.23/ac lower net return.
- Several legume species in the cover crop mix have the ability to fix nitrogen. The goal of the soil tests was to determine if there were differences in available soil N due to the cover crop. Because the samples from the replications were combined, no statistics are available. In future years tissue tests may be collected to evaluate N differences.
- There were no differences in the Solvita® or Haney soil health scores between the corn with interseeded cover crop and the check. Because samples from the replications were combined, no statistics are available for the PLFA tests. These beginning numbers will serve as a reference for future years of the study.

Impact of Interseeded Cover Crop at V4 on Irrigated Corn

Study ID: 0073081202001
County: Hamilton
Soil Type: Hastings silt loam 0-3% slope
Planting Date: 5/6/20
Harvest Date: 10/29/20
Seeding Rate: 32,000
Row Spacing (in): 30
Hybrid: Pioneer® P1639WAM
Reps: 7
Previous Crop: Soybean
Tillage: No-Till
Herbicides: ***Pre:*** 13 oz/ac Verdict®, 21 oz/ac FBN AMS Pro, and 9.5 gal/ac water on 5/8/20
Seed Treatment: None
Foliar Insecticides: 4 oz/ac Seize LFC and 3 gal/ac water on 5/6/20; 6 oz/ac Frenzy Veloz on 7/23/20
Foliar Fungicides: 10 oz/ac Headline AMP® on 7/23/20
Fertilizer: 150 lb/ac N as urea on 4/15/20; 1 gal/ac N-Cline on 7/23/20
Irrigation: Pivot, Total: 5"
Rainfall (in):



Introduction: This on-farm research study is in collaboration with The Nature Conservancy, Upper Big Blue NRD, NRCS, and Kellogg's. This study evaluated the impact of interseeded cover crops on corn yield and soil quality. There were two treatments: a check with no cover crops interseeded and an interseeeded diversity mix. The diversity mix consisted of 4 lb/ac hairy vetch, 4 lb/ac Pinkeye cowpeas, 1 lb/ac red clover, 1 lb/ac yellow blossom sweet clover, 4 lb/ac Red Ripper cowpeas, 3 lb/ac annual ryegrass, 1 lb/ac Italian ryegrass, 0.5 lb/ac smart radish, 0.5 lb/ac impact forage collards, 4 lb/ac Mancan buckwheat, 2 lb/ac golden flax, and 0.5 lb/ac mini pumpkins. A half rate of this mixture was used for a seeding rate of 13 lb/ac. The cover crops were interseeded on June 3, 2020, when corn was V4. Corn yield, stand counts, and stalk quality were measured (Table 1). Cover crop species and biomass were also measured by sampling 18.75 sq ft per treatment on September 23, 2020 (Table 2). Soil quality was also measured with the Haney test, PFLA tests, and standard soil tests (Tables 3 and 4).

Results:

Table 1. Stand counts, yield, and net return for the check and interseeded cover crop treatments.

	Stand Count (plants/ac)	Green snap (%)	Stalk Rot (%)	Moisture (%)	Yield (bu/ac)†	Marginal Net Return‡ ($/ac)
Check	30,700 A	7 A	12.50 A	15.5 A	175 A	614.51 A
Interseeded Cover Crop	29,600 A	9 A	20.00 A	15.3 B	166 B	549.33 B
P-Value	0.407	0.460	0.432	0.012	0.010	0.0002

†Yield values are from cleaned yield monitor data. Bushels per acre corrected to 15.5% moisture.
‡Marginal net return based on $3.51/bu corn, $16.86/ac for cover crop seed cost, and $18/ac for interseeding.

Table 2. Biomass measurements from September 23, 2020. Plants were sorted in the field into weeds, interseeded forbs, and interseeded grasses and recorded weights are on a dry matter basis.

	Weed Biomass (lb/ac)	Cover Crop Biomass - Forbs (lb/ac)	Cover Crop Biomass - Grass (lb/ac)	Total Biomass (lb/ac)
Check	1,435 A*	-	-	1,435 A
Interseeded Cover Crop	419 A	865	4	1,289 A
P-Value	0.133	N/A	N/A	0.694

*Values with the same letter are not significantly different at a 90% confidence level.

Table 3. Soil tests from September 2020 for check and interseeded cover crop at 0-8" depth.

	pH	Buffer pH	OM LOI %	Nitrate-N ppm N	lbs N/A	K ppm	Sulfate-S ppm	Zn ppm	Fe ppm	Mn ppm	Cu ppm	Ca ppm	Mg ppm	Na ppm	CEC me/100g	%H Sat	%K Sat	%Ca Sat	%Mg Sat	%Na Sat	Mehlich P-III ppm P
Check	5.8	6.6	3.7	3.5	8	294	7.2	2.28	77.2	61.3	0.83	1727	204	18	15.5	28	5	55	11	1	7
Interseeded	6	6.6	3.4	1.6	4	286	3.8	1.57	58.4	53.3	0.68	1771	213	17	15.2	25	5	58	12	0	6

	Aggregate Stability 1-2 mm (%)	Aggregate Stability 1-2 mm in bulk soil (%)	Available Water (g H_2O/g soil)	Available Water (in H_2O/in soil)	Total Available Water (in H_2O/samples)	Field Capacity % (wt.)	Permanent Wilting Point % (wt.)
Check	52	54	0.22	0.29	2.33	39.97	17.87
Interseeded Cover Crop	50	52	0.22	0.3	2.36	39.27	16.92

Table 4. Phospholipid fatty acid (PLFA) and Haney tests for the check and interseeded cover crop at 0-8". Total microbial biomass and fungal species are used as indicators of soil quality. Solvita® is a measure of carbon dioxide emitted from microbes. The Haney soil health score is an aggregated indicator of soil health.

	Total Biomass (ng/g)	Diversity Index	Total Bacteria Biomass (ng/g)	Total Fungi Biomass (ng/g)	Solvita® (ppm C)	Haney Soil Health Score
Check	2715	1.03	1418	103	72 A	11 A
Interseeded Cover Crop	1270	0.95	596	0	93 A	13 A
P-Value	N/A	N/A	N/A	N/A	0.187	0.176

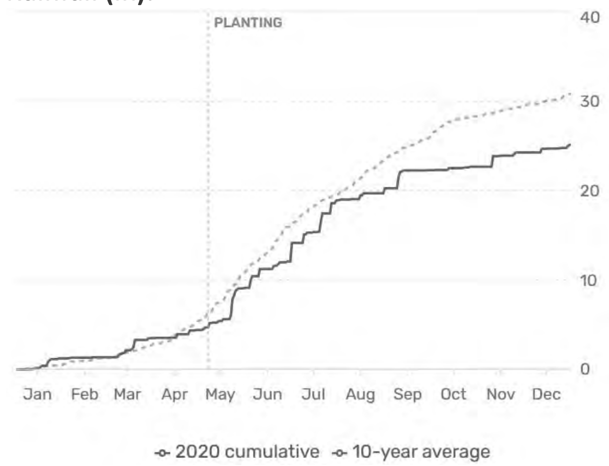
Summary:

- The interseeded cover crop produced approximately 1289 lb/ac biomass, of which 419 lb/ac was weeds. The check did not have any cover crop biomass, but had 1435 lb/ac weeds.
- There were no differences in stand count or stalk quality between the corn with interseeded cover crop and the check.
- The corn in the interseeded cover crop yielded 8.6 bu/ac lower than the corn with no interseeded cover crop. The corn with interseeded cover crop resulted in a $65.18/ac lower net return.
- Several legume species in the cover crop mix have the ability to fix nitrogen. The goal of the soil tests was to determine if there were differences in available soil N due to the cover crop. The soil test taken in September did not show any increase in soil N for the interseeded treatment. Because the samples from the replications were combined, no statistics are available. In future years tissue tests may be collected to evaluate N differences.
- There were no differences in the Solvita® or Haney soil health scores between the corn with interseeded cover crop and the check. Because the samples from the replications were combined, no statistics are available for the PLFA tests. These beginning numbers will serve as a reference for future years of the study.

Impact of Interseeded Cover Crop at V4 on Irrigated Corn

Study ID: 0918159202001
County: Seward
Soil Type: Hastings silt loam 0-1% slope; Hastings silt loam 1-3% slope; Hastings silty clay loam 3-7% slopes
Planting Date: 5/7/20
Harvest Date: 10/24/20
Seeding Rate: 33,000 for irrigated, 26,500 for non-irrigated
Row Spacing (in): 30
Hybrid: CROPLAN® 5335
Reps: 4
Previous Crop: Corn
Tillage: Ridge-Till
Herbicides: ***Pre:*** 2 pt/ac Staunch® II ***Post:*** 32 oz/ac Roundup® and Cadet®
Seed Treatment: Acceleron®

Fertilizer: 99 lb/ac N as 32% UAN on 5/10/20 and 107 lb/ac N as 32% UAN on 6/8/20
Irrigation: Pivot, Total: 3"
Rainfall (in):



Introduction: This on-farm research study is in collaboration with The Nature Conservancy, Upper Big Blue NRD, NRCS, and Kellogg's. The study evaluated the impact of interseeded cover crops on corn yield and soil quality. There were two treatments: a check with no cover crops interseeded and an interseeeded diversity mix. The diversity mix consisted of 4 lb/ac hairy vetch, 4 lb/ac Pinkeye cowpeas, 1 lb/ac red clover, 1 lb/ac yellow blossom sweet clover, 4 lb/ac Red Ripper cowpeas, 3 lb/ac annual ryegrass, 1 lb/ac Italian ryegrass, 0.5 lb/ac smart radish, 0.5 lb/ac impact forage collards, 4 lb/ac Mancan buckwheat, 2 lb/ac golden flax, and 0.5 lb/ac mini pumpkins. A half rate of this mixture was used for a seeding rate of 13 lb/ac. The cover crops were interseeded on June 9, 2020, when corn was V4. Corn yield, stand counts, and stalk quality were measured (Table 1). Cover crop species and biomass were also measured by sampling 18.75 sq ft per treatment on September 24, 2020 (Table 2). Soil quality was also measured with the Haney test, PLFA tests, and standard soil tests taken September 3, 2020 (Tables 3 and 4). A July 9, 2020, windstorm resulted in 45% green snap.

Results:

Table 1. Stand count, plant health, yield, and net return for no cover crop and interseeded cover crop.

	Harvest Stand Count (plants/ac)	Stalk Rot (%)	Green snap (%)	Moisture (%)	Yield (bu/ac)†	Marginal Net Return‡ ($/ac)
Check	16,375 A	1.25 A	46 A	9.5 A	131 A	459.05 A
Interseeded Cover Crop	17,750 A	1.25 A	40 A	9.5 A	126 B	407.30 B
P-Value	0.372	1	0.213	1	0.067	0.003

†Yield values are from cleaned yield monitor data. Bushels per acre corrected to 15.5% moisture.
‡Marginal net return based on $3.51/bu corn, $16.86/ac for cover crop seed cost, and $18/ac for interseeding.

Table 2. Biomass measurements collected on September 24, 2020. Plants were sorted into weeds, interseeded grasses, and interseeded forbs. Weights were recorded below on a dry matter basis.

	Weed Biomass (lb/ac)	Cover Crop Biomass - Grass (lb/ac)	Cover Crop Biomass - Forbs (lb/ac)	Total Biomass (lb/ac)
Check	286 A*	N/A	N/A	285 B
Interseeded Cover Crop	328 A	7	732	1,067 A
P-Value	0.817	N/A	N/A	0.026

*Values with the same letter are not significantly different at a 90% confidence level.

Table 3. Soil tests collected on September 3, 2020, for check and interseeded cover crop at 0-8" depth.

	pH	Buffer pH	OM LOI %	Nitrate-N ppm N	lbs N/A	K ppm	Sulfate-S ppm	Zn ppm	Fe ppm	Mn ppm	Cu ppm	Ca ppm	Mg ppm	Na ppm	CEC me/100g	%H Sat	%K Sat	%Ca Sat	%Mg Sat	%Na Sat	Mehlich P-III ppm P
Check	6.2	6.7	3.7	2	5	220	4.6	3.55	56.2	35.7	0.57	1904	209	18	15.1	21	4	62	12	1	23
Interseeded	6.5	6.7	3.7	1.4	3	193	7.2	3.5	39.3	37.7	0.57	2021	210	19	15.5	20	3	65	11	1	15

	Aggregate Stability 1-2 mm (%)	Aggregate Stability 1-2 mm in bulk soil (%)	Available Water (g H_2O/g soil)	Available Water (in H_2O/in soil)	Total Available Water (in H_2O/samples)	Field Capacity % (wt.)	Permanent Wilting Point % (wt.)
Check	51	53	0.19	0.25	2.01	37.64	18.66
Interseeded Cover Crop	49	51	0.2	0.26	2.11	37.63	17.68

Table 4. PLFA (phospholipid fatty acid) and Haney test at a 0-8" depth for the no cover crop check and interseeded cover crop. Total microbial biomass and fungal species are used as indicators of soil quality. Solvita® measures carbon dioxide emitted from microbes. The Haney soil health score is an aggregated indicator of soil health.

	Total Biomass (ng/g)	Diversity Index	Total Bacteria Biomass (ng/g)	Total Fungi Biomass (ng/g)	Solvita® (ppm C)	Haney Soil Health Score
Check	1492.5	1.17	51.34	2.74	70.1 B	11.4 B
Interseeded Cover Crop	1351.5	0.93	47.75	0.49	95.1A	13.2 A
P-Value	N/A	N/A	N/A	N/A	0.066	0.080

Summary:

- The interseeded cover crop produced approximately 1067 lb/ac biomass, of which 328 lb/ac was weeds. The check did not have any cover crop biomass, but had 286 lb/ac weeds.
- There was no difference in stand count or stalk quality between the corn with interseeded cover crop and the check.
- The corn in the interseeded cover crop yielded 4.8 bu/ac lower than the corn with no interseeded cover crop. The corn with interseeded cover crop resulted in a $51.75/ac lower net return.
- The 45% green snap opened up the canopy to higher rates of both weeds and cover crop biomass in this field. The combination impacted the yield and stand counts on this field.
- Several legume species in the cover crop mix have the ability to fix nitrogen. The goal of the soil tests was to determine if there were differences in available soil N due to the cover crop. Because the samples from the replications were combined, no statistics are available. On average, the soil N from the interseeded treatment was not higher than the check. In future years tissue tests may be collected to evaluate N differences.
- Statistics are not available for many of the soil measurements from Tables 3 and 4 as samples were combined between replications. There was a statistically significant difference in Solvita® and Haney soil health score with the interseeded cover crop treatment having greater values than the no cover crop check.

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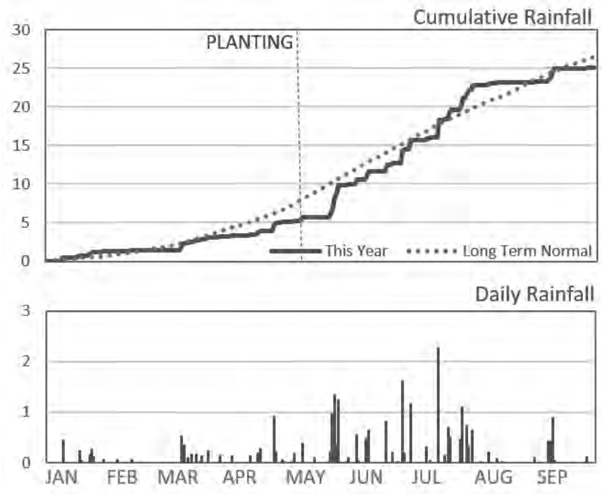
Non-Irrigated Soybeans following Winter Terminated and Winter Hardy Cover Crop, NRCS Demo Farm

Study ID: 0656127202001
County: Nemaha
Soil Type: Judson silt loam 0-2% slope
Planting Date: 5/7/20
Harvest Date: 9/23/20
Population: 145,000
Row Spacing (in): 15
Hybrid: Pioneer® P27A17X
Reps: 7
Previous Crop: Corn
Tillage: No-Till
Herbicides: ***Pre:*** 6 oz/ac Authority® First, 16 oz/ac Me-Too-Lachlor™, 16 oz/ac dicamba HD, and 6.4 oz/ac Absorb 100® ***Post:*** 32 to 40 oz/ac Buccaneer® 5 Extra, 16 oz/ac BattleStar®, 7 oz/ac clethodim, 1 qt/100 gal Absorb 100®, and 1 qt/100 gal N-TENSE™
Fertilizer: NPSZ starter fertilizer (10 lb N/ac, 40 lb N/ac, 40 lb N/ac, 6 lb S/ac, and 2 lb Zn/ac)

Irrigation: None:
Rainfall (in):



Introduction: This study is being conducted on a soil health demonstration farm as part of the Nebraska USDA/Natural Resources Conservation Service's (NRCS) Soil Health Initiative, and involves the farmer, the Nebraska On-Farm Research Network, and the USDA/NRCS. The two treatments, the use of winter terminated cover crops and the use of winter hardy cover crops, will be used in this five-year study (2016-2021). This is the fourth year of this study. The cover crops were drilled September 27, 2019. The winter terminated treatment was a mix of 30 lb/ac oats and 3 lb/ac turnips and radishes. The winter hardy treatment consisted of 30 lb/ac cereal rye and 3 lb/ac turnips and radishes. This study did not have a no-cover-crop control. Cattle were put out on the cover crop on November 17, 2019, and removed December 12, 2019. For uniformity, both cover crop mixes were sprayed with herbicide to terminate the cover crops on April 23, 2020. Baseline and soil health measures were collected in 2016, 2018, 2019, and 2020 (Table 1).

Results:

Table 1. Soil physical, chemical, and biological properties for winter hardy and winter terminated treatments.

Treatment	Infiltration (in/hr)	Soil moisture (%)	Bulk density (g/cm³)	Soil temp. (F)	Soil respiration[1]	Total soil health score[2]
2016 *(1 composite sample collected for all replications of a treatment; samples collected on Oct. 19, 2016)*						
Winter hardy	1.30	-	1.22	59	-	19.5
Winter terminated	1.12	-	1.32	59	-	20.8
2018 *(2 composite samples collected for all replications of a treatment, n=4 per treatment; samples collected on Oct. 31, 2018)*						
Winter hardy	0.86 A	29.4 A	1.20 A	49.0 A	-	18.5 A
Winter terminated	1.71 A	26.5 A	1.38 A	49.5 A	-	18.0 A
P-Value	0.350	0.777	0.113	0.500		0.5
2019 *(1 sample per treatment replication, n=4 per treatment; samples collected on Oct. 24, 2019)*						
Winter hardy	0.72 A	22.6 A	1.19 A	48.83 A	2.88 A	19.5 A
Winter terminated	0.62 A	26.4 A	1.26 A	48.98 A	2.38 A	19.5 A
P-Value	0.599	0.195	0.284	0.638	0.308	1.000

Table 1 Continued

Treatment	Infiltration (in/hr)	Soil moisture (%)	Bulk density (g/cm^3)	Soil temp. (F)	Soil respiration[1]	Total soil health score[2]
2020 *(1 sample per treatment replication, n=4 per treatment; samples collected on Oct. 15, 2020)*						
Winter hardy	10.87 A	13.3 A	1.29 A	58 A	2.62 B	18.5 A
Winter terminated	7.59 A	15.2 A	1.29 A	58 A	3.00 A	17.6 A
P-Value	0.2560	0.605	0.928	1.000	0.0577	0.628

[1]Soil respiration (Solvita® burst).
[2]Score based on field assessment. The overall indicator score is based on the sum of 8 indicators (1=degraded, 2=in transition, 3=healthy): soil structure, structure type, surface condition, soil management, soil pores, earthworms, biological activity, and smell.
[3]No test was completed in 2016 for soil moisture and 2016 and 2018 for soil respiration.
*Values with the same letter are not significantly different at a 90% confidence level.

Table 2. 2020 cover crop biomass and green cover for winter hardy and winter terminated cover crop treatments. Cover crop biomass measured on April 2, 2020.

	Biomass (lbs./acre)	Green cover (%)
Winter hardy Cover Crop	796.27	26.23 A
Winter terminated Cover Crop	-	0.24 B
P-Value	-	<.0001

- Biomass not measured on winter terminated cover crop strips, only weeds were present.

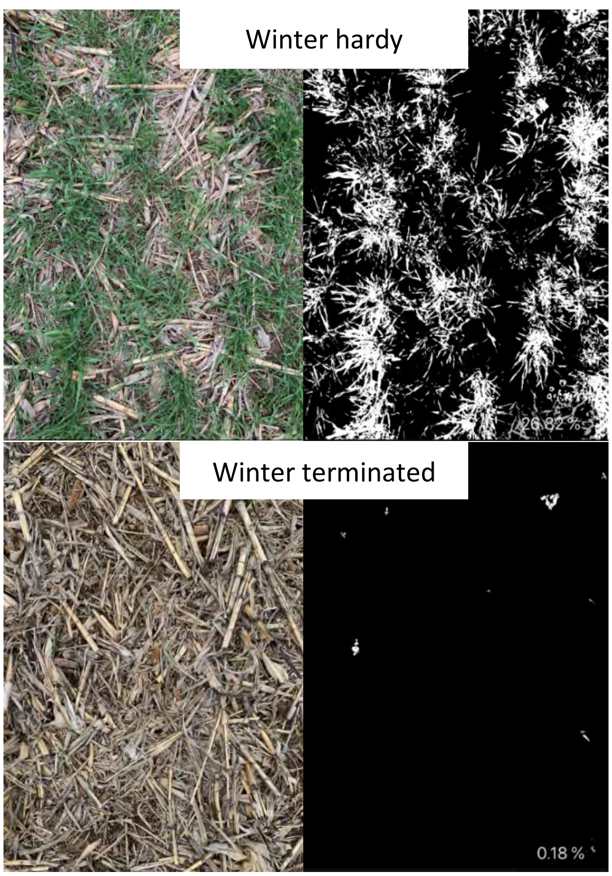


Figure 1. Cover crop green cover of winter hardy (top) and winter terminated (bottom) strips displayed as true color (left) and using the Canopeo measurement tool (right). Cover crop biomass measured on April 2, 2020.

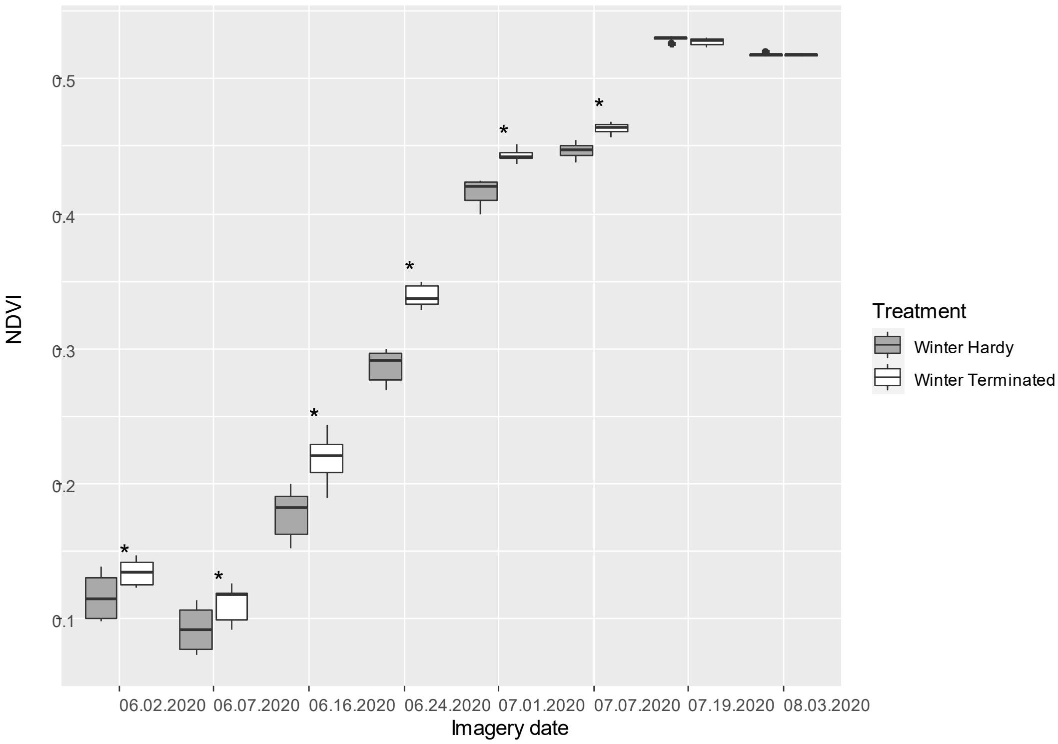


Figure 2. Normalized difference vegetation index (NDVI) values from aerial imagery for the soybean crop following winter hardy and winter terminated cover crops. Asterisk (*) within each date indicates significant difference (p < 0.10) between treatments at a 90% confidence level.

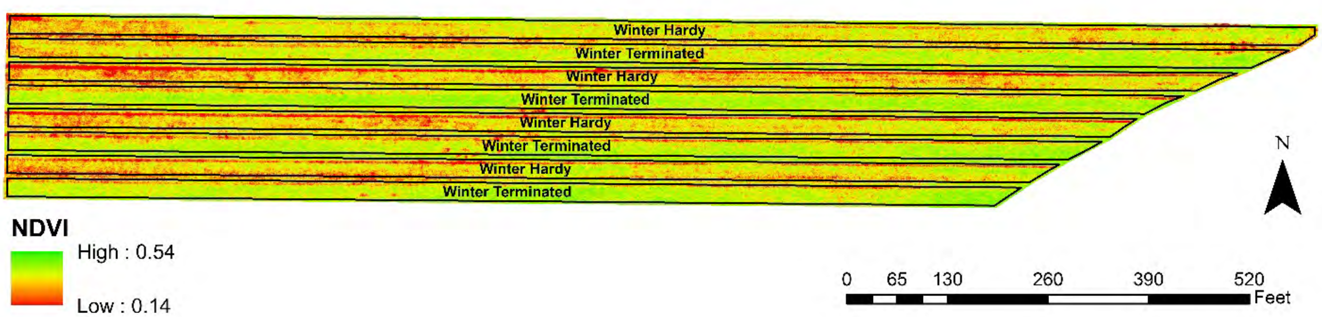


Figure 3. Aerial imagery from July 1 displayed as soybean normalized difference vegetation index (NDVI). Strips with winter hardy and winter terminated cover crop are indicated.

Table 3: 2020 soybean stand counts, test weight, yield, and net return for winter hardy and winter terminated cover crop treatments.

	Stand Count (plants/ac)	Test Weight (lb/bu)	Moisture (%)	Soybean Yield (bu/ac)†	Marginal Net Return‡ ($/ac)
Winter Terminated Cover Crop	127,187 A*	56 A	12.6 A	76 A	694.02 A
Winter Hardy Cover Crop	117,338 A	56 A	12.8 A	73 A	669.34 A
P-Value	0.179	0.527	0.268	0.452	0.419

*Values with the same letter are not significantly different at a 90% confidence level.
†Bushels per acre corrected to 13% moisture.
‡Marginal net return based on $9.50/bu soybean, $12.48/ac winter terminated cover crop seed mix, $12.45/ac winter hardy cover crop seed mix, and $14.40/ac drilling cost.

Summary:

- There were no differences in soil health parameters between the treatments in 2018, 2019, and 2020 (Table 1).
- Aerial imagery normalized difference vegetation index (NDVI) analysis showed higher values for soybeans in the winter terminated strips (Figures 2 and 3). Soybeans following winter hardy cover crops were not as large or canopied as soybeans following winter terminated cover crop.
- In 2020, there were no differences in soybean stand counts, yield, moisture, test weight, or net return between the winter terminated and winter hardy cover crop. Results from this portion of the field in previous years follow.

Summary of Previous Years

YEAR ONE | In year one, cover crops were drilled on September 29, 2016. The winter terminated treatment was a mix of oats, turnips, and common rapeseed, whereas the winter hardy treatment consisted of cereal rye, turnips, and common rapeseed. For uniformity, both cover crop mixes were sprayed with glyphosate on April 12, 2017. This terminated the winter hardy treatment and controlled weeds and brassicas, which had overwintered in the winter terminated cover crop treatment. In 2017, soybeans had no difference in yield, test weight, moisture, or net return following the winter terminated and winter hardy cover crops.

Table 4. 2017 soybean stand counts, test weight, yield, and net return for winter hardy and winter terminated cover crop treatments.

	Stand Count (plants/ac)	Test Weight (lb/bu)	Moisture (%)	Soybean Yield (bu/acre)†	Marginal Net Return‡ ($/ac)
Winter Terminated Cover Crop	102,178 A*	56 A	10.6 A	62 A	518.84 A
Winter Hardy Cover Crop	102,178 A	56 A	10.6 A	61 A	516.42 A
P-Value	1	0.4886	1	0.7345	0.735

*Values with the same letter are not significantly different at a 90% confidence level.
†Bushels per acre corrected to 13% moisture.
‡Marginal net return based on $8.90/bu soybean and $30.07 cost for cover crops.

YEAR TWO | In year two, following soybean harvest in 2017, wheat was planted in this area. No yield measurements were made for the winter terminated and winter hardy cover crop strips.

YEAR THREE | In year three, following wheat harvest, cover crops were drilled August 1, 2018. The winter terminated treatment was a mix of 30 lb/ac oats and 1 lb/ac turnip. The winter hardy treatment consisted of 30 lb/ac cereal rye and 1 lb/ac turnip. This study had no cover crop control. Cattle were put out on the cover crop on November 1 and taken off on November 26. For uniformity, both cover crop mixes were sprayed with herbicide to terminate the cover crops on April 2, 2019. In 2019, there were no differences in corn population, moisture, test weight, yield, or net return.

Table 5. 2019 corn stand counts, test weight, moisture, yield, and net return for winter hardy and winter terminated cover crop treatments.

	Stand Count (plans/ac)	Test Weight (lb/bu)	Moisture (%)	Corn Yield (bu/acre)†	Marginal Net Return‡ ($/ac)
Winter Terminated Cover Crop	29,952 A*	57 A	17.7 A	217 A	805.04 A
Winter Hardy Cover Crop	29,429 A	57 A	17.8 A	214 A	792.55 A
P-Value	0.207	0.552	0.891	0.277	0.216

*Values with the same letter are not significantly different at a 90% confidence level.
†Bushels per acre corrected to 15.5% moisture.
‡Marginal net return based on $3.83/bu corn, $12/ac winter terminated cover crop seed mix, $13.80/ac winter hardy cover crop seed mix, and $14.40/ac drilling cost.

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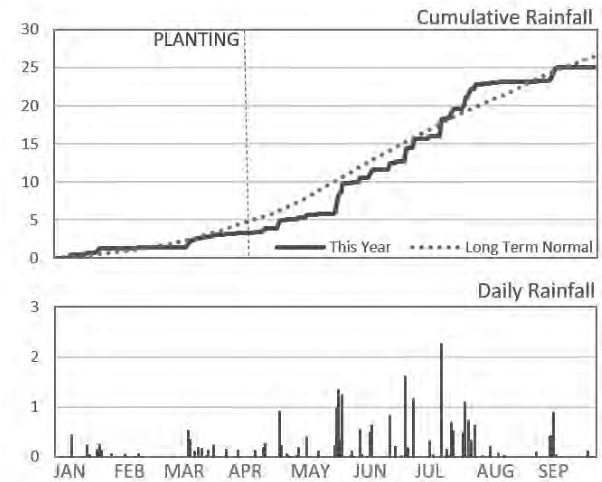
Non-Irrigated Corn Following Winter Terminated and Winter Hardy Cover Crop, NRCS Demo Farm

Study ID: 0656127202002
County: Nemaha
Soil Type: Judson silt loam 2-6% slopes
Planting Date: 4/8/20
Harvest Date: 9/15/20
Population: 33,000
Row Spacing (in): 30
Hybrid: Pioneer® P0589AM
Reps: 7
Previous Crop: Wheat
Tillage: No-Till
Herbicides: ***Pre:*** 1 lb/ac atrazine, 40 oz/ac Resicore®, 32 oz/ac glyphosate, 1 qt/100 gal N-TENSE™ on 4/2/20 ***Post:*** 40 oz/ac Resicore®, 32 oz/ac glyphosate, and 1 qt/100 gal N-TENSE™
Fertilizer: NPSZ starter fertilizer (10 lb N/ac, 40 lb N/ac, 40 lb N/ac, 6 lb S/ac, and 2 lb Zn/ac); 150 lb N/ac as 32% UAN, 46 lb N/ac as urea sidedress

Irrigation: None
Rainfall (in):



Introduction: This study is being conducted on a soil health demonstration farm as part of the Nebraska USDA/Natural Resources Conservation Service's (NRCS) Soil Health Initiative, and involves the farmer, the Nebraska On-Farm Research Network, and the USDA/NRCS. The two treatments, the use of winter terminated cover crops and the use of winter hardy cover crops, will be used in this five-year study (2016-2021). This is the fourth year of this study. The cover crops were drilled August 1, 2019. The winter terminated treatment was a mix of 30 lb/ac oats and 3 lb/ac turnips and radishes. The winter hardy treatment consisted of 30 lb/ac cereal rye and 3 lb/ac turnips and radishes. This study did not have a no-cover-crop control. Cattle were put out on the cover crop on November 17, 2019, and removed December 12, 2019. For uniformity, both cover crop mixes were sprayed with herbicide to terminate the cover crops on April 2, 2020. Baseline and soil health measures were collected in 2016, 2018, 2019, and 2020 (Table 1).

Results:

Table 1. Soil physical, chemical, and biological properties for winter hardy and winter terminated treatments.

Treatment	Infiltration (in/hr)	Soil moisture (%)	Bulk density (g/cm³)	Soil temp. (F)	Soil respiration[1]	Total soil health score[2]
2016 *(1 composite sample collected for all replications of a treatment; samples collected on Oct. 19, 2016)*						
Winter hardy	1.30	-	1.22	59	-[3]	19.5
Winter terminated	1.12	-	1.32	59	-	20.8
2018 *(2 composite samples collected for all replications of a treatment, n=4 per treatment; samples collected on Oct. 31, 2018)*						
Winter hardy	0.932	27.5 A	1.22 A	50.1 A	-	18.5
Winter terminated	0.743	24.7 A	1.26 A	50.6 A	-	18.5
P-Value	-	0.406	0.341	0.500		-
2019 *(1 sample per treatment replication, n=4 per treatment; samples collected on Oct. 24, 2019)*						
Winter hardy	0.631 A	29.5 A	1.28 A	48.4 A	4.12 A	20.2 A
Winter terminated	2.259 A	28.1 A	1.20 A	49.7 A	4.38 A	21.4 A
P-Value	0.338	0.594	0.433	0.350	0.604	0.186

Table 1 Continued

Treatment	Infiltration (in/hr)	Soil moisture (%)	Bulk density (g/cm^3)	Soil temp. (F)	Soil respiration[1]	Total soil health score[2]
2020 *(1 sample per treatment replication, n=4 per treatment; samples collected on Oct. 15, 2020)*						
Winter hardy	2.52 A	15.6 A	1.24 A	57.4 A	3.25 A	22.4 A
Winter terminated	4.85 A	15.7 A	1.25 A	57.9 A	3.00 A	22.5 A
P-Value	0.337	0.772	0.862	0.767	0.182	0.391

[1]Soil respiration (Solvita® burst).
[2]Score based on field assessment. The overall indicator score is based on the sum of 8 indicators (1=degraded, 2=in transition, 3=healthy): soil structure, structure type, surface condition, soil management, soil pores, earthworms, biological activity, and smell.
[3]No test was completed in 2016 for soil moisture and 2016 and 2018 for soil respiration.
*Values with the same letter are not significantly different at a 90% confidence level.

Table 2. 2020 cover crop biomass and green cover for winter hardy and winter terminated cover crop treatments. Cover crop biomass measured on April 2, 2020.

	Biomass (lbs./acre)	Green cover (%)
Winter Hardy Cover Crop	685 A*	13.33 A
Winter Terminated Cover Crop	120 B	2.12 B
P-Value	<.0001	0.0001

*Values with the same letter are not significantly different at a 90% confidence level.

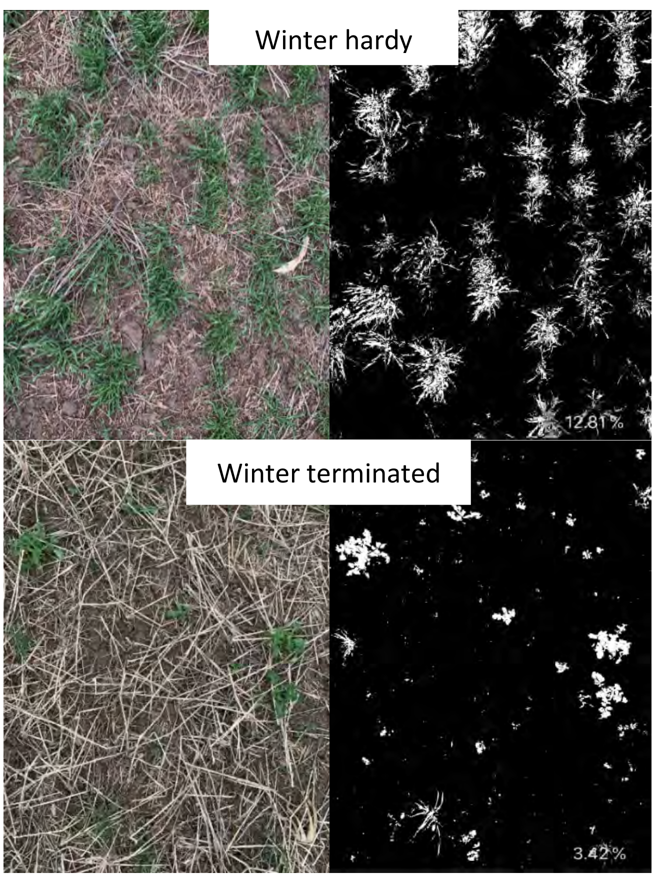


Figure 1. Cover crop green cover of winter hardy (top) and winter terminated (bottom) strips displayed as true color (left) and using the Canopeo measurement tool (right). Cover crop biomass measured on April 2, 2020.

Table 3. 2020 corn stand counts, test weight, yield, and net return for winter hardy and winter terminated cover crop treatments.

	Stand Count (plants/ac)	Test Weight (lb/bu)	Moisture (%)	Corn Yield (bu/ac)†	Marginal Net Return‡ ($/ac)
Winter Terminated Cover Crop	31,556 A*	53 A	21.1 A	213 A	719.79 A
Winter Hardy Cover Crop	30,352 A	53 A	20.9 A	208 A	701.16 A
P-Value	0.182	0.704	0.330	0.212	0.173

*Values with the same letter are not significantly different at a 90% confidence level.
†Bushels per acre corrected to 15.5% moisture.
‡Marginal net return based on $3.51/bu corn, $12/ac winter terminated cover crop seed mix, $13.80/ac winter hardy cover crop seed mix, and $14.40/ac drilling cost.

Summary:

- There were no differences in soil health parameters between the treatments in 2018, 2019, and 2020 (Table 1).
- In previous years, corn and soybeans in this portion of the field yielded lower when they followed the winter hardy cover crop. This was not the case this year. In 2020, there were no differences in corn population, moisture, test weight, yield, or net return. Results from this portion of the field in previous years follow.

Summary of Previous Years

YEAR ONE | In year one, cover crops were drilled on September 29, 2016. The winter terminated treatment was a mix of oats, turnips, and common rapeseed, whereas the winter hardy treatment consisted of cereal rye, turnips, and common rapeseed. For uniformity, both cover crop mixes were sprayed with glyphosate on April 12, 2017. This terminated the winter hardy treatment and controlled weeds and brassicas, which had overwintered in the winter terminated cover crop treatment.

Table 4. 2017 corn stand counts, test weight, yield, and net return for winter hardy and winter terminated cover crop treatments.

	Stand Count (plants/acre)	Test Weight (lb/bu)	Moisture (%)	Corn Yield (bu/acre)†	Marginal Net Return‡ ($/ac)
Winter Terminated	30,355 A*	54 A	18.0 B	183 A	546.97 A
Winter Hardy	30,023 A	52 B	19.1 A	168 B	498.00 B
P-Value	0.802	0.0209	0.0034	0.0003	0.0003

*Values with the same letter are not significantly different at a 90% confidence level.
†Bushels per acre corrected to 15.5% moisture.
‡Marginal net return based on $3.15/bu corn and $30.07 cost for cover crop seed and drilling in both treatments.

In 2017, corn planted after winter terminated cover crops had a higher yield, higher test weight, and was drier than the winter hardy cover crops. There were no differences in harvest stand counts for the corn following the winter terminated and winter hardy cover crops. The corn following the winter hardy mix was three days slower to tassel than the corn following the winter terminated mix.

YEAR TWO **|** In year two, cover crops were drilled on August 1, 2017. The winter terminated treatment was a mix of 30 lb/ac oats, 1.5 lb/ac canola/rapeseed, and 1 lb/ac turnip. The winter hardy treatment consisted of 30 lb/ac cereal rye, 1.5 lb/ac canola/rapeseed, and 1 lb/ac turnip. For uniformity, both cover crop mixes were sprayed with herbicide to terminate the cover crops on April 17, 2018.

Table 5. 2018 soybean stand counts, test weight, moisture, yield, and net return for winter hardy and winter terminated cover crop treatments.

	Stand Count (plants/ac)	Test Weight (lb/bu)	Moisture (%)	Soybean Yield† (bu/ac)	Marginal Net Return‡ ($/ac)
Winter Terminated	120,744 A*	56 B	11.3 A	65 A	452.80 A
Winter Hardy	120,246 A	56 A	11.2 A	59 B	410.75 B
P-Value	0.872	0.096	0.200	0.002	0.002

*Values with the same letter are not significantly different at a 90% confidence level.
†Bushels per acre corrected to 13% moisture for soybeans.
‡Marginal net return based on $7.40/bu soybean, $12.48/ac winter terminated cover crop seed mix, $12.45/ac winter hardy cover crop seed mix, and $14.40/ac drilling cost.

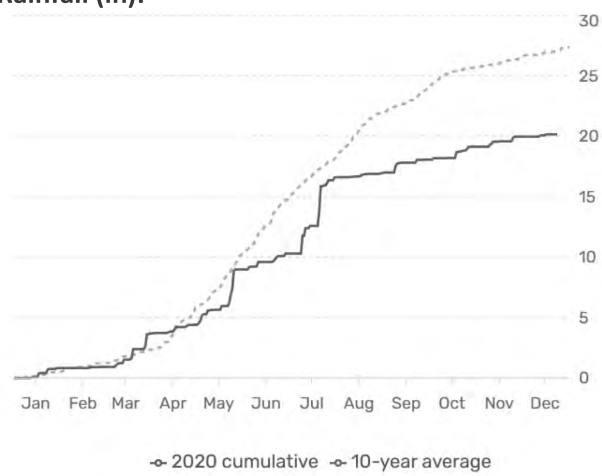
In 2018, soybeans planted after winter terminated cover crops had a higher yield, lower test weight, and higher net return than the winter hardy cover crops. The soybeans following the winter terminated had a darker green appearance.

YEAR THREE **|** In year three, wheat was planted following soybean harvest. No measurements were made on wheat yields in the winter terminated and winter hardy cover crop strips.

Impact of Cover Crop on Subsequent Irrigated Crop Yield and Soil Quality Indicators, NRCS Demo Farm

Study ID: 0708077202001
County: Greeley
Soil Type: Hersh fine sandy loam 3-6% slopes; Gates silt loam 6-11% slopes; Gates silt loam 11-17% slopes.
Planting Date: 11/1/19
Harvest Date: 7/25/20
Seeding Rate: 110 lb/ac
Row Spacing (in): 7.5
Hybrid: Rye
Reps: 6
Previous Crop: Rye (fall/winter)
Tillage: No-Till
Herbicides: ***Pre:*** None ***Post:*** None
Seed Treatment: None
Foliar Insecticides: None
Foliar Fungicides: None

Fertilizer: 20 lb/ac N as 32% UAN and 10 lb/ac S as thiosulfate through the pivot
Irrigation: Pivot, Total: 6"
Rainfall (in):



Introduction: This study is being conducted on a soil health demonstration farm as part of the Nebraska USDA/Natural Resources Conservation Service's (NRCS) Soil Health Initiative, and involves the farmer, the Nebraska On-Farm Research Network, and the USDA/NRCS. Two treatments, a no cover crop check and a cover crop mix, will be used in this five-year study (2016-2021). This is the fourth year of this study. In 2019, following soybean harvest, cereal rye was drilled across both cover crop and no cover crop treatments on November 1, 2019, and harvested between July 13 and July 25, 2020. Following rye harvest, cover crops were drilled. Cover crop mix consisted of oats, sorghum, pearl millet, radish, forage collards, rapeseed, buckwheat, mustard, sunn hemp, mung bean, winter pea, and soybean. Baseline and soil health measures were collected in 2017, 2018, 2019, and 2020 (Table 1).

Results:

Table 1. Soil physical, chemical, and biological properties for cover crop and no cover crop treatments.

Treatment	Infiltration (in/hr)	Soil moisture (%)	Bulk density (g/cm^3)	Soil temp. (F)	Soil respiration[1]	Total soil health score[2]
2017 *(1 sample per treatment replication, n=6 per treatment; samples collected on Oct. 18, 2017)*						
Check	5.19 A*	22.7 A	1.32 A	51.2 A	2.96 A	14.0 A
Cover Crop Mix	7.23 A	20.3 A	1.34 A	51.5 A	3.03 A	13.8 A
P-Value	0.682	0.374	0.726	0.352	0.854	0.6302
2019 *(1 sample per treatment replication, n=6 per treatment; samples collected on Oct. 22, 2019)*						
Check	2.03 A	13.25 A	1.41 A	44.16 B	2.44 A	12.9 A
Cover Crop Mix	6.45 A	14.56 A	1.27 A	46.06 A	2.86 A	13.3 A
P-Value	0.267	0.488	0.179	0.098	0.296	0.477
2020 *(1 sample per treatment replication, n=6 per treatment; samples collected on Oct. 20, 2020)*						
Check	6.32 A	20.1 A	1.28 A	47.0 A	2.57 A	13.9 B
Cover Crop Mix	5.19 A	18.2 A	1.34 A	47.1 A	2.64 A	16.8 A
P-Value	0.7222	0.4355	0.3813	0.8661	0.9255	0.0001

[1]Soil respiration (Solvita® burst).
[2]Score based on field assessment. The overall indicator score is based on the sum of 8 indicators (averaged from 1-3; 1=degraded, 2=in transition, 3=healthy): soil structure, structure type, surface condition, soil management, soil pores, earthworms, biological activity, and smell.
Soil assessment was not completed in 2018 as it was originally planned for every other year interval.
*Values with the same letter are not significantly different at a 90% confidence level.

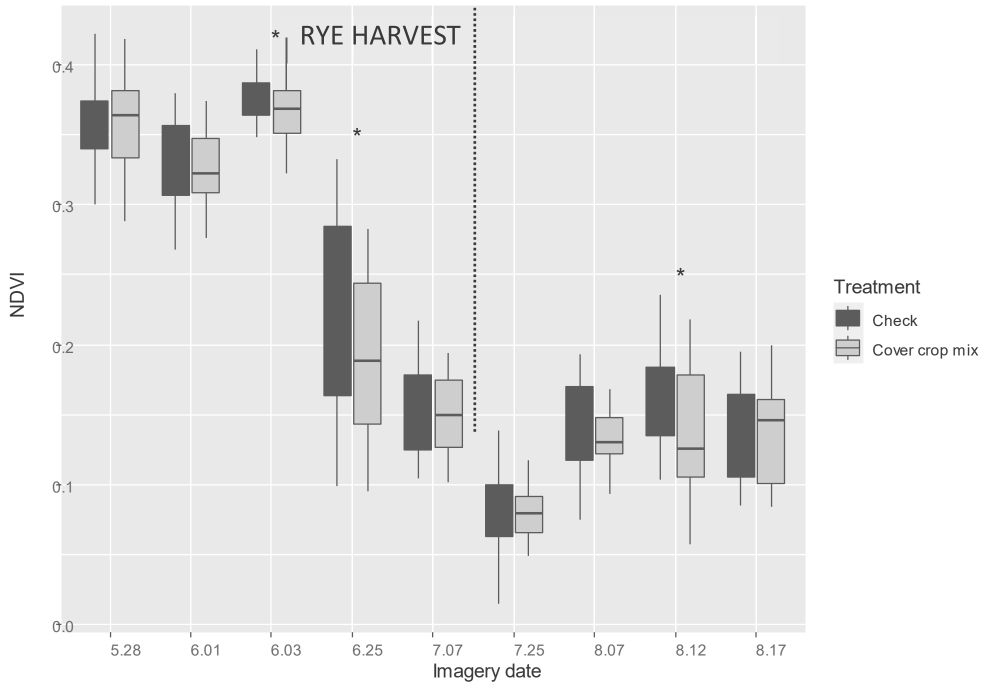


Figure 1. Normalized difference vegetation index (NDVI) values from aerial imagery for the rye and cover crop in check and cover crop mix strips from May 28 to August 17. Asterisk (*) within each date indicates significant differences at a 90% confidence level.

Table 2. 2020 rye test weight, moisture, yield, and net return for cover crop mix and no cover crop treatments.

	Test Weight (lb/bu)	**Moisture (%)**	**Rye Yield (bu/acre)†**	**Marginal Net Return‡ ($/ac)**
Check	53.70 A*	12.4 A	42.2 A	253 A
Cover Crop Mix	53.77 A	12.4 A	40.0 A	240 A
P-Value	0.7538	1.0000	0.1993	0.1993

*Values with the same letter are not significantly different at a 90% confidence level.
†Bushels per acre corrected to 15% moisture.
‡Marginal net return based on $6.01/bu cereal rye. Costs of cover crop drilled after rye harvest ($20/ac) were not included on the analysis.

Summary:

- Total soil health score was lower for the no cover crop check in 2020 (Table 1).
- Multiple rain and wind events in late July delayed/interrupted harvest, and the last wind storm flattened the rye on the east half of the field. Farmer had to combine one way going east to west. This destroyed the yield sampling process. Farmer was only able to collect yield data on 3 of the 6 reps.
- There were no differences in rye test weight, moisture, yield and marginal net return between the treatments (Table 2). Results from previous years follow.

Summary of Previous Years

YEAR ONE | In year one, following cover crop termination corn was planted in this area. No yield measurements were made for the check and cover crop mix treatments

YEAR TWO | In year two, the cover crop was drilled following corn harvest on November 17, 2018. Cover crop mixture was composed of 50 lbs/ac cereal rye, 1 lbs/ac forage collards, 1 lbs/ac turnips, 1 lbs/ac rapeseed, and 1 lbs/ac kale. Soybeans were planted into the cover crop on May 15, 2019. The cover crop was terminated on June 1, 2019, with a herbicide application. Cover crops were 10" tall at the time of termination. Soybeans were harvested in November 2019. The year was very wet with 21" of rain from planting to August 26, 2019. There were no differences in soybean yield, moisture, or test weight between the cover crop treatment and no cover crop check. Marginal net return was lower for the cover crop treatment due to the additional cost of cover crop seed and drilling.

Table 3. 2019 soybean yield, moisture, and marginal net return for cover crop mix and no cover crop treatments.

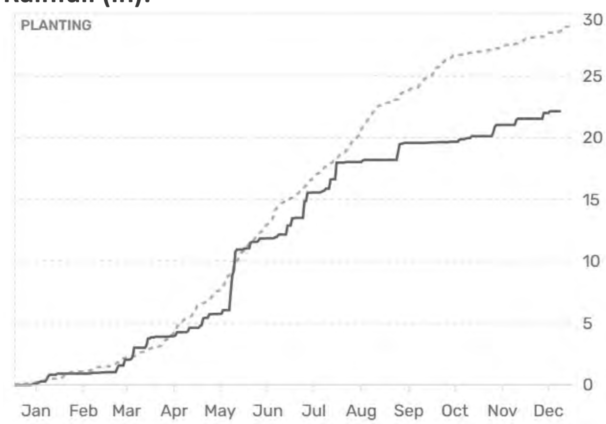
	Test Weight (lb/bu)	**Moisture (%)**	**Soybean Yield (bu/ac)†**	**Marginal Net Return‡ ($/ac)**
No Cover Crop	57 A	10.0 A	55 A	444.82 A
Cover Crop Mix	57 A	9.9 A	54 A	397.26 B
P-Value	0.180	0.530	0.514	0.010

†Bushels per acre adjusted to 13% moisture.
‡Marginal net return based on $8.10/bu soybean, $25/ac cover crop seed cost, and $14.40/ac for drilling.

Rye Planted Following Cover Crop Mix and No Cover Crop, NRCS Demo Farm

Study ID: 0914093202001
County: Howard
Soil Type: Holdrege silty clay loam
Planting Date: 10/9/19
Harvest Date: 7/23/20
Seeding Rate: 72 lb/ac
Row Spacing (in): 7.5
Hybrid: Rye
Reps: 7
Previous Crop: Soybean
Tillage: No-Till
Herbicides: ***Pre:*** None ***Post:*** None
Seed Treatment: Inoculant
Foliar Insecticides: None
Foliar Fungicides: None

Fertilizer: 117 lb/ac 11-52-0, 86 lb/ac lb K-mag, 27 lb/ac pell lime, 2 lb/ac 36% zinc.
Irrigation: Pivot, Total: 6” on cover crops
Rainfall (in):



Introduction: This study is being conducted on a soil health demonstration farm as part of the Nebraska USDA/Natural Resources Conservation Service's (NRCS) Soil Health Initiative, and involves the farmer, the Nebraska On-Farm Research Network, and the USDA/NRCS. Two treatments are being evaluated in this five-year study: cover crop mix and no-cover crop check. These plots will be maintained throughout the project (2017-2021). This is the fourth year of this study. In 2019, following soybean harvest, rye was drilled across both cover crop and no cover crop treatments on October 9, 2019, and harvested on July 23, 2020. Baseline and soil health measures were collected in 2017, 2018, 2019, and 2020 (Table 1).

Results:

Table 1. Soil physical, chemical, and biological properties for cover crop and no cover crop treatments.

Treatment	Infiltration (in/hr)	Soil moisture (%)	Bulk density (g/cm^3)	Soil temp. (F)	Soil respiration[1]	Total soil health score[2]
2017 *(1 sample per treatment replication, n=7 per treatment; samples collected on Nov. 16, 2017)*						
Check	7.07 A*	24.1 A	1.08 A	48.3 A	5.04 A	12.8 A
Cover Crop Mix	13.11 A	26.7 A	1.11 A	48.6 A	4.79 A	12.9 A
P-Value	0.446	0.525	0.457	0.724	0.391	0.750
2018 *(1 sample per treatment replication, n=7 per treatment; samples collected on Oct. 28, 2018)*						
Check	-	30.1 A	1.19 A	48.5 A	-	13.8 A
Cover Crop Mix	-	31.3 A	1.21 A	48.8 A	-	14.5 A
P-Value	-	0.422	0.654	0.799	-	0.286
2019 *(1 sample per treatment replication, n=7 per treatment; samples collected on Oct. 29, 2019)*						
Check	0.59 A	21.51 A	1.16 A	47.71 A	3.64 A	14.1 B
Cover Crop Mix	0.62 A	23.33 A	1.15 A	46.69 A	4.43 A	16.0 A
P-Value	0.781	0.616	0.817	0.521	0.297	0.00205
2020 *(1 sample per treatment replication, n=7 per treatment; samples collected on Oct. 8, 2020)*						
Check	36.1 A	10.1 A	1.04 A	54.3 A	3.83 A	18.6 B
Cover Crop Mix	33.7 A	11.6 A	1.09 A	53.3 A	3.42 A	20.3 A
P-Value	0.886	0.138	0.396	0.497	0.259	0.0212

[1]Soil respiration (Solvita® burst).
[2]Score based on field assessment. The overall indicator score is based on the sum of 8 indicators (1=degraded, 2=in transition, 3=healthy): soil structure, structure type, surface condition, soil management, soil pores, earthworms, biological activity, and smell.
*Values with the same letter are not significantly different at a 90% confidence level.

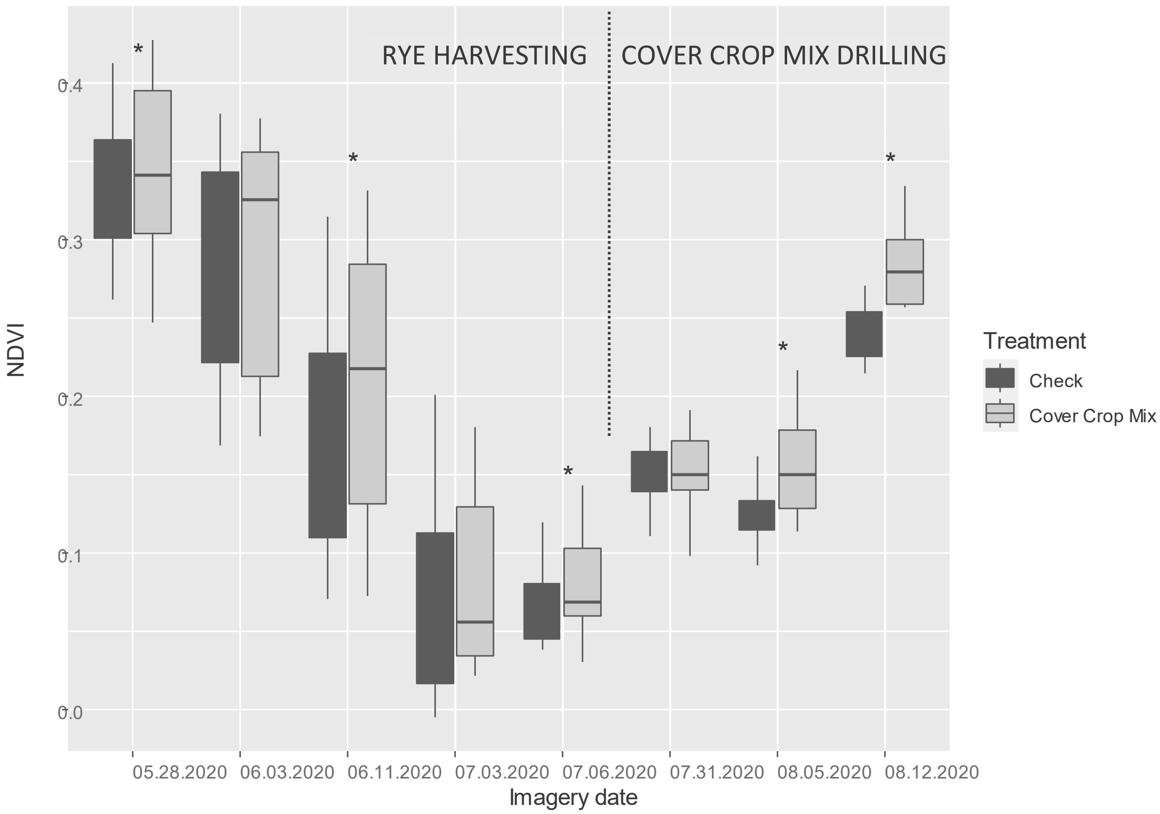


Figure 1. Normalized difference vegetation index (NDVI) values from aerial imagery for the rye crop following cover crop and no-cover crop mixture. Asterisk (*) within each date indicates significant difference (p < 0.10) between treatments at a 90% confidence level.

Table 1. 2020 rye test weight, moisture, yield, and net return for cover crop mix and no cover crop treatments.

	Moisture (%)	Rye Yield (bu/acre)†	Marginal Net Return‡ ($/ac)
Check	14.5 A	40.9 A	246 A
Cover Crop Mix	14.5 A	42.4 A	255 A
P-Value	0.965	0.35144	0.35144

*Values with the same letter are not significantly different at a 90% confidence level.
†Bushels per acre corrected to 15% moisture.
‡Marginal net return based on $6.01/bu cereal rye. Costs of cover crop drilled after rye harvest were not included on the analysis.

Summary:

- Total soil health score was lower for the no cover crop check in 2019 and 2020 (Table 1).
- Aerial imagery normalized difference vegetation index (NDVI) analysis before rye harvest showed higher values for rye following cover crop (May 26, June 11 and July 6). After cover crop drilling, NDVI showed higher values for the cover crop compared to check strips due to cover crop biomass growth. Check strips showed increases in NDVI after rye harvest due to volunteer rye.
- There were no differences in rye test weight, moisture, yield and marginal net return between the treatments. Results from previous years follow.

Summary of Previous Years

YEAR ONE | In year one, cover crops were drilled after corn harvest in 2016. The cover crop mix was kale, Trophy rapeseed, purple turnips, forage collards, hairy vetch and rye. Cover crop that did not winter terminate was terminated with herbicides on May 2017. Soybeans were planted in this area on May 26, 2017, and harvested on October 15, 2017. No yield measurements were made for cover crop and no cover crop strips.

YEAR TWO | In year two, following soybean harvest in October 2017, cover crop mix of 33 lbs/ac cereal rye, 0.8 lbs/ac turnip, 1.6 lbs/ac canola, 0.6 lbs/ac African cabbage, 0.5 lbs/ac Forage collards, 1.1 lbs/ac sunflower, 1.6 lbs/ac hairy vetch, 1.1 lbs/ac radish, 1 lbs/ac safflower and 1 lbs/ac winter lentil was drilled. Cover crop that did not winter terminate was terminated with herbicides on May 2018. Corn was planted in this area on May 7, 2018, and harvested on September 11, 2018. Corn experienced hail damage on August 16, 2018. No yield measurements were made for cover crop and no cover crop strips.

YEAR THREE | In year three, the cover crop mix was Barkant turnips, African cabbage, impact forage collards, Dwarf Essex rapeseed, Eco-Till radish, peredovik sunflowers, finish safflowers, VNS hairy vetch, Viceroy lentils, and rye. The cover crop was seeded after corn harvest on September 21, 2018. Cover crops that did not winter terminate were terminated with herbicides on May 14, 2019, at a height of 3". Soybeans were planted on May 16 in 30" row spacing and harvested on September 30, 2019. Soybeans experienced damage from heavy thistle caterpillar infestations. Due to visual differences observed in imagery and crop senescence, additional grain quality samples were collected. The treatments did not result in differences in soybean moisture, yield, or net return. Aerial imagery normalized difference vegetation index (NDVI) analysis showed soybeans following the no cover crop treatments had greater leaf senescence and were more mature.

Table 3. 2019 soybean yield, yield components, oil, moisture, and marginal net return for cover crop mix and no cover crop treatments.

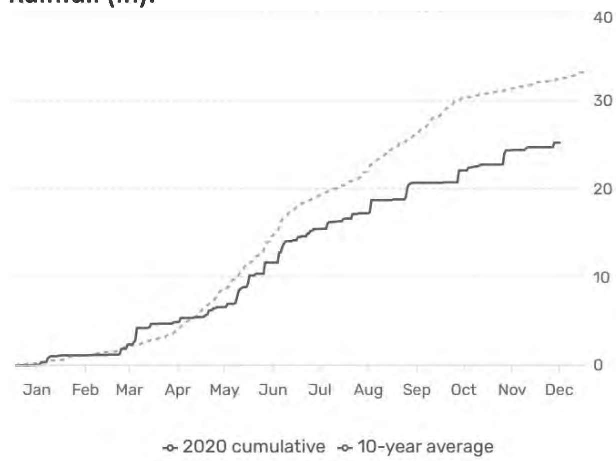
	Pods/ plant	Grain/ plant	Linoleic (%)	Saturated fat (%)	Protein (%)	Oil (%)	Fiber (%)	Moisture (%)	Yield (bu/ac)†	Marginal Net Return‡ ($/ac)
Check	48.5 A	103 A	6.7 A	10.6 A	34.0 A	19.6 A	4.9 A	15.0 A	67.9 A	549.67 A
Cover Crop Mix	49.9 A	107 A	6.6 A	11.1 A	35.1 A	19.2 A	4.8 A	16.8 A	69.5 A	524.69 A
P-Value	0.897	0.771	0.880	0.397	0.385	0.175	0.178	0.210	0.779	0.605

*Values with the same letter are not significantly different at a 90% confidence level.
†Yield values are from cleaned yield monitor data. Bushels per acre adjusted to 13% moisture.
‡Marginal net return based on $8.10/bu soybean, $24/ac cover crop seed, and $14.40 drilling.

Non-Irrigated Wheat Planted Following a Cover Crop Mix and No Cover Crop, NRCS Demo Farm

Study ID: 0913037202001
County: Colfax
Soil Type: Moody silty clay loam 0-2% slope; Moody silty clay loam 2-6% slopes
Planting Date: 10/15/19
Harvest Date: 7/21/20
Population: 105 lb/ac
Row Spacing (in): 7.5
Hybrid: Valliant
Reps: 6
Previous Crop: Soybean
Tillage: No-Till
Herbicides: ***Pre:*** 0.5 pt/ac 2,4-D and 0.8 oz/ac Affinity® Broadspec on 5/6/20 ***Post:*** None
Foliar Insecticides: None
Foliar Fungicides: 6.8 oz/ac Prosaro®

Fertilizer: 100 lb/ac 11-52-0 on 10/24/19; 30 gal/ac 32% UAN on 4/8/20
Irrigation: None
Rainfall (in):



Introduction:

This study is being conducted on a soil health demonstration farm as part of the Nebraska USDA/Natural Resources Conservation Service's (NRCS) Soil Health Initiative, and involves the farmer, the Nebraska On-Farm Research Network, and the USDA/NRCS. Two treatments are being evaluated in this five-year study: cover crop mix and no-cover crop check. These plots will be maintained throughout the project (2017-2021). 2020 was the third year of this study. In 2019, wheat was planted following soybean harvest on the cover crop and check strips. Following the wheat harvest, cover crops were drilled on August 6, 2020. Baseline and soil health measures were collected in 2017 and 2019 (Table 1).

Results:

Table 1. Soil physical, chemical, and biological properties for cover crop and no cover crop treatments.

Treatment	Infiltration (in/hr)	Soil moisture (%)	Bulk density (g/cm^3)	Soil temp. (F)	Soil respiration[1]	Total soil health score[2]
2017 *(1 sample per treatment replication, n=6 per treatment; samples collected on Oct. 30, 2017)*						
Check	15.58 A	25.5 A	1.04 A	50.4 A	3.85 A	16.2 A
Cover Crop - Mix	6.87 B	25.5 A	1.03 A	50.0 A	4.10 A	18.1 A
P-Value	0.0808	0.986	0.785	0.354	0.1817	0.342
2019 *(1 sample per treatment replication, n=6 samples per treatment; samples collected on Nov. 5, 2019)*						
Check	2.09 A*	23.61 A	1.14 A	40.85 A	3.33 A	17.4 A
Cover Crop - Mix	4.93 A	24.60 A	1.13 A	40.93 A	2.67 A	18.6 A
P-Value	0.422	0.336	0.478	0.794	0.102	0.295

[1]Soil respiration (Solvita® burst).
[2]Score based on field assessment. The overall indicator score is based on the sum of 8 indicators (1=degraded, 2=in transition, 3=healthy): soil structure, structure type, surface condition, soil management, soil pores, earthworms, biological activity, and smell. Soil assessment was not completed in 2018 and 2020 as it was originally planned for every other year interval.
*Values with the same letter are not significantly different at a 90% confidence level.

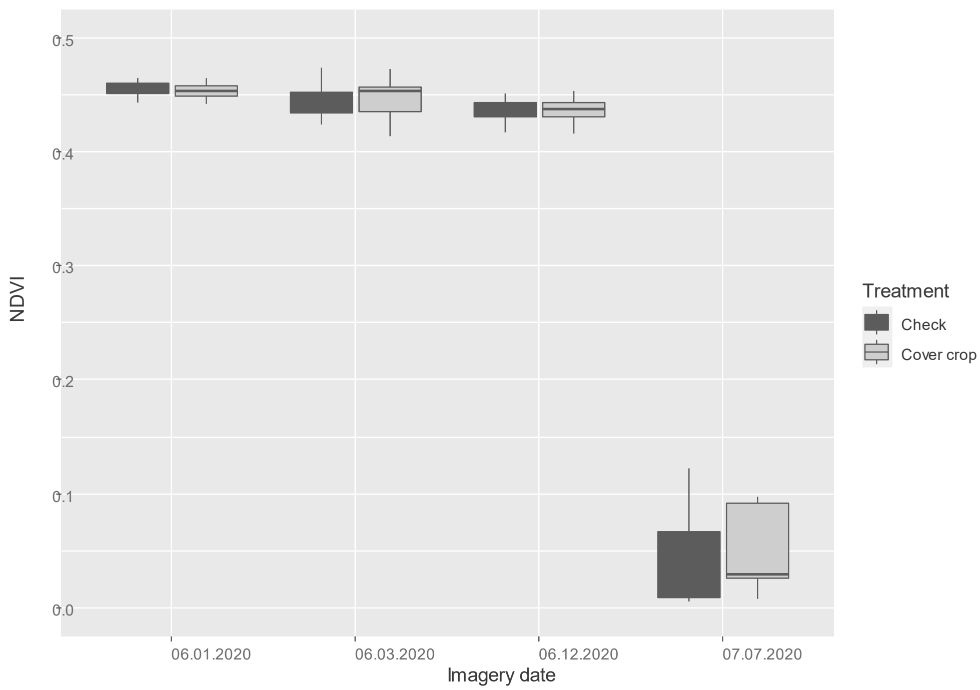


Figure 1. Normalized difference vegetation index (NDVI) values from aerial imagery for the wheat crop following cover crop and no cover crop. Asterisk (*) within each date indicates significant difference ($p < 0.10$) between treatments at a 90% confidence level.

Table 2. 2020 wheat moisture, yield, and net return for the check and cover crop mix.

	Moisture (%)	Wheat Yield (bu/acre)†	Marginal Net Return‡ ($/acre)
Check	13.3 A*	82.4 A	358 A
Cover Crop Mix	13.0 A	84.8 A	369 A
P-Value	0.1089	0.4397	0.4397

*Values with the same letter are not significantly different at a 90% confidence level.
†Bushels per acre corrected to 13.5% moisture.
‡Marginal net return based on $4.35/bu wheat. Costs of cover crop drilled after wheat harvest were not included on the analysis.

Summary:

- Aerial imagery normalized difference vegetation index (NDVI) analysis showed no differences in values for wheat following cover crops.
- There were no differences in soil health parameters between the treatments in 2017 and 2019.
- There were no differences in wheat moisture, yield, or marginal net return between the treatments. These observations are in agreement with the crop vigor (NDVI) calculated throughout the wheat growing season that showed no differences between the two cover crop treatments. Results from previous years follow.

Summary of Previous Years

YEAR ONE | In year one, corn was planted on the cover crop and check strips. No measurements were made on corn yields in the cover crop and check strips.

YEAR TWO **|** In year two, cover crops were drilled on November 19, 2018. The cover crop mix was 8 lb/ac winter wheat, 8 lb/ac winter rye, 8 lb/ac triticale, 1 lb/ac Dwarf Essex rapeseed, 5 lb/ac winter oats, 8 lb/ac winter barley, 1 lb/ac camelina, 1 lb/ac hairy vetch, 2.5 lb/ac winter Morton lentil and 1 lb/ac Dixie crimson clover. The cover crop was terminated with herbicides on May 10, 2019, at a height of 10-18".

Table 3. 2019 soybean yield, moisture, and marginal net return for cover crop mix and no cover crop treatments.

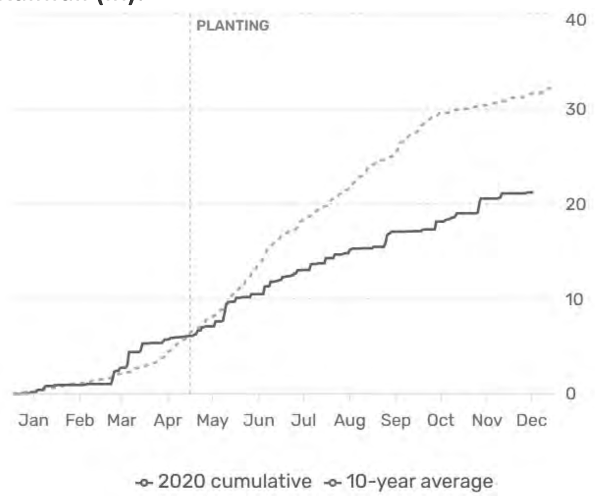
	Moisture (%)	Soybean Yield (bu/ac)†	Marginal Net Return‡ ($/ac)
No Cover Crop	11.8 A*	68 A	549.30 A
Cover Crop - Mix	11.9 A	68 A	514.83 B
P-Value	0.607	0.994	0.002

*Values with the same letter are not significantly different at a 90% confidence level.
†Yield values are from cleaned yield monitor data. Bushels per acre adjusted to 13% moisture.
‡Marginal net return based on $8.10/bu soybean, $20.11/ac cover crop seed, and $14.40 for cover crop drilling.

In 2019, there were no differences in soybean moisture or yield soybeans. Marginal net return was lower for the cover crop treatment due to the additional cost of seed and drilling.

Impact of Monoculture Rye Cover Crop versus Multispecies Cover Crop on Subsequent Crop Yield and Soil Quality Indicators, NRCS Demo Farm

Study ID: 0732167202001
County: Stanton
Soil Type: Nora-Crofton complex 6-11% slopes; Nora silty clay loam 11-17% slopes; Moody silty clay loam 2-6% slopes; Nora silty clay loam 6-11% slopes; Alcester silty clay loam 2-6% slopes
Planting Date: 4/30/20
Harvest Date: 10/9/20
Population: 133,650
Row Spacing (in): 20
Hybrid: Golden Harvest® GH2041X
Reps: 10
Previous Crop: Corn
Tillage: No-Till
Herbicides: ***Pre:*** 1.5 pt/ac Stalwart® C, 1.0 pt/ac Clash™, 32 oz/ac Buccaneer®, 3.0 oz/ac Tronido™ on 5/14/20 ***Post:*** 12 oz/ac fomesafen, 0.4 oz/ac Cadet®, 32 oz/ac Buccaneer®, 10.0 oz/ac clethodim, 1.0 pt/ac Helmet on 6/26/20
Seed Treatment: CruiserMaxx®, Vibrance®
Foliar Insecticides: None
Foliar Fungicides: 10 oz/ac Quilt Xcel®
Fertilizer: 5 gal/ac 5-18-5 on 4/30/20
Irrigation: None
Rainfall (in):



Introduction: This study is being conducted on a soil health demonstration farm as part of the Nebraska USDA/Natural Resources Conservation Service's (NRCS) Soil Health Initiative, and involves the farmer, the Nebraska On-Farm Research Network, and the USDA/NRCS. Two treatments are being evaluated in this five-year study (2017-2021): a monoculture rye cover crop versus a cover crop mix. These treatment plots will be maintained throughout the project. 2020 was the third year of this study. Cover crops were drilled in November following corn harvest in 2019. The monoculture cover crop was 50 lb/ac cereal rye. The cover crop multispecies mix was 30 lb/ac cereal rye, 10 lb/ac winter barley, 3 lb/ac red clover, 1 lb/ac rapeseed, 4 lb/ac hairy vetch, and 0.5 lb/ac camelina. Soybeans were planted on April 30, cover crops were terminated on May 14, and soybeans were harvested on October 9. Baseline and soil health measures were collected in 2016, 2019, and 2020 (Table 1).

Results:

Table 1. Soil physical, chemical, and biological properties for single species and multispecies cover crop treatments.

Treatment	Infiltration (in/hr)	Soil moisture (%)	Bulk density (g/cm^3)	Soil temp. (F)	Soil respiration[1]	Total soil health score[2]
2016 *(2-5 composite samples collected for all replications of a treatment; samples collected on Nov. 14, 2016)*						
Single species	3.13 A*	26.7 A	1.02 A	48.3 A	3.33 A	19.7 A
Multispecies	8.50 A	27.6 A	1.17 A	48.2 A	2.33 B	17.2 B
P-Value	0.762	0.734	0.103	0.991	<0.001	0.0903
2019 *(1 sample per treatment replication, n=7 per treatment; samples collected on Nov. 5, 2019)*						
Single species	12.24 A	25.63 A	1.13 A	36.24 A	3.13 A	19.9 A
Multispecies	18.88 A	25.11 A	1.10 A	36.61 A	3.22 A	19.8 A
P-Value	0.356	0.766	0.5083	0.454	0.879	0.885

Table 1 Continued

Treatment	Infiltration (in/hr)	Soil moisture (%)	Bulk density (g/cm³)	Soil temp. (F)	Soil respiration[1]	Total soil health score[2]
2020 *(1 sample per treatment replication, n=7 per treatment; samples collected on Nov. 4, 2020)*						
Single species	12.7 A	23.1 A	1.17 A	45.1 A	3.19 A	19.6 A
Multispecies	13.6 A	22.7 A	1.11 A	46.5 A	3.64 A	17.9 B
P-Value	0.873	0.615	0.201	0.449	0.252	0.023

[1]Soil respiration (Solvita® burst).

[2]Score based on field assessment. The overall indicator score is based on the sum of 8 indicators (1=degraded, 2=in transition, 3=healthy): soil structure, structure type, surface condition, soil management, soil pores, earthworms, biological activity, and smell. Soil assessment was not completed in 2017 and 2018 as it was originally planned for every other year interval.

*Values with the same letter are not significantly different at a 90% confidence level.

Table 2. 2020 cover crop biomass and green cover for single species and multispecies cover crop treatments. Cover crop biomass measured on May 6, 2020.

	Biomass (lbs./acre)	Green cover (%)
Single species Cover Crop	85.3 A*	3.303 A
Multispecies Cover Crop	14.9 B	0.703 B
P-Value	<.0001	0.0002

*Values with the same letter are not significantly different at a 90% confidence level.

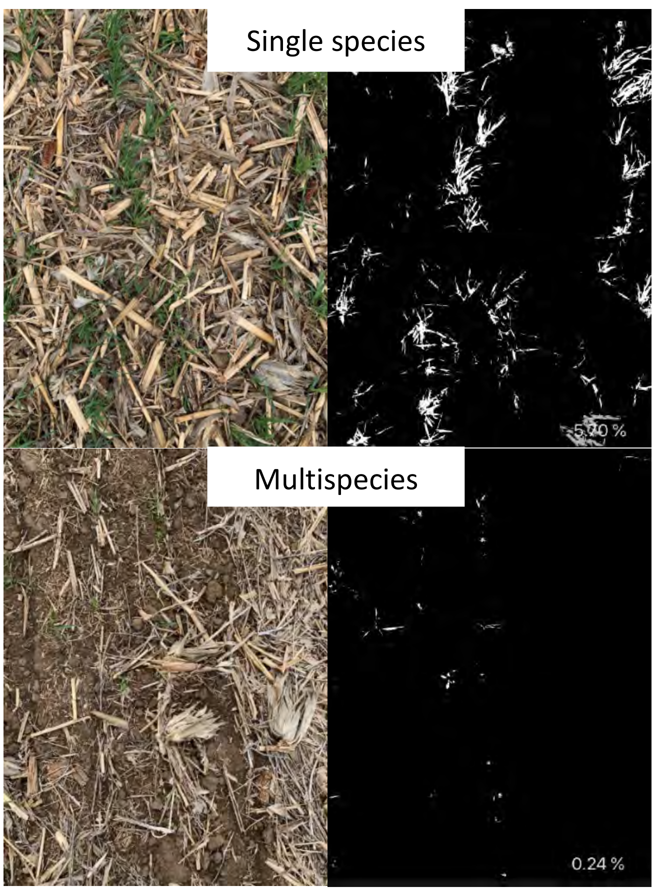


Figure 1. Cover crop green cover of single species (top) and multispecies (bottom) strips displayed as true color (left) and using the Canopeo measurement tool (right). Cover crop biomass measured on May 6, 2020.

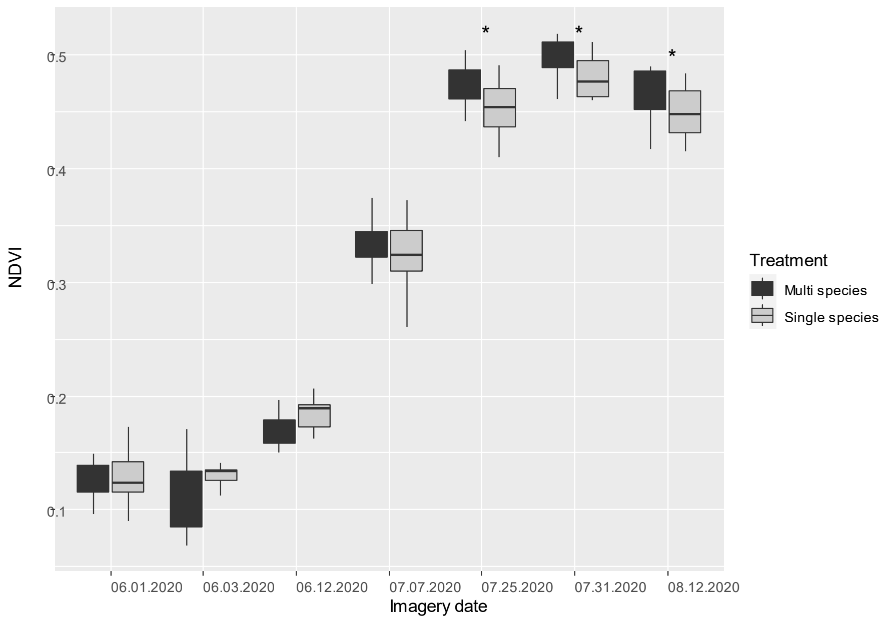


Figure 2. Normalized difference vegetation index (NDVI) values from aerial imagery for the soybean crop following single species and multispecies cover crops. Asterisk (*) within each date indicates significant difference ($p < 0.10$) between single species and multispecies cover crop at a 90% confidence level.

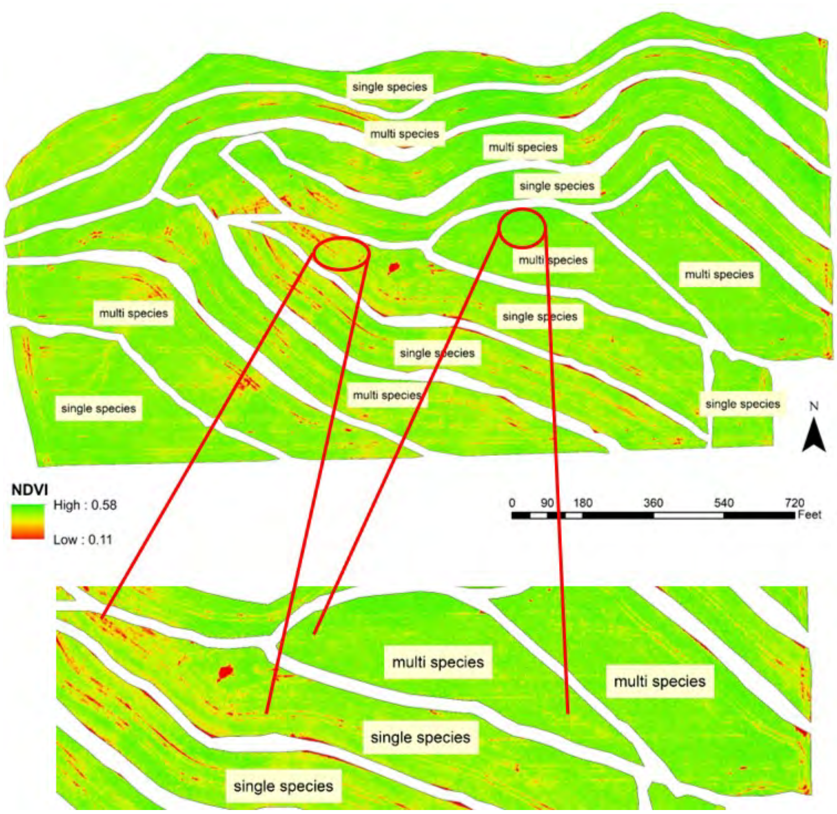


Figure 3. Aerial imagery from July 31 displayed as soybean normalized difference vegetation index (NDVI). Strips with single and multispecies cover crop are indicated.

Table 3. 2020 soybean moisture, yield, and net return for single species and multispecies cover crop treatments.

	Moisture (%)	Soybean Yield (bu/acre)†	Marginal Net Return‡ ($/ac)
Single species Cover Crop	8.25 A*	48.3 B	431 B
Multispecies Cover Crop	7.63 B	55.4 A	495 A
P-Value	0.032	0.0497	0.0589

*Values with the same letter are not significantly different at a 90% confidence level.
†Bushels per acre corrected to 13% moisture.
‡Marginal net return based on $9.50/bu soybean, $27.33/ac for the rye seed and drilling, and $31.34/ac for the mix seed and drilling.

Summary:

- Aerial imagery normalized difference vegetation index (NDVI) analysis showed higher values for soybeans in the multispecies in treatment in late July and early August (Figures 1 and 2).
- Soybeans planted in the multispecies treatment had a higher yield than the single species strips (Table 3). These observations are in agreement with the crop vigor analysis (NDVI) that showed higher values in the multispecies strips.
- Total soil health score was lower for the multispecies treatment both in 2016 and 2020 (Table 1). Results from previous years follow.

Summary of Previous Years

YEAR ONE | In year one, cover crops were drilled in October 2016. The single species cover crop was 50 lb/ac rye. The cover crop mix consisted of 35 lb/ac Elbon rye, 0.5 lb/ac Bayou kale, 0.5 lb/ac Impact forage collards, 0.5 lb/ac Trophy rapeseed, 0.5 lb/ac purple top turnip, 0.5 lb/ac African cabbage, 3.5 lb/ac hairy vetch, 30 lb/ac Austrian winter pea, and 2 lb/ac winter lentil. Cover crops were terminated on May 14, 2017, and soybeans were planted on May 25, 2017, and harvested on September 29, 2017. Wheat was planted in October 2017. Wheat yield was obtained for each treatment using yield monitor data with a 15' buffer applied to the treatments. There was no difference in wheat yield or moisture for the monoculture versus cover crop mix. The field was hailed on June 23, 2018.

Table 4. 2018 wheat moisture and yield for single species and multispecies treatments.

	Moisture (%)	Wheat Yield† (bu/ac)
Single species Cover Crop	14.2 A*	35 A
Multispecies Cover Crop	14.6 A	33 A
P-Value	0.591	0.366

†Yield values are from cleaned yield monitor data. Bushels per acre corrected to 13.5% moisture.
*Values with the same letter are not significantly different at a 90% confidence level.

YEAR TWO | In year two, cover crops were drilled in July 27, 2018, following wheat harvest in July 2018. The single species cover crop was 50 lb/ac cereal rye. The cover crop mix was 30 lb/ac cereal rye, 3 lb/ac red clover, 2 lb/ac rapeseed/canola, and 6 lb/ac hairy vetch. Cover crops were terminated on May 16, 2019, and corn was planted on May 17, 2019. Yield was very close to statistically significant, with the monoculture rye cover crop having a higher yield than the multispecies cover crop. The monoculture rye cover crop had a higher net return.

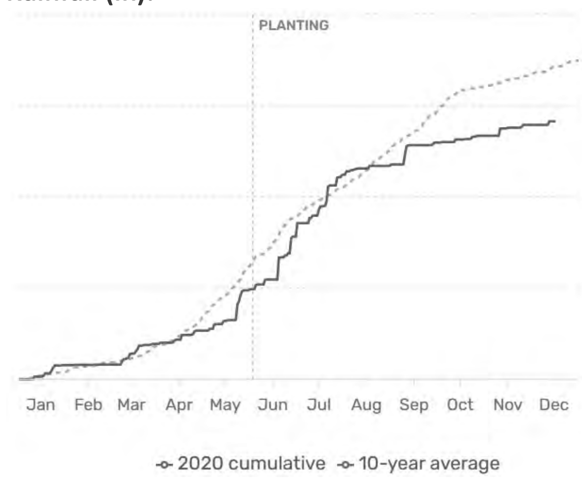
Table 5. 2019 corn yield, moisture, and marginal net return for single species and multispecies treatments.

	Moisture (%)	Corn Yield (bu/ac)†	Marginal Net Return‡ ($/ac)
Single species Cover Crop	20.3 A*	192 A	708.03 A
Multi species Cover Crop	19.9 A	179 A	655.90 B
P-Value	0.317	0.101	0.085

†Yield values are from cleaned yield monitor data. Bushels per acre adjusted to 15.5% moisture.
‡Marginal net return based on $3.83/bu corn, $27.33/ac for the rye seed and drilling, and $31.34/ac for the mix seed and drilling.
*Values with the same letter are not significantly different at a 90% confidence level.

Impact of Mono Cereal Grain versus Multiple Cereal Grains in Cover Crop Mixtures on Subsequent Crop Yield and Soil Quality Indicators, NRCS Demo Farm

Study ID: 0388131202001
County: Otoe
Soil Type: Judson silt loam 2-6% slopes; Pawnee clay loam 4-8% slopes, eroded; Wymore silty clay loam 2-6% slopes
Planting Date: 6/2/20
Harvest Date: 10/14/20
Population: 167,000
Row Spacing (in): 10
Hybrid: Channel® 3.1-3.2
Reps: 4
Previous Crop: Cool season forage for hay
Tillage: No-Till
Herbicides: ***Pre:*** Roller-Crimper on 6/2/20 ***Post:*** 14 oz/ac Mad Dog® K6, 42 oz/ac Noventa™, 2.5 lb/ac AMS, 5 lb/ac ARRAY® on 7/14/20
Seed Treatment: None
Foliar Insecticides: None
Foliar Fungicides: None
Fertilizer: 24 lb/ac N, 13 lb/ac P, 30 lb/ac K, 15 lb/ac S applied on April 21, 2020.
Irrigation: None
Rainfall (in):



Introduction: This study is being conducted on a soil health demonstration farm as part of the Nebraska USDA/Natural Resources Conservation Service's (NRCS) Soil Health Initiative, and involves the farmer, the Nebraska On-Farm Research Network, and the USDA/NRCS. The two treatments, a cover crop mixture with one cereal grain and a cover crop mixture with multiple cereal grains, will be used in this five-year study (2016-2021). 2020 was the fourth year of this study. The cover crop monospecies (60 lb/ac cereal rye) and multiple cereal grain (wheat, triticale, winter barley, spring barley, and oats) were drilled in October 2019, following warm-season forage harvest. Cover crop was terminated on June 6 and 7 by roller crimper. Soybeans were planted in standing green cover crop on June 2, 2020, and harvested on October 14, 2020. Baseline and soil health measures were collected in 2016, 2017, 2018, 2019, and 2020 (Tables 1 and 2).

Results:

Table 1. Soil physical, chemical, and biological properties for cover crop mix with one cereal rye and multiple cereal grains treatments.

Treatment	Infiltration (in/hr)	Soil moisture (%)	Bulk density (g/cm³)	Soil temp. (F)	Soil respiration[1]	Total soil health score[2]
2016 *(1 composite sample collected for all replications of a treatment; samples collected on Oct. 18, 2016)*						
Cover Crop – Rye	9.60	33.3	1.12	57.0	3.0	21.5
Cover Crop – Mix	2.29	37.1	1.18	58.6	2.5	18.0
2018 *(1 sample per treatment replication, n=4 per treatment; samples collected on Nov. 1, 2018)*						
Cover Crop – Rye	1.11 A*	30.1 A	1.07 A	48.5 A	-[3]	22.1 A
Cover Crop – Mix	0.88 A	29.2 A	1.08 A	48.5 A	-	21.6 A
P-Value	0.6038	0.643	0.788	0.959	-	0.670
2019 *(1 sample per treatment replication, n=4 per treatment; samples collected on Oct. 30, 2019)*						
Cover Crop – Rye	2.34 A	26.4 A	1.11 A	42.3A	3.75 A	21.0 A
Cover Crop – Mix	1.32 A	24.3 A	1.14 A	44.5 A	3.50 A	20.5 A
P-Value	0.419	0.279	0.514	0.365	0.604	0.2522

Table 1 Continued

Treatment	Infiltration (in/hr)	Soil moisture (%)	Bulk density (g/cm^3)	Soil temp. (F)	Soil respiration[1]	Total soil health score[2]
2020 *(1 sample per treatment replication, n=4 per treatment; samples collected on Oct. 20, 2020)*						
Cover Crop – Rye	27.5 A	20.5 A	1.22 A	50.6 A	3.25 A	21.7A
Cover Crop – Mix	23.6 A	21.2 A	1.19 A	50.4 A	2.62 B	19.9 A
P-Value	0.892	0.8838	0.235	0.6928	0.0796	0.50

[1]Soil respiration (Solvita® burst).
[2]Score based on field assessment. The overall indicator score is based on the sum of 8 indicators (1=degraded, 2=in transition, 3=healthy): soil structure, structure type, surface condition, soil management, soil pores, earthworms, biological activity, and smell.
[3]No test was completed in 2018 for soil respiration.
*Values with the same letter are not significantly different at a 90% confidence level.

Table 2. Haney soil health test from 2016, 2017, 2018, and 2019 for cover crop mix with one cereal rye and multiple cereal grains treatments.

Treatment[1]	Solvita CO_2 Burst (ppm)	Total N (ppm)	Org. N (ppm)	Total Org. C (ppm)	Nitrate (ppm)	Ammonium (ppm)	Inorg. N (ppm)	Org. C:N	Org. N Release (ppm)	Soil Health Score[2]
2016 Baseline	118	27.3	17.9	184	9.3	1	10.2	10.3	17.9	15.05
2017 Cover Crop - Rye	71.8	16.3	12.5	180	2.7	0.1	2.8	14.4	12.5	12.02
2017 Cover Crop - Mix	119.2	20.1	13.5	194	4.7	1.5	6.2	14.4	13.5	15.17
2018 Cover Crop - Rye	136.3	21.7	12.3	199	9	2.5	11.5	16.2	12.3	16.57
2018 Cover Crop - Mix	74.5	23.7	14.1	202	8.7	2.9	11.6	14.3	14.1	12.9
2019 Cover Crop - Rye	66.2 A*	27.4 A	17.4 A	201 A	8.32 A	1.5 A	9.78 A	11.6 A	16.4 A	12.4 A
2019 Cover Crop - Mix	61.1 A	26.2 A	17.4 A	208 A	7.6 A	1.85 A	9.43 A	12.0 A	17.1 A	12.0 A
P-value	0.684	0.637	0.977	0.869	0.649	0.504	0.86	0.548	0.671	0.795

[1]A representative sample was taken from each treatment for Haney soil tests in 2016-2018 and in 2019 one sample was taken per treatment replication (n=4 per treatment), which allowed statistical analysis on treatment effects.
[2]Calculated using the amount of CO_2–C release in 24 h along with a separate procedure from the H3A extract to measure soil concentrations of water-extractable organic C (WEOC) and water-extractable organic N (WEON). SH score = CO_2/10 + WEOC/100 + WEON/10 (Roper et al., 2017).
*Values with the same letter are not significantly different at a 90% confidence level.

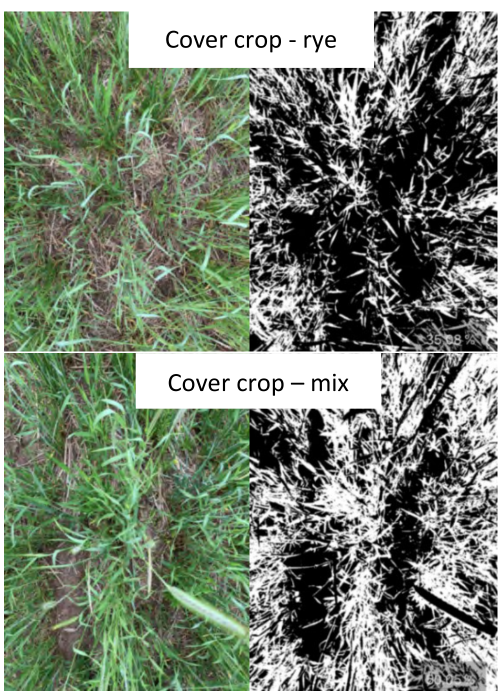


Figure 1. Cover crop green cover of rye (top) and mix (bottom) strips displayed as true color (left) and using the Canopeo measurement tool (right). Cover crop biomass measured on May 20, 2020.

Table 3. 2020 cover crop biomass and green cover for cover crop mix with one cereal rye and multiple cereal grains treatments. Cover crop biomass measured on May 20, 2020.

	Biomass (lbs./acre)	Green cover (%)
Cover Crop – Rye	2652 B*	44.0 A
Cover Crop – Mix	3715 A	48.7 A
P-Value	0.0039	0.3022

*Values with the same letter are not significantly different at a 90% confidence level.

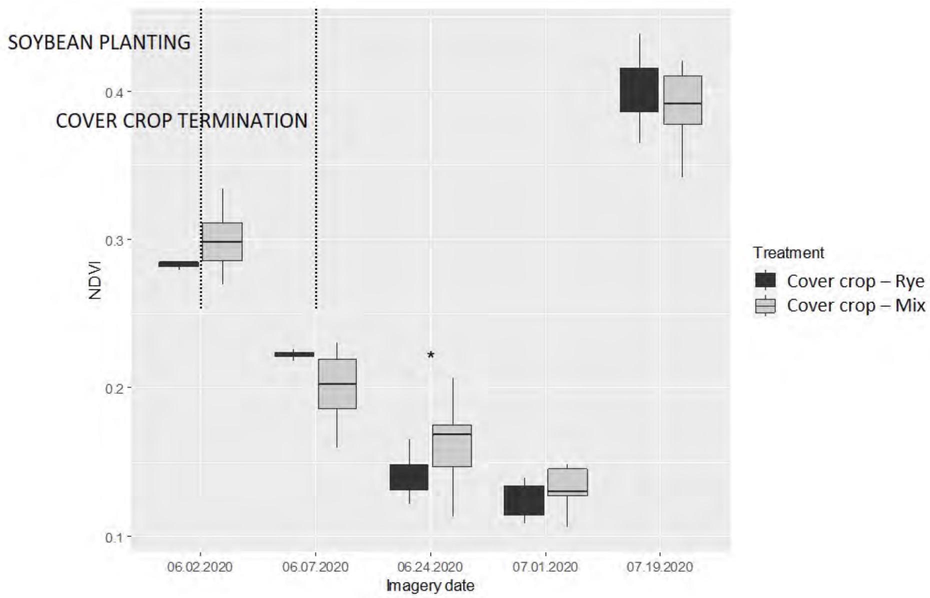


Figure 2. Normalized difference vegetation index (NDVI) values from aerial imagery for the cover crop and soybean crop following mix with one cereal grain and mix with multiple cereal grains cover crops. Asterisk (*) within each date indicates significant difference ($p < 0.10$) between treatments at a 90% confidence level.

Figure 3. Cover crop termination by roller crimper. As the farmer drives over the cover crop, the roller crimper pushes the plants down, crimping the stems every seven inches. Image courtesy: Gary Lesoing.

Table 4. 2020 soybean moisture, yield, and net return for mix with one cereal grain and multiple cereal grains cover crop treatments.

	Moisture (%)	Soybean Yield (bu/acre)†	Marginal Net Return‡ ($/ac)
Cover Crop – Rye	10.5 A	27.8 A	210 A
Cover Crop – Mix	10.4 A	28.1 A	217 A
P-Value	0.647	0.964	0.922

*Values with the same letter are not significantly different at a 90% confidence level.
†Bushels per acre corrected to 13% moisture.
‡Marginal net return based on $9.50/bu soybean, $53.84/acre for cover crop mix with one cereal grain, $50.21/acre for cover crop mix with multiple cereal grains.

Summary:

- There were no differences in most of the soil health parameters between the treatments (2016-2020) (Tables 1 and 2).
- Aerial imagery normalized difference vegetation index (NDVI) analysis after cover crop was roller crimped showed higher values for multiple cereal grains cover crop treatment on June 24. These observations are in agreement with cover crop biomass measurements that showed higher biomass production in the cover crop mix (Table 3 and Figures 1, 2, and 3).
- There were no differences in soybean moisture, yield, or marginal net return between the treatments (Table 4). The late termination timing and dry soil conditions might help explain the low soybean yields. These observations are in agreement with the crop vigor (NDVI) calculated for soybeans that showed no differences between the two cover crop treatments (July 19). Results from previous years follow.

Summary of Previous Years

YEAR ONE | In year one, cover crops were drilled in the fall of 2016. Both mixtures included annual rye, canola, Balansa clover, camelina, vetch, crimson clover, winter lentils, alfalfa, and northern annual field peas. The cover crop mix with one cereal grain included cereal rye as a base whereas the cover crop mix with multiple cereal grains included winter oats, spring barley, winter barley, triticale, wheat, and cereal rye. The cover crops were terminated with glyphosate herbicide on 4/16/17. This is an early termination date relative to the corn planting date of May 7 for the area (NRCS Zone 3). In 2017, there was no significant differences in yield, moisture, or marginal net return for the two treatments.

Table 5. 2017 corn yield, moisture, and net return for soybeans following cover crops with one cereal grain and with multiple cereal grains

	Moisture (%)	Corn Yield (bu/acre)†	Marginal Net Return‡ ($/ac)
Cover Crop – Rye	14.6 A	157 A	421.56 A
Cover Crop – Mix	14.8 A	159 A	432.92 A
P-Value	0.209	0.708	0.588

*Values with the same letter are not significantly different at a 90% confidence level.
†Yield values are from cleaned yield monitor data. Bushels per acre corrected to 15.5% moisture.
‡Marginal net return based on $3.15/bu corn, $53.84/acre for cover crop mix with one cereal grain, $50.21/acre for cover crop mix with multiple cereal grains.

YEAR TWO **|** In year two, cover crops were drilled in late October 2017. The one cereal grain mix included 56 lb/ac cereal rye, 2 lb/ac annual ryegrass, and 1.3 lb/ac canola. The cover crop mix with multiple cereal grains included 10 lb/ac cereal rye, 1.3 lb/ac annual ryegrass, 1.3 lb/ac canola, 10 lb/ac winter barley, 6.7 lb/ac triticale, 10 lb/ac oats, 6.7 lb/ac winter wheat, 8 lb/ac spring barley, and 1.3 lb/ac turnip. The cover crops were terminated with the pre-herbicide application on May 6, 2018. In 2018, there were several challenges to soybean production. Dectes stem borer was evident. There was no rain from July 12 through August 22. Excessive rain after maturity delayed harvest and negatively impacted the crop quality and harvestability. There were no differences in moisture, soybean yield, or net return for the two treatments.

Table 6. 2018 soybean yield, moisture, and net return for soybeans following cover crops with one cereal grain and with multiple cereal grains.

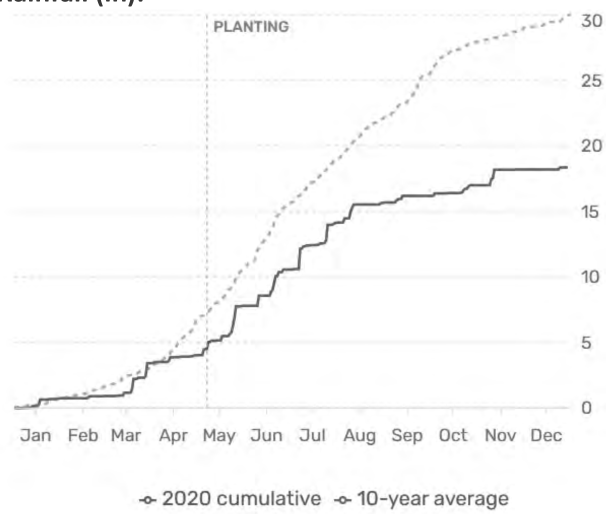
	Moisture (%)	Soybean Yield† (bu/ac)	Marginal Net Return‡ ($/ac)
Cover Crop – Rye	11.3 A	65 A	452.80 A
Cover Crop – Mix	11.2 A	59 B	410.75 B
P-Value	0.200	0.002	0.002

*Values with the same letter are not significantly different at a 90% confidence level.
†Yield values are from cleaned yield monitor data. Bushels per acre corrected to 13% moisture.
‡Marginal net return based on $7.40/bu soybean, $53.84/ac for the one cereal grain mix, and $50.21/ac for the multiple cereal grain mix with multiple cereal grains.

YEAR THREE **|** In year three, Fridge winter triticale and oats (2lb/ac) forage was drilled (November 2018) across all field following soybean harvest. The forage was cut in June 2019. In early July 2019, warm-season forage was drilled (35 lb/ac sorghum-sudangrass, 30.1 lb/ac German millet) and cut and laid in the field in early August and September 2019. No measurements were made on warm-season forage in the monospecies and multispecies cover crop strips.

Impact of Grazed versus Non-Grazed Cover Crops on Subsequent Crop Yield and Soil Quality Indicators, NRCS Demo Farm

Study ID: 0719107202001
County: Knox
Soil Type: Trent silt loam 0-2% slope; Nora silt loam 2-6% slopes; Moody loam 2-6% slopes
Planting Date: 5/7/20
Harvest Date: 9/29/20
Seeding Rate: 27,000
Row Spacing (in): 30
Hybrid: Golden Harvest® E116K4-GH and Pioneer® P0506AM
Reps: 10
Previous Crop: Prevented Plant - Cover Crops
Tillage: No-Till
Herbicides: ***Pre:*** 32 oz/ac Roundup®, 1.6 oz/ac Outlook®, 5 oz/ac Verdict®, and 16.3 oz/ac atrazine on 5/15/20 ***Post:*** 0.10 gal/ac Brazen™ on 6/16/20; 0.15 oz/ac Cadet®, 3 oz/ac Callisto®, and 32 oz/ac Roundup® on 6/25/20
Seed Treatment: None
Foliar Insecticides: None
Foliar Fungicides: None
Fertilizer: 117 lb/ac 12-0-0, 97 lb/ac 10-34-0, 0.26 gal/ac 2-0-0, and 0.15 gal/ac zinc applied with planter on 5/7/20; 168 lb/ac N as 32% UAN with herbicide on 5/15/20; 204 lb/ac 46-0-0, and 133 lb/ac 21-0-0-24 sidedress on 6/16/20
Irrigation: None
Rainfall (in):



Introduction: This study is being conducted on a soil health demonstration farm as part of the Nebraska USDA/Natural Resources Conservation Service's (NRCS) Soil Health Initiative, and involves the farmer, the Nebraska On-Farm Research Network, and the USDA/NRCS. Two treatments are being evaluated in this five-year study: grazed cover crop/forage and non-grazed cover crop. The field was divided into plots approximately 2 acres in size that were assigned as grazed or non-grazed. These plots will be maintained throughout the project (2016-2020). This is the fourth and last year of this study. In July 2018, prevented plant cover crops were drilled and grazed during fall 2018 in the grazing plots. Corn was then planted on May 7, 2020, and harvested on September 29, 2020. Baseline and soil health measures were collected in 2016, 2017, 2018, 2019, and 2020 (Tables 1 and 2).

Results:

Table 1. Soil physical, chemical, and biological properties for non-grazed and grazed cover crop treatments.

Treatment	Infiltration (in/hr)	Soil moisture (%)	Bulk density (g/cm³)	Soil temp. (F)	Soil respiration[1]	Total soil health score[2]
2016 *(1 sample per treatment replication, n=4 per treatment; samples collected on Oct. 20, 2016)*						
Non-grazed	7.8 A*	30.8 A	1.24 A	50.3 A	-	19.6 A
Grazed	29.2 A	27.7 A	1.21 A	51.2 A	-	19.8 A
P-value	0.206	0.424	0.659	0.168	-	0.834
2019 *(1 sample per treatment replication, n=4 per treatment; samples collected on Nov. 8, 2019)*						
Non-grazed	45.0 A	29.2 A	1.11 A	34.3 A	4.62 A	21.8 A
Grazed	22.1 A	33.5 A	1.14 A	33.6 A	4.38 A	21.5 A
P-Value	0.138	0.259	0.831	0.299	0.6042	0.1817

Table 1 Continued

Treatment	Infiltration (in/hr)	Soil moisture (%)	Bulk density (g/cm^3)	Soil temp. (F)	Soil respiration[1]	Total soil health score[2]
2020 *(1 sample per treatment replication, n=4 per treatment; samples collected on Oct. 14, 2020)*						
Non-grazed	26.4 A	10.4 A	1.22 A	50.2 A	3.88 A	22.6 A
Grazed	23.6 A	10.6 A	1.33 A	49.5 A	4.25 A	22.0 A
P-Value	0.869	0.943	0.412	0.587	0.391	0.391

[1]Soil respiration (Solvita® burst).

[2]Score based on field assessment. The overall indicator score is based on the sum of 8 indicators (1=degraded, 2=in transition, 3=healthy): soil structure, structure type, surface condition, soil management, soil pores, earthworms, biological activity, and smell. Soil assessment was not completed in 2017 and 2018 as it was originally planned for every other year interval.

*Values with the same letter are not significantly different at a 90% confidence level.

Table 2. Haney soil health test from 2016, 2017, 2018, and 2019 for non-grazed and grazed cover crop treatments at 0-6 in depth.

Treatment[1]	OM (%)	Solvita CO_2 Burst (ppm)	Total N (ppm)	Org. N (ppm)	Total Org. C (ppm)	Nitrate (ppm)	Ammonium (ppm)	Inorg. N (ppm)	Org. C:N	Org. N Release (ppm)	Soil Health Score[2]
2016 Non-grazed	3	90.2	23.7	15.2	185	7.8	0.5	8.3	12.2	15.2	10.8
2016 Grazed	2.9	41.5	22.5	14.5	178	7.3	1.2	8.5	12.3	9.5	6.6
2017 Non-grazed	3.7	24	29.6	14.5	142	13.6	0.4	14	9.8	9.9	6.7
2017 Grazed	3.7	41	27.8	13.3	137	12.6	0.6	13.2	10.3	13.3	8.2
2018 Non-grazed	3.5	60	12.8	9.3	130	3	2.1	5.1	13.9	9.3	9.5
2018 Grazed	3.4	81.8	12.5	9	117	2.5	2.6	5.1	13	9	11.4
2019 Non-grazed	4.1 A*	70.1 A	19.4 A	9.45 A	113 A	7.17 A	4.9 A	12.05 A	12.1 B	9.45 A	10.21A
2019 Grazed	3.92 A	55 A	13.8 B	7.4 B	102 A	4.95 A	2.8 A	7.72 A	13.8 A	7.4 B	8.27 A
P-value	0.523	0.22	0.0568	0.0455	0.33	0.283	0.291	0.165	0.0392	0.0455	0.176

[1]A representative sample was taken from each treatment for Haney soil tests in 2016-2018 and in 2019 one sample was taken per treatment replication (n=4 per treatment), which allowed statistical analysis on treatment effects.

[2]Calculated using the amount of CO_2–C release in 24 h along with a separate procedure from the H3A extract to measure soil concentrations of water-extractable organic C (WEOC) and water-extractable organic N (WEON). SH score = CO_2/10 + WEOC/100 + WEON/10 (Roper et al., 2017).

*Values with the same letter are not significantly different at a 90% confidence level.

Table 3. 2020 cover crop biomass for grazed and non-grazed treatments. Cover crop biomass measured on May 6, 2020.

	Biomass (lb/ac)
Non-grazed	3632 A*
Grazed	2423 B
P-Value	0.0518

*Values with the same letter are not significantly different at a 90% confidence level.

Table 4. 2020 corn moisture and yield, for grazed and non-grazed cover crop treatments.

	Moisture (%)	Corn Yield (bu/ac)†
Non-grazed	22.3 A	156 A
Grazed	23.6 A	161 A
P-Value	0.356	0.615

*Values with the same letter are not significantly different at a 90% confidence level.

†Bushels per acre corrected to 15.5% moisture.

‡Marginal net return based on $3.51/bu corn.

Summary:

- There were no differences in most of the soil health parameters between the treatments in 2017, 2019, and 2020 (Table 1). Total and organic N and organic N release (N being released through microbial activity from the organic N pool) was higher for non-grazed (Table 2).
- There were no differences in corn moisture and yield between the treatments. The middle part of the field was wet at planting and the seeds ended up damping off. The southern half of the field was harvested as earlage so no yield map is available. Therefore, yield results are from the northern half of the field. Results from previous years follow.

Summary of Previous Years

YEAR ONE | In year one, cover crops were drilled on October 15, 2016, following corn harvest, and the grazed treatments had 100 head of cows grazing for 1 week in April 2017. Field peas were then planted on April 20, 2017, and harvested on July 26, 2017. Cover crops were again planted July 30, 2017 and 180 head of cows grazed from October 20, 2017, through October 28, 2017, in the grazed treatments. Dry forage production was 9,380 lb/ac.

YEAR TWO **|** In year two, winter wheat was planted on November 4, 2017, at a rate of 2 bu/ac. Wheat was harvested July 27, 2018. Winter wheat yield was evaluated for grazed versus non-grazed cover crop treatments. A 30' buffer was applied to the treatments to adjust for GPS drift when laying out fences and recording yield data. In 2018, there was no wheat yield difference for the grazed versus non-grazed treatment.

Table 5. 2018 wheat yield for grazed and non-grazed cover crop treatments.

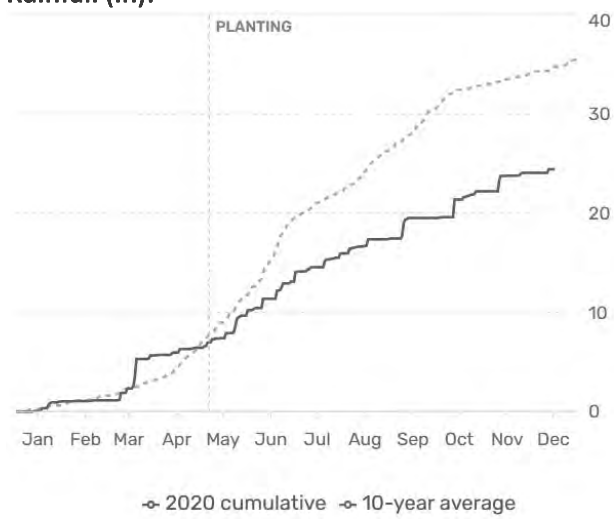
	Wheat Yield† (bu/ac)
Non-grazed	46 A
Grazed	47 A
P-Value	0.220

*Values with same letters are not significantly different at 90% confidence level.
†Yield values are from cleaned yield monitor data.

YEAR THREE **|** In year three, a prevented plant cover crop was drilled on July 8, 2019. Mix was composed of 2.5 lbs/ac pearl millet, 5 lbs/ac Japanese millet, 10 lbs/ac spring oats, 10 lbs/ac winter triticale, and 10 lbs/ac non-GMO soybeans. No yield measurements were made for the non-grazed and grazed cover crop strips.

Incorporation of Small Grain and Cover Crop in a Corn-Soybean Rotation, NRCS Demo Farm

Study ID: 0933053202001
County: Dodge
Soil Type: Nora silty clay 6-11% slopes; Moody silty clay loam 2-6% slopes; Belfore silty clay loam 0-2% slope
Planting Date: 5/6/20
Harvest Date: 9/27/20
Population: 140,000
Row Spacing (in): 15
Hybrid: Mycogen® 289E Enlist E3™
Reps: 4
Previous Crop: Corn
Tillage: No-Till
Herbicides: ***Pre:*** 16 oz/ac ZAAR™, 6 oz/ac Zidua® PRO, 43.98 oz/ac Roundup PowerMAX® on 5/13/20
Post: 31.5 oz/ac Liberty®, 7.25 oz/ac Section® Three, 5.90 oz/ac Superb® HC, 45 oz/ac Warrant®, 2 oz/ac Resource® on 6/26/20
Seed Treatment: Acceleron® E-007 SAT
Foliar Insecticides: None
Foliar Fungicides: None
Fertilizer: None
Irrigation: None
Rainfall (in):



Introduction: This study is being conducted on a soil health demonstration farm as part of the Nebraska USDA/Natural Resources Conservation Service's (NRCS) Soil Health Initiative, and involves the farmer, the Nebraska On-Farm Research Network, and the USDA/NRCS. The traditional crop rotation for this producer is a corn and soybean crop rotation with a cover crop following soybeans and no-till residue management. There is interest in intensifying the cropping system by incorporating a cool-season cash crop such as winter wheat and increasing the amount of time living plants are growing in the field. The two treatments, a check and an intensified system, will be used in this five-year study (2017-2022). The check treatment is a corn and soybean rotation with a cover crop following corn and soybeans. The intensive cropping system is a corn, soybean, small grain rotation with cover crop following each cash crop. Both phases of the rotation (corn-soybean) are present each year. This report focuses on the portion of the field with soybean phase in 2020. For the soybean phase in 2020, wheat straw was baled and removed on July 30, 2019, and sold (intensive system plots). An 8-way mix cover crops (20 lb/ac cereal rye, 2 lb/ac radish, 3 lb/ac sunn hemp, 5 lb/ac African cabbage, 8 lb/ac winter pea, 5 lb/ac common vetch, 5 lb/ac buckwheat, and 10 lb/ac spring oats) were drilled on August 3, 2019 following wheat harvest (intensive system plots) and 65 lb/ac cereal rye on September 29 following corn harvest (check plots). Cover crop was terminated on May 13, 2020. Prior to cover crop termination, soybeans were planted on May 6, 2020, and harvested on September 27, 2020. Baseline and soil health measures were collected in 2017, 2019, and 2020 (Table 1).

Results:

Table 1. Soil physical, chemical, and biological properties for check and intensive system treatments.

Treatment	Infiltration (in/hr)	Soil moisture (%)	Bulk density (g/cm^3)	Soil temp. (F)	Soil respiration[1]	Total soil health score[2]
2017 *(1 sample per treatment replication, n=4 per treatment; samples collected on Nov. 14, 2020)*						
Check	1.42 A	24.8 A	1.04 A	43.5 A	3.17 A	16.7 A
Intensive System	1.44 A	24.8 A	1.07 A	42.8 A	3.17 A	16.3 A
P-Value	0.12567	0.968	0.614	0.510	1.0000	0.802

Table 1 Continued

Treatment	Infiltration (in/hr)	Soil moisture (%)	Bulk density (g/cm^3)	Soil temp. (F)	Soil respiration[1]	Total soil health score[2]
2019 *(1 sample per treatment replication, n=4 per treatment; samples collected on Nov. 6, 2019)*						
Check	2.42 A	27.4 A	1.10 A	39.88 A	4.00 A	18.5 A
Intensive System	7.90 A	25.5 A	1.13 A	39.90 A	3.88 A	19.0 A
P-Value	0.223	0.251	0.602	0.718	0.895	0.252
2020 *(2 samples per treatment replication, n=8 per treatment; samples collected on Nov. 3, 2020)*						
Check	22.1 A	26.1 A	1.21 A	44.2 A	3.38 A	20.1 A
Intensive System	16.7 A	26.4 A	1.15 A	44.4 A	3.00 A	20.2 A
P-Value	0.748	0.784	0.177	0.628	0.377	0.792

[1]Soil respiration (Solvita® burst).

[2]Score based on field assessment. The overall indicator score is based on the sum of 8 indicators (1=degraded, 2=in transition, 3=healthy): soil structure, structure type, surface condition, soil management, soil pores, earthworms, biological activity, and smell. Soil assessment was not completed in 2018 as it was originally planned for every other year interval.

*Values with the same letter are not significantly different at a 90% confidence level.

Table 2. 2020 cover crop biomass and green cover for check and intensive system treatments. Cover crop biomass measured on May 5, 2020.

	Biomass (lbs./acre)	Green cover (%)
Check	358 B	10.7 B
Intensive System	896 A	22.1 A
P-Value	0.0048	0.0196

*Values with the same letter are not significantly different at a 90% confidence level.

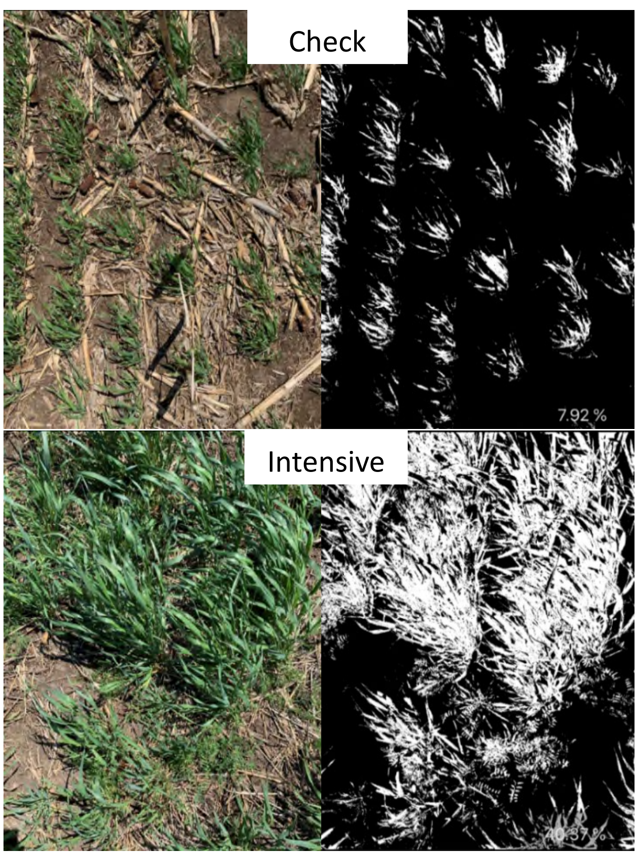


Figure 1. Cover crop green cover of check (top) and intensive system (bottom) strips displayed as true color (left) and using the Canopeo measurement tool (right). Plots where soybean was the 2020 cash crop. Samples collected on May 5, 2020.

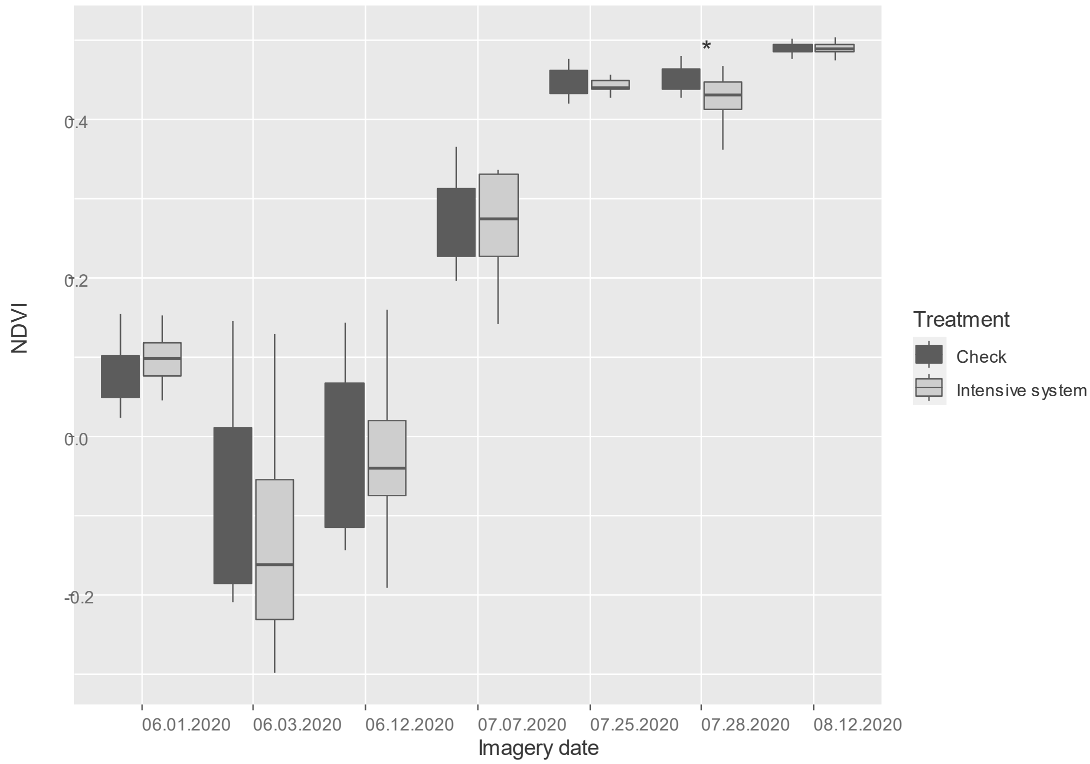


Figure 2. Normalized difference vegetation index (NDVI) values from aerial imagery for the soybean crop following check and intensive management system. Asterisk (*) within each date indicates significant difference ($p < 0.10$) between treatments at 90% confidence level.

Table 3: 2020 soybean moisture, yield, and net return for check and intensive system treatments.

	Moisture (%)	Soybean Yield (bu/ac)†
Check	13.5 A	35.7 A
Intensive System	12.5 A	34.7 B
P-Value	0.005	0.009

*Values with the same letter are not significantly different at a 90% confidence level.
†Bushels per acre corrected to 13% moisture.

Summary:

- June and July were hot, dry, and windy. On June 3, received .10"; on June 9, received .40" rain with strong southwest winds. On Jun 18, received .80" rain. July did not record any measurable rain events.
- Aerial imagery normalized difference vegetation index (NDVI) analysis showed higher values for soybeans in the check treatment on July 28 (Figure 2).
- There were no differences in soil health parameters between the treatments in 2017, 2019, and 2020. However, there is a trend of increases in infiltration rates and total soil health score over time (Table 1)
- Soybeans planted in the check system had a higher yield than the intensive system strips. These observations are in agreement with the crop vigor analysis (NDVI) that showed higher values in the check strips. Results from previous years follow.

Summary of Previous Years

YEAR ONE | In year one, cover crop (35 lbs/ac winter rye) was drilled across both, check and intensive plots, on October 4, 2016, following soybean harvest. Cover crop was terminated on April 12, 2017. Corn was planted on May 7, 2017, and harvested on October 28, 2017. In 2017, corn had no difference in yield and moisture following check or intensive system.

Table 4. 2017 corn moisture, yield, and net return for check and intensive system treatments.

	Moisture (%)	Corn Yield (bu/acre)†
Check	16.4 A	190 A
Intensive System	16.5 A	196 A
P-Value	0.346	0.326

*Values with the same letter are not significantly different at a 90% confidence level.
†Bushels per acre corrected to 15.5% moisture.

YEAR TWO | In year two, following corn harvest in 2017, cover crop (50 lbs/ac of winter rye) was drilled on November 7, 2017, in the check and intensive plots. Cover crop mixes were terminated on April 25, 2018. Soybeans were planted in both treatment strips on May 9, 2018, and harvested on October 20, 2018. In 2018, soybeans had no difference in yield following check or intensive system.

Table 5. 2018 soybean moisture, yield, and net return for check and intensive system treatments.

	Moisture (%)	Soybean Yield (bu/acre)†
Check	11.5 A	54.2 A
Intensive System	11.4 B	56.9 A
P-Value	0.0972	0.2136

*Values with the same letter are not significantly different at a 90% confidence level.
†Bushels per acre corrected to 13% moisture.

YEAR THREE | In year three in the check plots, following soybean harvest, cover crops were drilled on October 24, 2018. The check treatment was a mix of 35 lbs/ac rye, 2 lbs/ac rapeseed, and 1 lbs/ac red clover. Cover crop was terminated on April 23, 2019, then corn was planted on May 12 and harvested on November 1, 2019. In the intensive system plots, wheat was planted following soybean harvest on October 22, 2018, and harvested on July 26, 2019.

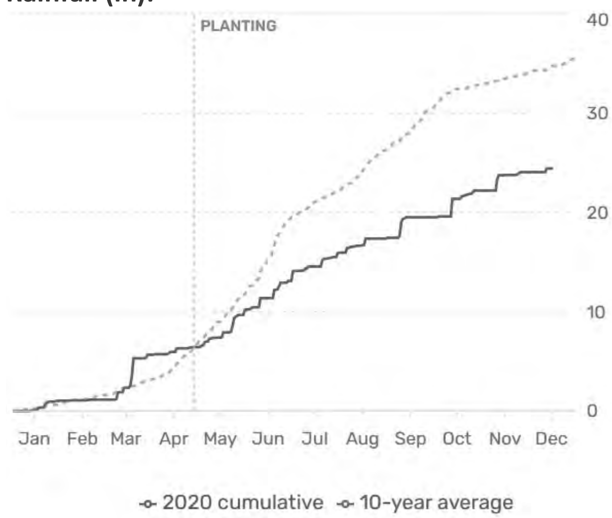
Table 6. 2019 corn and wheat moisture, yield, and net return for check and intensive system treatments.

Treatment	Crop	Moisture (%)	Yield (bu/ac)†
Check	Corn	17.5	167.2
Intensive System	Wheat	11.7	48.2

†Bushels per acre corrected to15.5% (corn) and 13.5% (wheat) moisture.

Incorporation of Small Grains and Cover Crop in a Corn-Soybean Rotation, NRCS Demo Farm

Study ID: 0933053202002
County: Dodge
Soil Type: Belfore silty clay loam 0-2% slope; Nora silty clay loam 6-11% slopes; Moody silty clay loam 2-6% slopes; Moody silty clay loam 2-6% slopes, eroded
Planting Date: 4/28/20
Harvest Date: 10/14/20
Population: 29,000
Row Spacing (in): 30
Hybrid: Channel® 217-41 DroughtGard® VT2P RIB Complete, DEKALB® DKC62-98 VT2P RIB
Reps: 4
Previous Crop: Soybean
Tillage: No-Till
Herbicides: ***Pre:*** 32 oz/ac Roundup PowerMAX® with AMS on 4/23/20 burndown; 1.5 qt/ac Harness® Xtra, 3 oz/ac Balance® Flexx, 1.3 qt/ac Roundup PowerMAX® on 4/30/20 pre-emerge
Post: 16 oz/ac ZAAR®, 32 oz/ac Roundup®, 3 oz/ac Laudis®, and 8 oz/ac atrazine on 6/11/20
Seed Treatment: BAS250
Foliar Insecticides: None
Foliar Fungicides: None
Fertilizer: 176 lb/ac MESZ 12-40-0-10S-1Zn, 50 lb/ac 0-0-60 Potash applied on 12/26/19; 421 lb/ac UAN 32-0-0 on 4/30/20
Irrigation: None
Rainfall (in):



Introduction: This study is being conducted on a soil health demonstration farm as part of the Nebraska USDA/Natural Resources Conservation Service's (NRCS) Soil Health Initiative, and involves the farmer, the Nebraska On-Farm Research Network, and the USDA/NRCS. The traditional crop rotation for this producer is corn and soybean with a cover crop following soybeans and no-till residue management. There is interest in intensifying the cropping system by incorporating a cool-season cash crop such as winter wheat and increasing the amount of time living plants are growing in the field. The two treatments, a check and an intensified system, will be used in this five-year study (2017-2022). The check treatment is a corn and soybean rotation with a cover crop following corn and soybeans. The intensive cropping system is a corn, soybean, small grain rotation with cover crop following each cash crop. Both phases of the rotation (corn—soybean) are present each year in this field. This report focuses on the portion of the field with corn phase in 2020. For the corn phase in 2020, 3-way mix cover crops (35 lb/ac winter rye, 2 lb/ac rapeseed, and 1 lb/ac red clover) were drilled on October 15, 2019 following soybean harvest on both plots (intensive and check). Cover crop was terminated on April 23, 2020. Then corn was planted on April 28, 2020, and harvested on October 14, 2020. Baseline and soil health measures were collected in 2017, 2019, and 2020 (Table 1).

Results:

Table 1. Soil physical, chemical, and biological properties for check and intensive system treatments.

Treatment	Infiltration (in/hr)	Soil moisture (%)	Bulk density (g/cm^3)	Soil temp. (F)	Soil respiration[1]	Total soil health score[2]
2017 *(1 sample per treatment replication, n=4 per treatment; samples collected on Nov. 14, 2020)*						
Check	0.01 A*	24.5 A	1.21 A	41.9 A	3.67 A	12.6 A
Intensive System	0.48 A	23.5 A	1.06 A	42.5 A	3.92 A	15.2 A
P-Value	0.55	0.3471	0.315	0.500	0.678	0.272

Table 1 Continued

Treatment	Infiltration (in/hr)	Soil moisture (%)	Bulk density (g/cm^3)	Soil temp. (F)	Soil respiration[1]	Total soil health score[2]
2019 *(1 sample per treatment replication, n=4 per treatment; samples collected on Nov. 6, 2019)*						
Check	1.84 A	26.8 A	1.06 A	39.92 A	3.12 A	14.9 B
Intensive System	3.20 A	25.8 A	1.06 A	39.95 A	3.00 A	18.5 A
P-Value	0.2692	0.591	0.869	0.718	0.638	0.0721
2020 *(2 samples per treatment replication, n=8 per treatment; samples collected on Nov. 3, 2020)*						
Check	1.36 A	28.7 A	1.14 A	44.1 A	2.94 A	17.8 B
Intensive System	3.46 A	28.7 A	1.14 A	44.0 A	2.94 A	18.6 A
P-Value	0.117	0.969	0.992	0.781	1.00	0.055

[1]Soil respiration (Solvita® burst).

[2]Score based on field assessment. The overall indicator score is based on the sum of 8 indicators (1=degraded, 2=in transition, 3=healthy): soil structure, structure type, surface condition, soil management, soil pores, earthworms, biological activity, and smell. Soil assessment was not completed in 2018 as it was originally planned for every other year interval.

*Values with the same letter are not significantly different at a 90% confidence level.

Table 2. Cover crop biomass and green cover for check and intensive system treatments. Cover crop biomass measured on April 22, 2020.

	Biomass (lbs./acre)	Green cover (%)
Check	602 A*	10.55 A*
Intensive System	507 A	7.28 B
P-Value	0.2160	0.0031

*Values with the same letter are not significantly different at a 90% confidence level.

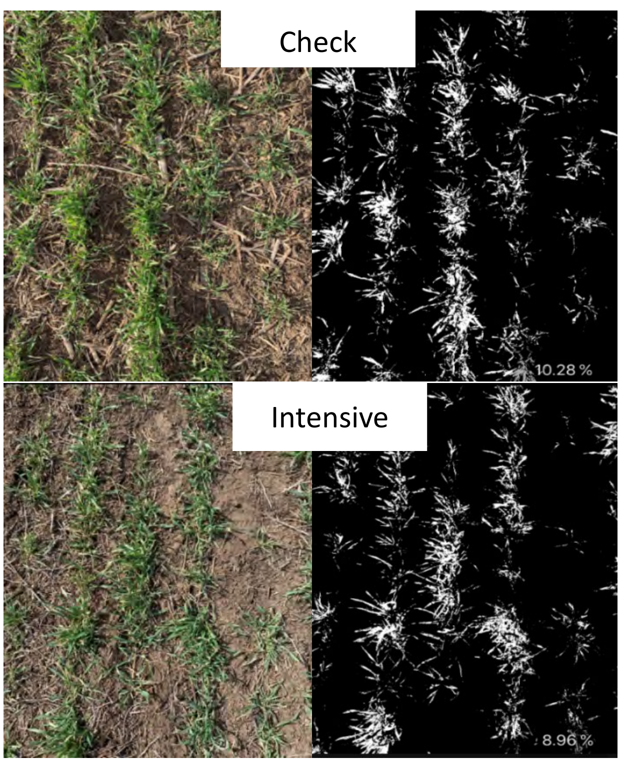


Figure 1. Cover crop green cover of check (top) and intensive system (bottom) strips displayed as true color (left) and using the Canopeo measurement tool (right). Samples collected on April 22, 2020.

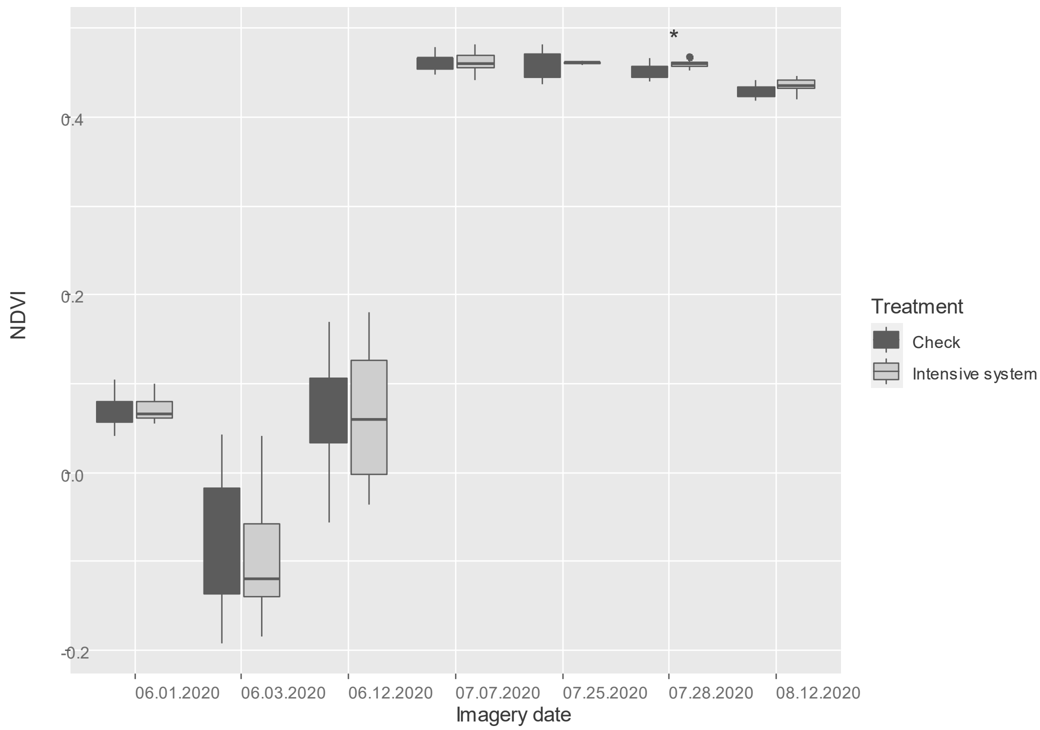


Figure 2. Normalized difference vegetation index (NDVI) values from aerial imagery for the corn crop following intensive management and non-intensive check. Asterisk (*) within each date indicates a significant difference (p < 0.10) between treatments at a 90% confidence level.

Table 3: 2020 corn moisture, yield, and net return for check and intensive system treatments.

	Moisture (%)	**Corn Yield (bu/ac)†**
Check	14.7 A	183 B
Intensive System	14.3 A	202 A
P-Value	0.168	0.00413

*Values with the same letter are not significantly different at a 90% confidence level.
†Bushels per acre corrected to 15.5% moisture.

Summary:

- June and July were hot, dry, and windy. On June 3, the field received 0.10"; on June 9, the field received 0.40" rain with strong southwest winds. On June 18, the field received 0.80" rain. No measureable rain events were recorded in July.
- Aerial imagery normalized difference vegetation index (NDVI) analysis showed higher values for corn in the intensive system treatment on July 28 (Figure 2).
- Total soil health score was lower for the check than the intensive system treatment both in 2019 and 2020.
- Corn planted in the intensive system had higher yield than the check strips. These observations are in agreement with the crop vigor analysis (NDVI) that showed higher values in the intensive system strips. Results from previous years follow.

Summary of Previous Years

YEAR ONE | In year one, soybeans were planted across both, check and intensive plots, on May 10, 2017, and harvested on October 17, 2017. In 2017, soybeans had no difference in yield following check or intensive system.

Table 4. 2017 soybean moisture, yield, and net return for check and intensive system treatments.

	Moisture (%)	Soybean Yield (bu/acre)†
Check	12.9 A	61.3 A
Intensive System	12.1 B	64.2 A
P-Value	0.0331	0.127

*Values with the same letter are not significantly different at a 90% confidence level.
†Bushels per acre corrected to 13% moisture.

YEAR TWO | In year two, following soybean harvest in 2017, cover crop mix of 30 lbs/ac rye, 3.5 lbs/ac radish, 5lbs/ac hairy vetch, 1lbs/ac crimson Clover was drilled on October 18, 2017, in the check plots. Cover crop mixes were terminated on April 28, 2018, with 42 oz. Roundup® burndown application, then corn was planted on May 7, 2018, and harvest on November 1, 2018. In the intensive system plots, wheat was planted on October 18, 2017, and harvested on August 6, 2018. As this was the first time the farmer had planted or harvested wheat, it was not successful as far as weed control and harvest yield. Therefore, no measurements were made on wheat yields in the intensive system strips.

Table 5. 2018 corn and wheat moisture, yield, and net return for check and intensive system treatments.

Treatment	Crop	Moisture (%)	Yield (bu/ac)†
Check	corn	14.5	181.4
Intensive System	wheat	-	-

†Bushels per acre corrected to15.5% (corn) and 13.5% (wheat) moisture.

YEAR THREE | In year three, 20 lbs/ac rye, 2 lb/ac radishes, 0.5 lb/ac African cabbage, 8 lb/ac winter pea, 5 lb/ac common vetch, 3 lb/ac sunn hemp, 5 lbs/ac buckwheat, 10lbs/ac spring oats cover crop mix was drilled on August 7, 2018, following wheat (intensive plots) and 65 lbs/ac rye drilled on November 7, 2018, following corn (check plots) harvest. Plots were sprayed on April 23, 2019, prior to soybean planting. Soybeans were planted on May 14, 2019, and harvested on October 14, 2019. In 2019, soybean yield was higher in the check plots compared to the intensive system plots that followed wheat.

Table 6. 2019 soybean moisture, yield, and net return for check and intensive system treatments.

	Moisture (%)	Soybean Yield (bu/acre)†
Check	13.1 B	49.1 A
Intensive System	13.3 A	46.7 B
P-Value	0.0471	0.087

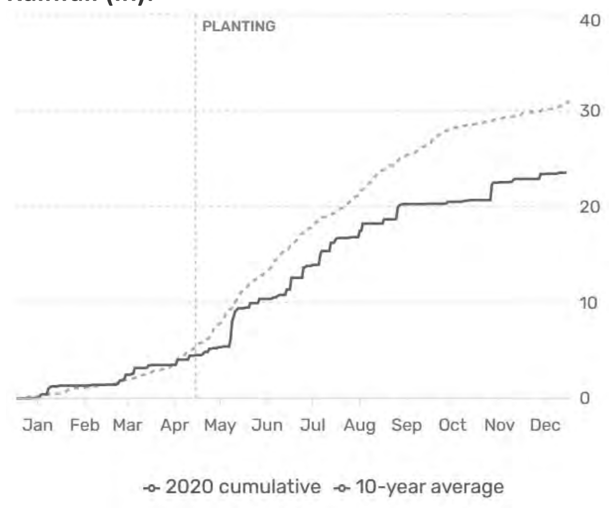
*Values with the same letter are not significantly different at a 90% confidence level.
†Bushels per acre corrected to 13% moisture.

CROP PROTECTION

Evaluating Soybean Seed Treatments for Sudden Death Syndrome in Soybeans

Study ID: 0276185202001
County: York
Soil Type: Hastings silt loam
Planting Date: 5/1/20
Harvest Date: 9/25/20
Seeding Rate: 130,000
Row Spacing (in): 30
Variety: Pioneer® P31A22X
Reps: 8
Previous Crop: Seed Corn
Tillage: Spring tillage, row cultivation, hilling
Herbicides: ***Pre:*** 5 oz/ac Sonic® at planting ***Post:*** 1.5 pt/ac Ultra Blazer®, 1.33 pt/ac Brawl™, and 26 oz/ac Durango® on 6/12/20; 6 oz/ac Targa® on 6/23/20
Foliar Insecticides: 5 oz/ac Hero® on 7/25/20
Foliar Fungicides: 5 oz/ac TOPGUARD® on 7/25/20
Fertilizer: 150 lb/ac MESZ®

Irrigation: Pivot, Total: 3"
Rainfall (in):



Soil Tests (November 2019):

Soil pH 1:1	Soluble Salts 1:1 mmho/cm	Excess Lime Rating	Organic Matter LOI %	Nitrate – N ppm N	Nitrate lb N/ac (0-10")	Mehlich P-III ppm P	Sulfate-S ppm S	Ammonium Acetate (ppm)				CEC me/100g	% Base Saturation				
								K	Ca	Mg	Na		H	K	Ca	Mg	Na
6.9	0.16	NONE	2.7	2.4	7	44	8.3	251	2358	276	40	14.9	0	4	79	15	1
7.0	0.18	NONE	3.0	3.6	11	26	6.7	324	2566	323	32	16.5	0	5	78	16	1

Introduction: Sudden death syndrome (SDS) is caused by the soil—borne fungus *Fusarium solani f. sp. glycines*. In fields where SDS is present and soybean cyst nematode is also present the disease can be more severe. There are not clear guidelines to determine at what point treatment is justified; therefore, on-farm research projects like this one are needed. Additionally, as new seed treatment products become available, evaluations such as this one are needed to help producers evaluate the impact of various treatments. The field in this study has historically had SDS present. The variety used in the study has good SDS resistance, with a company score of 8 out of 9. This study evaluated three seed treatment packages.

A: Base soybean treatment contains CruiserMaxx® and Vibrance® (thiamethoxam, mefenoxam, fludioxonil, and sedaxane).

B: Base soybean treatment plus BASF ILeVO® (fluopyram) at a rate of 2.14 oz/100 lb seed.

C: Base soybean treatment plus Syngenta® Saltro® (pydiflumetofen) at a rate of 1.29 oz/100 lb seed.

Because of the relationship between soybean cyst nematode (SCN) and SDS, samples were taken on May 11 and August 19 in each treatment and replication to estimate initial and mid-season population densities, respectively (Table 1). SCN eggs were extracted and used to calculate the SCN Reproduction factor (Rf) for each treatment. Sudden death syndrome severity and incidence were visually estimated on August 28 and September 4 and used to calculate the SDS Severity Index (Table 1). Early and late season stand counts were also collected (Table 2). Yield, grain moisture, and net return were evaluated (Table 2).

Results:

Table 1. SCN and SDS ratings for baseline, baseline plus ILeVO®, and baseline plus Saltro® treatment.

	SCN Initial Population (P_i) [z] May 11, 2020	SCN Mid-Season Population (P_m) [y] Aug. 19, 2020	SCN Reproduction Factor (Rf) [x]	SDS Disease Severity Index[wv] Aug. 28, 2020	SDS Disease Severity Index[zv] Sept. 4, 2020
Base Treatment	536 A	1716 A	3.6 A	6.4	9.5 A
Base Treatment + ILeVO®	396 A	1440 A	4.2 A	0.6 A	2.5 B
Base Treatment + Saltro®	330 A	629 A	2.3 A	1.1 A	1.2 B
P-Value	0.754	0.296	0.528	0.391	0.005

[z]Data were transformed before analysis with the following formula: Log(x+1).

[y]Data were transformed before analysis with the following formula: √(x+0.5).

[x]Rf=(P_m+1)/(P_i+1). Rf greater than "1" indicates SCN reproduction since the initial sampling date and Rf less than "1" indicates a decline in SCN population densities since the initial sampling date.

[w]Check treatment was excluded from analysis to correct for skewness/kurtosis.

[v]Calculated with the following equation: Index=((Incidence % * Severity Value)/9); the severity value was found with the SIUC Method for SDS Scoring. Plant Dis. 99:347—354. https://apsjournals.apsnet.org/doi/pdf/10.1094/PDIS-06-14-0577-RE

Table 2. Stand counts, grain moisture, yield, and net return for baseline, baseline plus ILeVO®, and baseline plus Saltro® treatment.

	Early Season Stand Count (plants/ac)	Harvest Stand Count (plants/ac)	Moisture (%)	Yield (bu/ac)†	Marginal Net Return‡ ($/ac)
Base Treatment	114,625 A*	127,250 A	11.9 A	83 B	776.69 AB
Base Treatment + ILeVO®	114,750 A	126,375 A	12.0 A	86 A	790.28 A
Base Treatment + Saltro®	112,375 A	123,000 A	11.8 A	83 B	763.45 B
P-Value	0.768	0.175	0.256	0.006	0.023

*Values with the same letter are not significantly different at a 90% confidence level.

†Yield values are from cleaned yield monitor data. Bushels per acre corrected to 15.5% moisture.

‡Marginal net return based on $9.50/bu corn, $12/ac for check seed treatment (CruiserMaxx® and Vibrance®) that all treatments received, $15/ac additional for ILeVO® seed treatment, and $14/ac additional for Saltro® seed treatment.

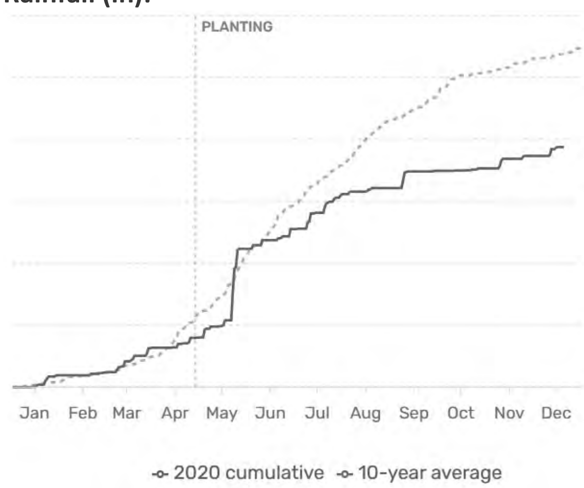
Summary:

- There were no stand count or grain moisture differences between the soybean treatments.
- Yield was 3 bu/ac higher for the ILeVO® treatment. The ILeVO® treatment resulted in a $26.83/ac higher net return than the Saltro® treatment.
- Initial SCN population densities in the plots ranged from 120 to 1,280 SCN eggs per 100 cm^3 (~6 in^3) soil. There were no differences between the treatments on SCN reproduction in this trial.
- ILeVO® and Saltro® seed treatments both reduced SDS Disease Severity Index compared to the base treatment. Overall, SDS severity and incidence were fairly low across the field.

Evaluating Soybean Seed Treatments for Sudden Death Syndrome in Soybeans

Study ID: 1120019202002
County: Buffalo
Soil Type: Hall silt loam; Hord silt loam
Planting Date: 4/28/20
Harvest Date: 9/21/20
Population: 160,000
Row Spacing (in): 30
Hybrid: Pioneer® P25A54X
Reps: 7
Previous Crop: Corn
Tillage: Strip-Till, Ridge-Till
Herbicides: ***Pre:*** 3 oz/ac Fierce®DG, 4 oz/ac metribuzin 75DF, 32 oz/ac Roundup PowerMAX®, 8.5 lb AMS per 100 gal water ***Post:*** 22 oz/ac XtendiMax®, 1.9 qt/ac Warrant®, 32 oz/ac Roundup PowerMAX® with an approved drift control agent and water conditioner

Foliar Insecticides: None
Foliar Fungicides: None
Fertilizer: 5 gal/ac 10-34-0 strip-till in fall
Irrigation: Pivot
Rainfall (in):



Soil Tests (October 2019):

pH	Soluble Salts	Excess Lime	% OM	Nitrate	Nitrate	P	K	S	Zn	Fe	Mn	Cu
				ppm	lb/ac	----------------------ppm--------------------------						
7.5	0.32	None	3	4.3	13	33	488	25.9	2.47	12.7	4	0.6

Introduction: Sudden death syndrome (SDS) is caused by the soil—borne fungus *Fusarium solani f. sp. glycines*. In fields where SDS is present and soybean cyst nematode is also present the disease can be more severe. There are not clear guidelines to determine at what point treatment is justified; therefore, on-farm research projects like this one are needed. Additionally, as new seed treatment products become available, evaluations such as this one are needed to help producers evaluate the impact of various treatments. The field in this study has not historically had high levels of SDS present. This study evaluated three seed treatment packages. The field was scouted for foliar disease symptoms of SDS; however, very few symptoms were seen.

A: Hefty Complete Seed Treatment contains Intego® Suite (1.91 lb/gal clothianidin neonicotinoid insecticide) applied at 3.37 lb fl oz/100 lb seed, 0.282 lb/gal ethaboxam group 22 fungicide, 0.094 lb/gal ipconazole group 3 fungicide, 0.075 lb/gal metalaxyl group 4 fungicide, systemic insecticide, Nutri-Cycle ST biological, and ROOTastic inoculant and extender.

B: Pioneer® Lumisena™ (fungicide) and BASF ILeVO® contains EverGol® metalaxyl group 4 fungicide, penflufen group 7 fungicide, prothioconazole group 3 fungicide at 0.5 fluid oz/140K seeds, Lumisena™ oxathiapiprolin U15 fungicide at 0.284 fl oz/140K seeds, oxathiapiprolin U15 fungicide, 1 fl oz L-2030 G biological fungicide and growth stimulant, imidacloprid neonicotinoid insecticide at 0.8 fl oz/140K seeds, ILeVO® at 1.18 fl oz/140K seeds, and inoculant

C: Bayer® Acceleron® Standard (fungicide and insecticide) and Syngenta® Saltro® contains Acceleron® pyraclostrobin group 11 fungicide at 0.3 fl oz/140K seeds, metalaxyl group 4 fungicide at 0.19 fl oz/140K seeds, fluxapyroxad group 7 fungicide at 0.12 fl oz/140K seeds, imidacloprid neonicotinoid insecticide at 1 fl oz/140K seeds, Saltro® at 0.71 oz/140K seeds, and Exceed inoculant.

Results:

	Early Season Stand Count	Moisture (%)	Yield (bu/ac)†	Marginal Net Return‡ ($/ac)
Hefty Complete Seed Treatment	153,476 A*	9.3 A	60 A	551.15 A
Pioneer® Lumisena™ + BASF ILeVO®	154,381 A	9.1 A	61 A	547.76 A
Bayer® Acceleron® Standard + Syngenta® Saltro®	152,667 A	9.3 A	58 A	528.97 A
P-Value	0.456	0.135	0.314	0.250

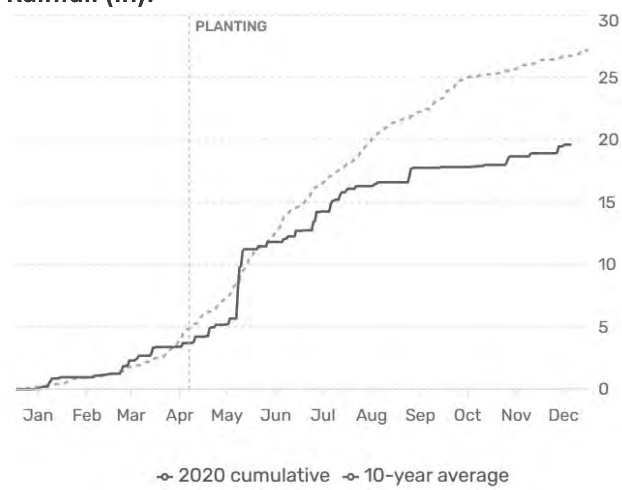
*Values with the same letter are not significantly different at a 90% confidence level.
†Bushels per acre corrected to 13% moisture.
‡Marginal net return based on $9.50/bu soybean, $18.85/ac for Hefty Complete Seed Treatment, $26.85/ac for Pioneer® Lumisena™ with BASF ILeVO®, and $25.02/ac for Bayer® Acceleron® Standard with Syngenta® Saltro®.

Summary: The three seed treatment packages evaluated did not result in differences in stand count, grain moisture, yield, or net return.

Impact of Ethos® XB Fungicide and Insecticide with In-Furrow Starter on Corn

Study ID: 1120019202003
County: Buffalo
Soil Type: Hord silt loam
Planting Date: 4/21/20
Harvest Date: 10/5/20
Population: 34,000
Row Spacing (in): 30
Hybrid: Channel® 216-36 DG VT2RIB
Reps: 8
Previous Crop: Corn
Tillage: Strip-till
Herbicides: ***Pre:*** 1.5 qt/qc Degree Xtra®, 3 oz/ac mesotrione, 32 oz/ac Roundup PowerMAX®, 1% COC, 8.5 lb AMS per 100 gal water ***Post:*** 1.5 qt/ac Resicore®, 1 pt/ac atrazine, 32 oz/ac Roundup PowerMAX®, 8.5 lb AMS per 100 gal water

Fertilizer: 5 gal/ac 10-34-0 and 15 gal/ac 28% UAN with strip-till; 3 gal/ac 10-34-0 in-furrow and 12 gal/ac 32% UAN surface dribble starter; 44 gal/ac 32% UAN sidedress
Note: Green snap on 7/9/20
Irrigation: Pivot
Rainfall (in):

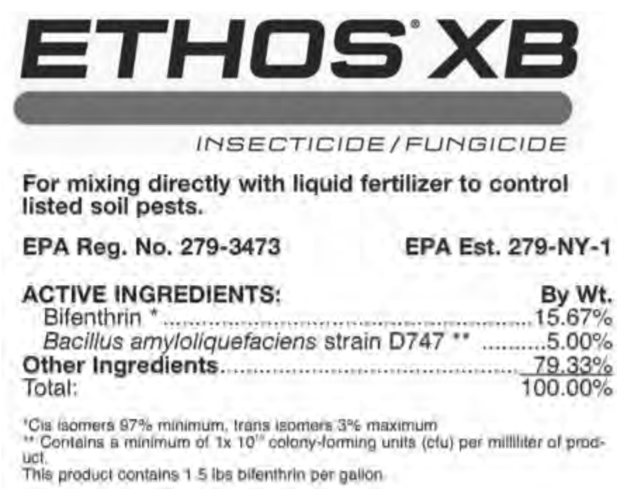


Soil Tests (October 2019):

pH	Soluble Salts	Excess Lime	% OM	Nitrate (ppm)	Nitrate (lb/ac)	P (ppm)
7.8	0.17	Low	2.7	3.8	11	26

Introduction: This study evaluated 4 oz/ac Ethos® XB in-furrow fungicide and insecticide added to 3 gal/ac 10-34-0 starter fertilizer. Ethos® XB product information is at right. Stand counts, moisture, yield, and net return were evaluated.

Product information from:
https://www.cdms.net/ldat/ldCGE005.pdf



Results:

	Early Season Stand Count (plants/ac)	Harvest Stand Count (plants/ac)	Moisture (%)	Yield (bu/ac)†	Marginal Net Return‡ ($/ac)
Check	33,375 A*	29,417 A	19.9 A	249 A	872.99 A
4 oz/ac Ethos® XB	33,125 A	29,875 A	19.9 A	251 A	872.91 A
P-Value	0.598	0.686	0.543	0.554	0.996

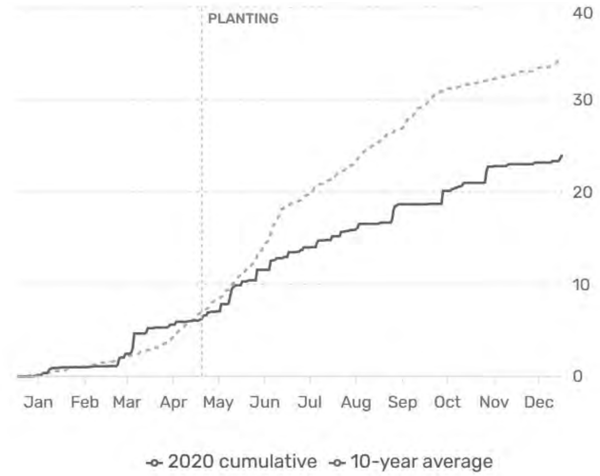
*Values with the same letter are not significantly different at a 90% confidence level.
†Bushels per acre corrected to 15.5% moisture.
‡Marginal net return based on $3.51/bu corn and $8.60/ac Ethos® XB.

Summary: The use of Ethos® XB did not result in different corn stand, moisture, yield, or net return.

Impact of Fungicide and Insecticide Application on Soybeans

Study ID: 0926039202002
County: Cuming
Soil Type: Moody silty clay loam 6-11% slopes; Alcester silty clay loam 2-6% slopes; Moody silty clay loam 2-6% slopes, eroded; Calco silty clay loam occasionally flooded
Planting Date: 5/4/20
Harvest Date: 9/25/20
Seeding Rate: 135,000
Row Spacing (in): 30
Hybrid: Midland Genetics® 2990
Reps: 4
Previous Crop: Corn
Tillage: Disk
Herbicides: ***Pre:*** Treflan® ***Post:*** Enlist®

Fertilizer: None
Irrigation: None
Rainfall (in):



Introduction: This study builds on soybean benchmarking studies the grower has participated in during the 2019 and 2020 growing seasons. These studies examined an "improved" soybean practice of lower soybean seeding rate, earlier planting date, and using foliar fungicide and insecticide applications. The producer's improved practice resulted in a 7.5 bu/ac yield increase in 2019 and a 4.2 bu/ac yield increase in 2020. Because the study tested these factors in combination, it is not possible to determine how much of the yield difference is due to seeding rate, planting date, or fungicide and insecticide use. Therefore, this study evaluated fungicide and insecticide application at the same seeding rate and planting date. The earlier planting date (May 4, 2020) and lower seeding rate (135,000 seeds/ac) from the producer's 2020 benchmarking study was used for all treatments in this study. The study compared no fungicide and insecticide application (check) to 8 oz/ac Delaro® fungicide (active ingredients are prothioconazole and trifloxystrobin) and 8 oz/ac Tundra® Supreme insecticide (active ingredients are chlorpyrifos and bifenthrin) applied on 7/23/20. Little to no insect or disease pressure was noted in the field.

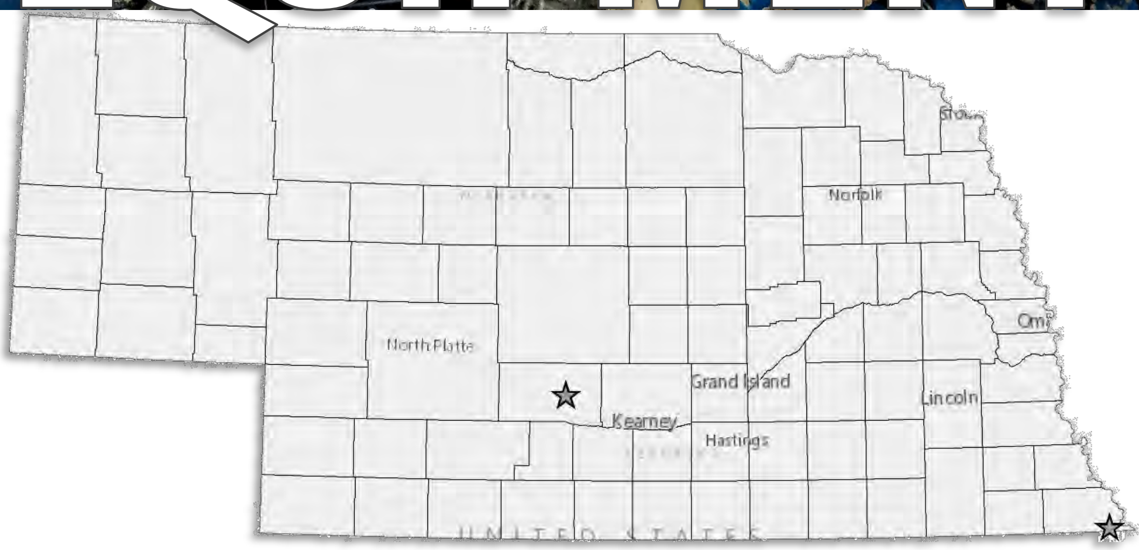
Results:

	Moisture (%)	Yield (bu/ac)†	Marginal Net Return‡ ($/ac)
Check (no fungicide or insecticide)	12.1 A*	55 A	522.62 A
Fungicide & insecticide	12.0 A	56 A	512.34 A
P-Value	0.141	0.683	0.667

*Values with the same letter are not significantly different at a 90% confidence level.
†Bushels per acre corrected to 13% moisture.
‡Marginal net return based on $9.50/bu soybean, $12.50 for fungicide and insecticide, and $7.50 for fungicide and insecticide application.

Summary: There were no differences in soybean moisture, yield, or net return between the check and the soybeans with fungicide and insecticide.

EQUIPMENT


Norfolk
North Platte
Grand Island
Kearney
Hastings
Lincoln

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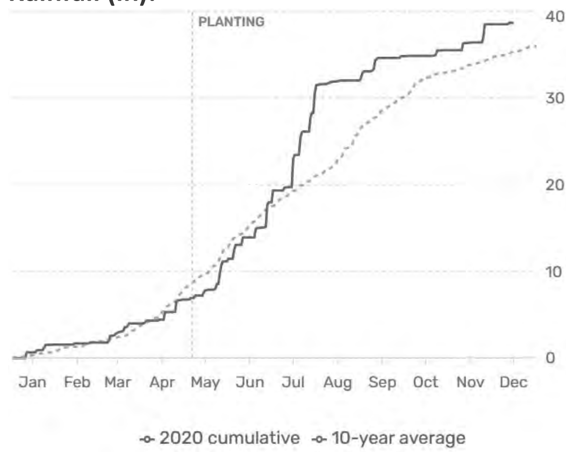
Kinze® True Depth™ Hydraulic Active Downforce vs Manual Downforce

Study ID: 0416147202002
County: Richardson
Soil Type: Zook silty clay loam occasionally flooded
Planting Date: 5/6/20
Harvest Date: 10/8/20
Seeding Rate: 32,000—34,000
Row Spacing (in): 30
Hybrid: Pioneer® P1197
Reps: 4
Previous Crop: Soybean
Tillage: No-Till / Strip-Till
Fertilizer: 180 lb/ac N from anhydrous ammonia on 11/20/19; average of 25 lb/ac N from 11-52-0 variable-rate application on 2/20/20

Irrigation: None
Rainfall (in):



Introduction: When planters use constant, uniform down pressure, varying soil density can result in poor seed depth control. Because of the soil variability, an even distribution of downforce across a planter can lead to uneven planting depth and emergence. Hydraulic active down pressure systems are of interest to reduce sidewall compaction and achieve consistent planting depth across various soil types and conditions. This study evaluated the Kinze® True Depth™ hydraulic active downforce system. The two treatments were:

1) manual pressure setting at a consistent down force of 120 lb in addition to existing unit weight (check)

2) active down pressure set at a custom setting, resulting in a net of 180 lb total downforce between the gauge wheel and the soil surface.

The manual setting of 120 lb down force (check), when combined with existing unit weight resulted in over 300 lb of sensed force (Figure 1). In order to achieve the net of 180 lb total downforce, the active down pressure was lifting up on most row units (Figure 2). Rows 5, 7, 8, and 11 in Figure 2 show where the active down pressure was pushing down; these rows correspond to row units planting behind the planter tractor tires and in sprayer tracks.

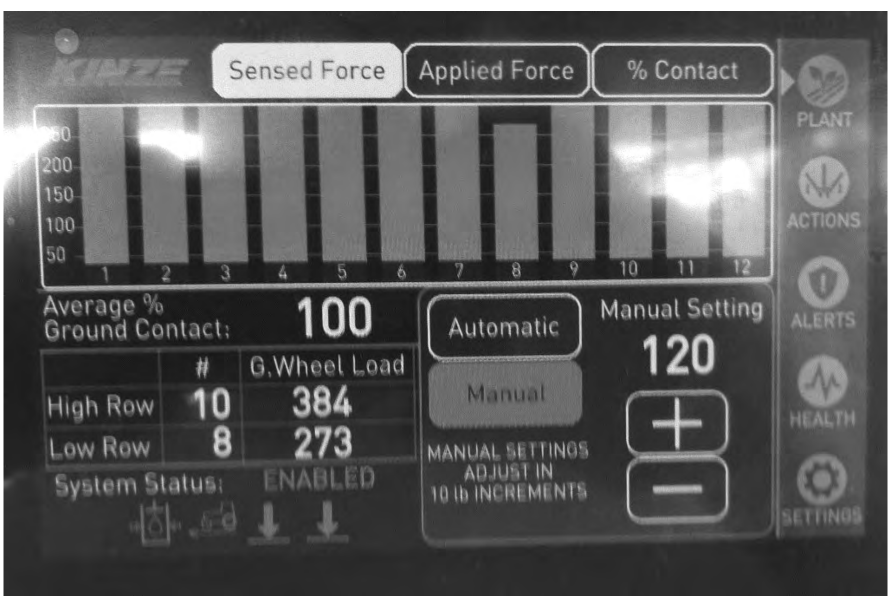


Figure 1. Monitor showing the sensed force for the manual setting. When combined with existing unit weight force, the sensed force was over 300 lb.

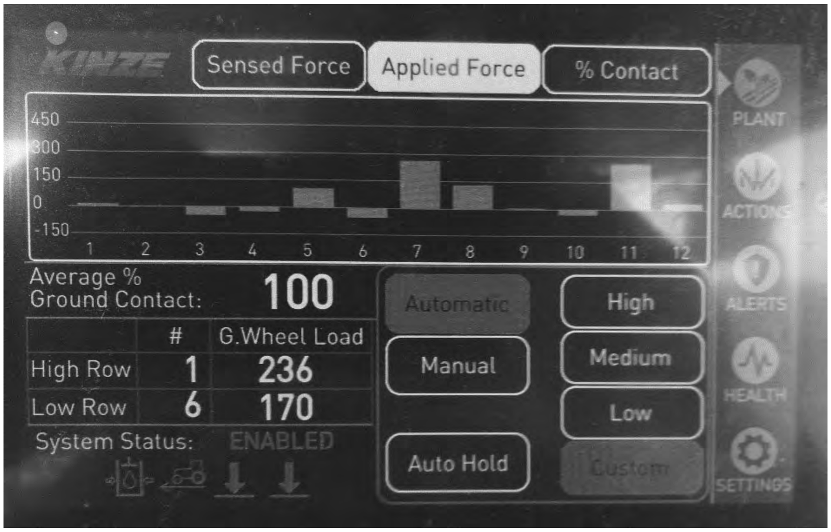


Figure 2. Image of monitor showing the applied force with the automatic down pressure set at 180 lb total downforce.

Emergence counts were taken for one replication as the corn emerged to determine if the active down pressure resulted in a more uniform emergence (Figure 3). Moisture, yield, and net return were also evaluated.

Results:

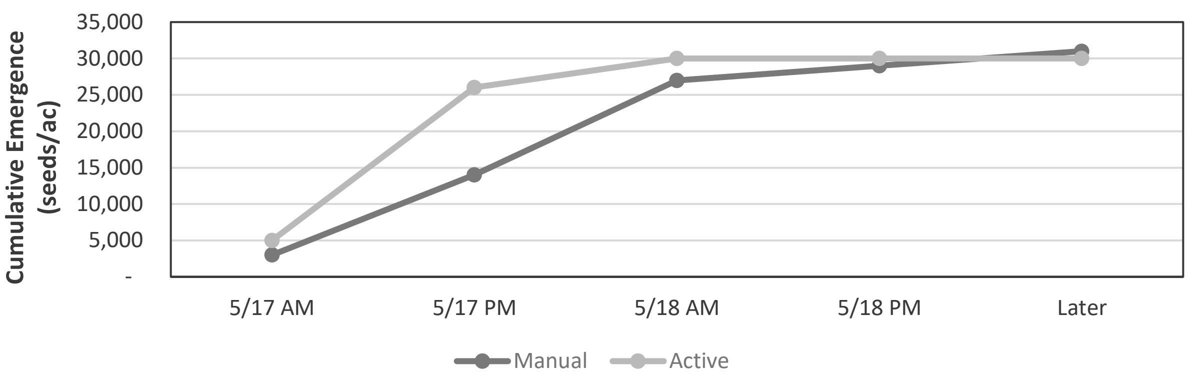


Figure 3. Cumulative emergence by date for manual downforce and active downforce.

	Moisture (%)	Yield (bu/ac)†	Marginal Net Return‡ ($/ac)
Manual Downforce (120 lb/ac)	13.9 A*	233 A	818.03 A
Active Downforce	13.6 A	235 A	820.17 A
P-Value	0.316	0.234	0.676

*Values with the same letter are not significantly different at a 90% confidence level.
†Yield values are from cleaned yield monitor data. Bushels per acre corrected to 15.5% moisture.
‡Marginal net return based on $3.51/bu corn and $4.75/ac for active downforce ($20,000 cost for active downforce system spread over 600 acres and prorated over 7 years).

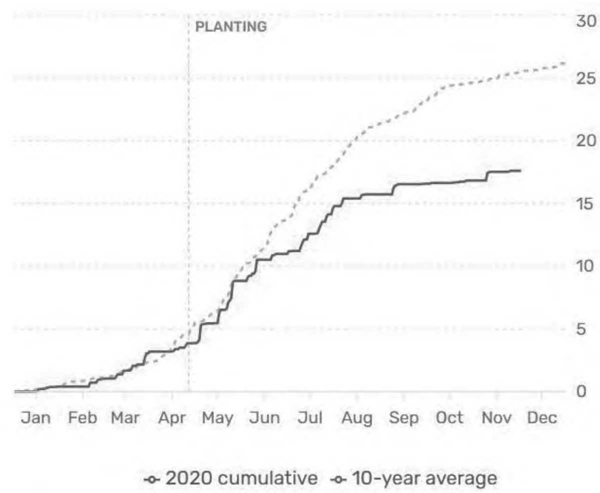
Summary: There were no statistically significant differences in yield, moisture, or net return between the two treatments. Planting was on a tilled strip of soil created by a fall strip-till operation.

Ag Leader® SureForce™ Systems at Different Pressures (Manual vs Medium vs Heavy)

Study ID: 0709047202003
County: Dawson
Soil Type: Cozad silt loam; Hord silt loam
Planting Date: 4/26/20
Harvest Date: 10/24/20
Population: 34,000
Row Spacing (in): 30
Hybrid: Pioneer® P1353Q
Reps: 6
Previous Crop: Corn
Tillage: Strip-Till
Herbicides: ***Pre:*** 2 oz/ac Sharpen®, 24 oz/ac Durango® DMA®, 1 pt/ac atrazine 4L on 4/30/20
Post: 24 oz/ac Durango® DMA® on 6/03/20
Seed Treatment: None
Foliar Insecticides: 5 oz/av bifenthrin 2 EC, 2 oz/ac lambda-cyhalothrin 1 EC on 7/20/20
Foliar Fungicides: 10.5 oz-ac Quilt Xcel® on 7/20/20

Fertilizer: 19 gal/ac 32-0-0, 10 gal/ac 10-34-0, 5 gal/ac 12-0-0-26s on 4/11/20 with strip-till; 1 gal/ac Altura™, 1 gal/ac ReaX™ K, 0.5 gal/ac ReaX™ Mn, 0.125 gal/ac ReaX™ Zn on 4/27/20 in-furrow; 10 gal/ac 32-0-0 on 4/30/20 in burndown; 8 gal/ac 32-0-0, 2 gal/ac 12-0-0-26S on 6/13/20 by chemigation.

Irrigation: SDI, Total: 5.2"
Rainfall (in):



Soil Tests (Dec. 2019):

Soil pH 1:1	Soluble Salts 1:1 mmho/cm	Organic Matter LOI %	KCl Nitrate – N ppm N	Nitrate lb N/A	Mehlich P-III ppm P	$CaPO_4$ SO_4-S ppm	Ammonium Acetate (ppm)				Sum of Cations me/100g	DPTA (ppm)			
							K	Ca	Mg	Na		Zn	Fe	Mn	Cu
6.4	0.4	3.0	13	31	72	5	488	2867	332	38	19	2.1	24.2	14.8	0.7
6.7	0.4	2.8	11	26	53	4	580	2800	358	37	19	1.8	20.1	9.9	0.7
6.7	0.4	2.8	6	14	62	2	600	3287	432	37	19	1.1	19.9	9.0	0.8
6.8	0.4	2.3	9	22	17	2	389	2467	261	31	19	1.0	17.9	10.1	0.6

Introduction: An uneven distribution of downforce across a planter can lead to uneven planting depth and emergence. Hydraulic active down pressure systems are of interest to reduce sidewall compaction and achieve consistent planting depth across various soil types and conditions. This study evaluated the Ag Leader® SureForce™ system. The three treatments were:

1) manual pressure set at a consistent down pressure of 100 lb force (check)

2) active down pressure set at medium, resulting in a net of 100 lb of downforce at the gauge wheel

3) active down pressure set at heavy, resulting in a net of 150 lb of downforce at the gauge wheel.

The field planted at about 6 mph. Emergence counts were taken for each replication on a near-daily basis as the crop emerged to determine if the active down pressure resulted in a more uniform emergence (Figure 1). Early season (V4—V6) and harvest stand counts, moisture, yield, and net return were also evaluated.

Results:

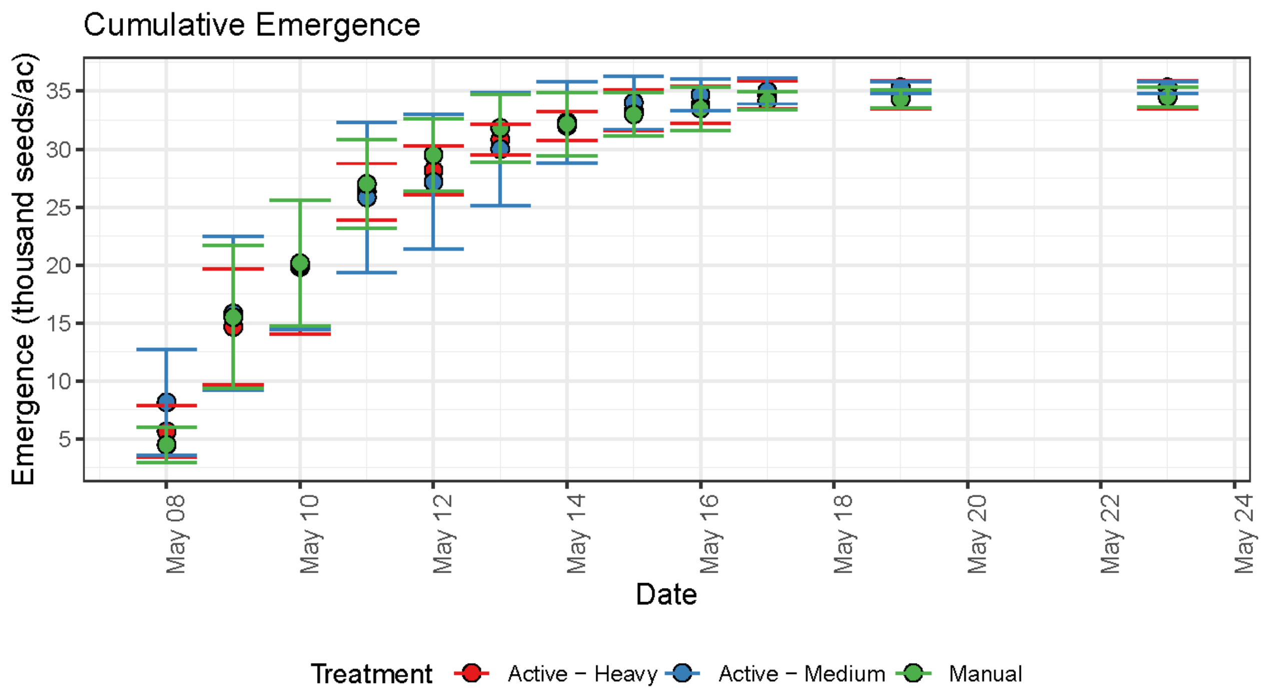


Figure 1. Cumulative emergence by date for manual downforce, active downforce at medium pressure, and active downforce at heavy pressure.

	Early Season Stand Count (plants/ac)	Harvest Stand Count (plants/ac)	Moisture (%)	Yield (bu/ac)†	Marginal Net Return‡ ($/ac)
Manual Downforce (100 lb added)	34,167 A*	32,722 A	17.7 B	224 A	785.16 A
Active Downforce - Medium pressure (Net 100 lb at gauge wheel)	34,667 A	32,389 A	17.7 AB	234 A	820.01 A
Active Downforce - Heavy pressure (Net 150 lb at gauge wheel)	34,278 A	32,056 A	17.7 A	222 A	778.75 A
P-Value	0.364	0.427	0.078	0.270	0.282

*Values with the same letter are not significantly different at a 90% confidence level.
†Bushels per acre corrected to 15.5% moisture.
‡Marginal net return based on $3.51/bu corn and $1.90/ac for active downforce ($20,000 cost for active downforce system spread over 1500 acres and prorated over 7 years).

Summary:

- There were no statistically significant differences in emergence at each date between the three down pressure approaches evaluated.
- There was no difference in stand counts, yield, or net return between the three down pressure systems evaluated.

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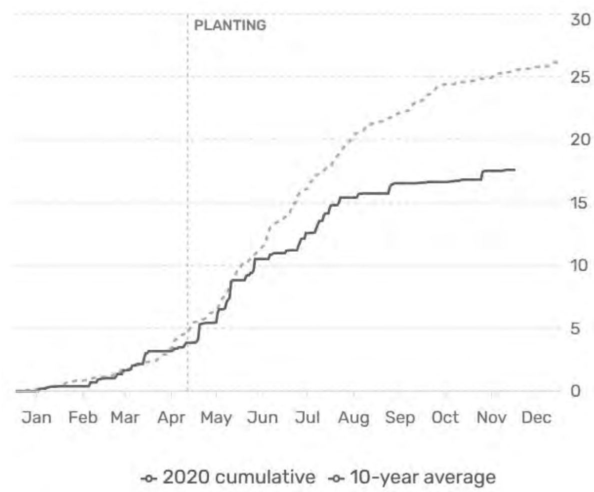
Corn Planting Speed with Ag Leader® SureForce™

Study ID: 0709047202004
County: Dawson
Soil Type: Cozad silt loam; Hord silt loam, 0-1% slope
Planting Date: 4/26/20
Harvest Date: 10/24/20
Population: 34,000
Row Spacing (in): 30
Hybrid: Pioneer® P1353Q
Reps: 5
Previous Crop: Corn
Tillage: Strip-till
Herbicides: ***Pre:*** 2 oz/ac Sharpen®, 24 oz/ac Durango® DMA®, 1 pt/ac atrazine 4L on 4/30/20
Post: 24 oz/ac Durango® DMA® on 6/03/20
Seed Treatment: None
Foliar Insecticides: 5 oz/ac bifenthrin 2 EC, 2 oz/ac lambda-cyhalothrin 1 EC on 7/20/20
Foliar Fungicides: 10.5 oz/ac Quilt Xcel® on 7/20/20

Fertilizer: 19 gal/ac 32-0-0, 10 gal/ac 10-34-0, 5 gal/ac 12-0-0-26s on 4/11/20 with strip-till; 1 gal/ac Altura™, 1 gal/ac ReaX™ K, 0.5 gal/ac ReaX™ Mn, 0.125 gal/ac ReaX™ Zn on 4/27/20 in-furrow; 10 gal/ac 32-0-0 on 4/30/20 in burndown; 8 gal/ac 32-0-0, 2 gal/ac 12-0-0-26S on 6/13/20 by chemigation.
Irrigation: SDI, Total: 5.2"
Rainfall (in):



Soil Tests (Dec. 2019):

Soil pH 1:1	Soluble Salts 1:1 mmho/cm	Organic Matter LOI %	KCl Nitrate – N ppm N	Nitrate lb N/A	Mehlich P-III ppm P	$CaPO_4$ SO_4-S ppm	Ammonium Acetate (ppm) K	Ca	Mg	Na	Sum of Cations me/100g	DPTA (ppm) Zn	Fe	Mn	Cu
6.4	0.4	3.0	13	31	72	5	488	2867	332	38	19	2.1	24.2	14.8	0.7
6.7	0.4	2.8	11	26	53	4	580	2800	358	37	19	1.8	20.1	9.9	0.7
6.7	0.4	2.8	6	14	62	2	600	3287	432	37	19	1.1	19.9	9.0	0.8
6.8	0.4	2.3	9	22	17	2	389	2467	261	31	19	1.0	17.9	10.1	0.6

Introduction: Too high planting speeds coupled with uneven distribution of downforce across a planter can lead to uneven planting depth and emergence. An electric drive system coupled with hydraulic active down pressure systems are of interest to reduce sidewall compaction, achieve consistent planting depth and achieve consistent spacing across various soil types and conditions. This study evaluated the Ag Leader® SureForce™ system coupled with the SureForce™ system and evaluated if faster planting speeds are possible when using an active down pressure system. The standard planting speed of 5 mph was compared with faster speeds of 7 mph and 10 mph. The $1.90/ac treatment cost for the active downforce system was included in net return calculations for the 7 mph and 10 mph planting speeds.

Emergence counts were taken for each replication on a near-daily basis as the crop emerged to determine if the active down pressure resulted in a more uniform emergence (Figure 1). Early season (V4—V6) and harvest stand counts, moisture, yield, and net return were also evaluated.

Results:

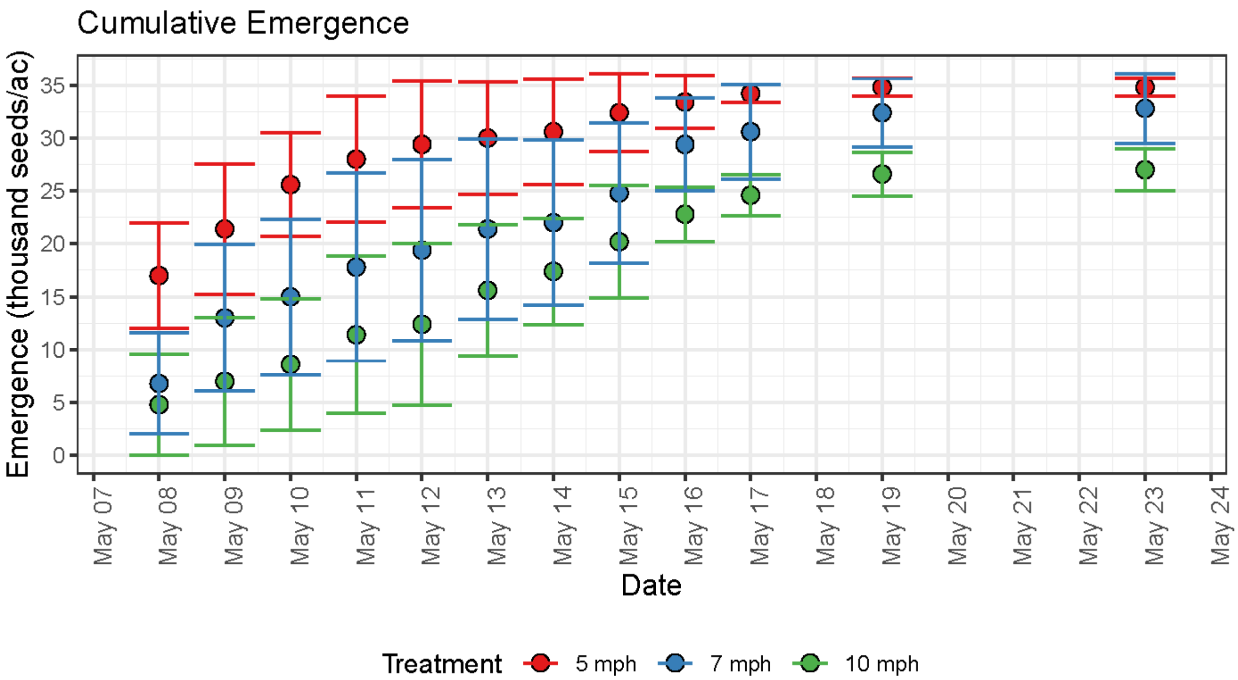


Figure 1. Cumulative emergence by date for 5 mph, 7 mph, and 10 mph planting speeds.

	Early Season Stand Count (plants/ac)	Harvest Stand Count (plants/ac)	Moisture (%)	Yield (bu/ac)†	Marginal Net Return‡ ($/ac)
5 mph	34,067 A*	32,400 A	17.8 A	240 B	841.64 B
7 mph	33,733 A	31,467 A	17.8 A	256 A	895.10 A
10 mph	27,667 B	26,267 B	17.8 A	235 B	821.05 B
P-Value	<0.0001	0.0001	0.546	0.006	0.006

*Values with the same letter are not significantly different at a 90% confidence level.
†Bushels per acre corrected to 15.5% moisture.
‡Marginal net return based on $3.51/bu corn and $1.90 for active downforce for the 7 mph and 10 mph treatment ($20,000 cost for active downforce system spread over 1,500 acres and prorated over 7 years).

Summary:

- The emergence for the 7 mph and 10 mph treatments were initially lower than the 5 mph treatment and continued through May 17. At the final two emergence count dates (May 19 and 23), the 7 mph treatment caught up to the 5 mph treatment, and only the 10 mph treatment lagged in emergence. This is also apparent in the early and harvest stand counts where the 10 mph treatment had lower stand counts than the 5 mph and 7 mph treatments. There were no difference in stand counts between the 5 mph and 7 mph treatments.
- Yield and marginal net return was significantly higher for the 7 mph treatment. It is unclear why the 7 mph treatment, which initially emerged slower than the 5 mph treatment, resulted in higher yields. Additionally, despite the lower final stand count for the 10 mph treatment, there was no yield difference between the 5 mph and 10 mph treatments.

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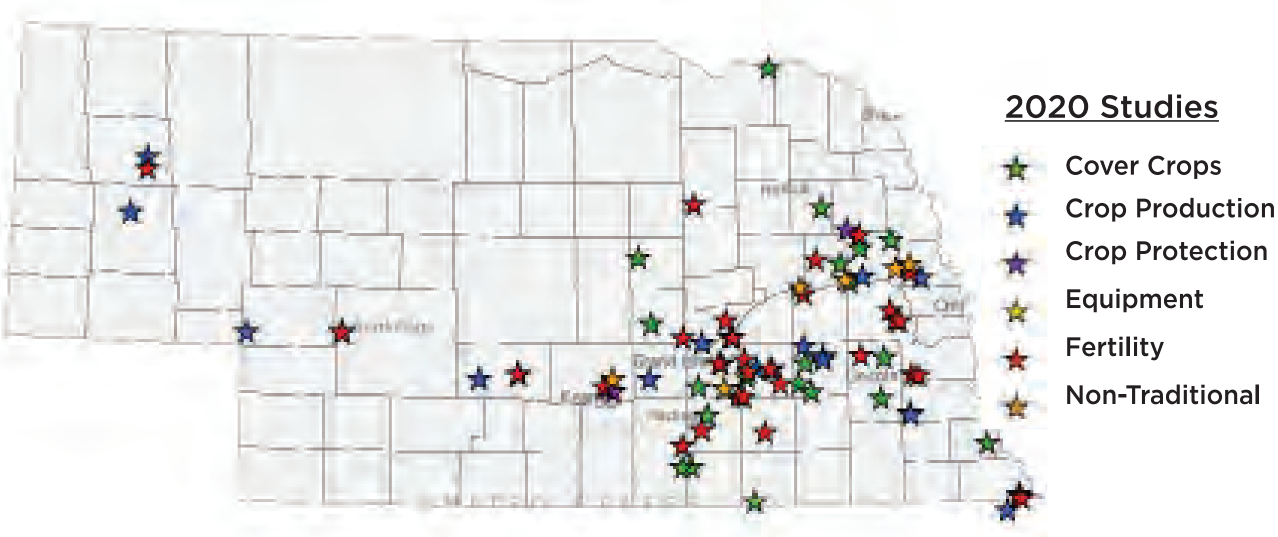

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